FUSION

AT THE FRONTIERS OF SCIENCE AND ENERGY

June 1981

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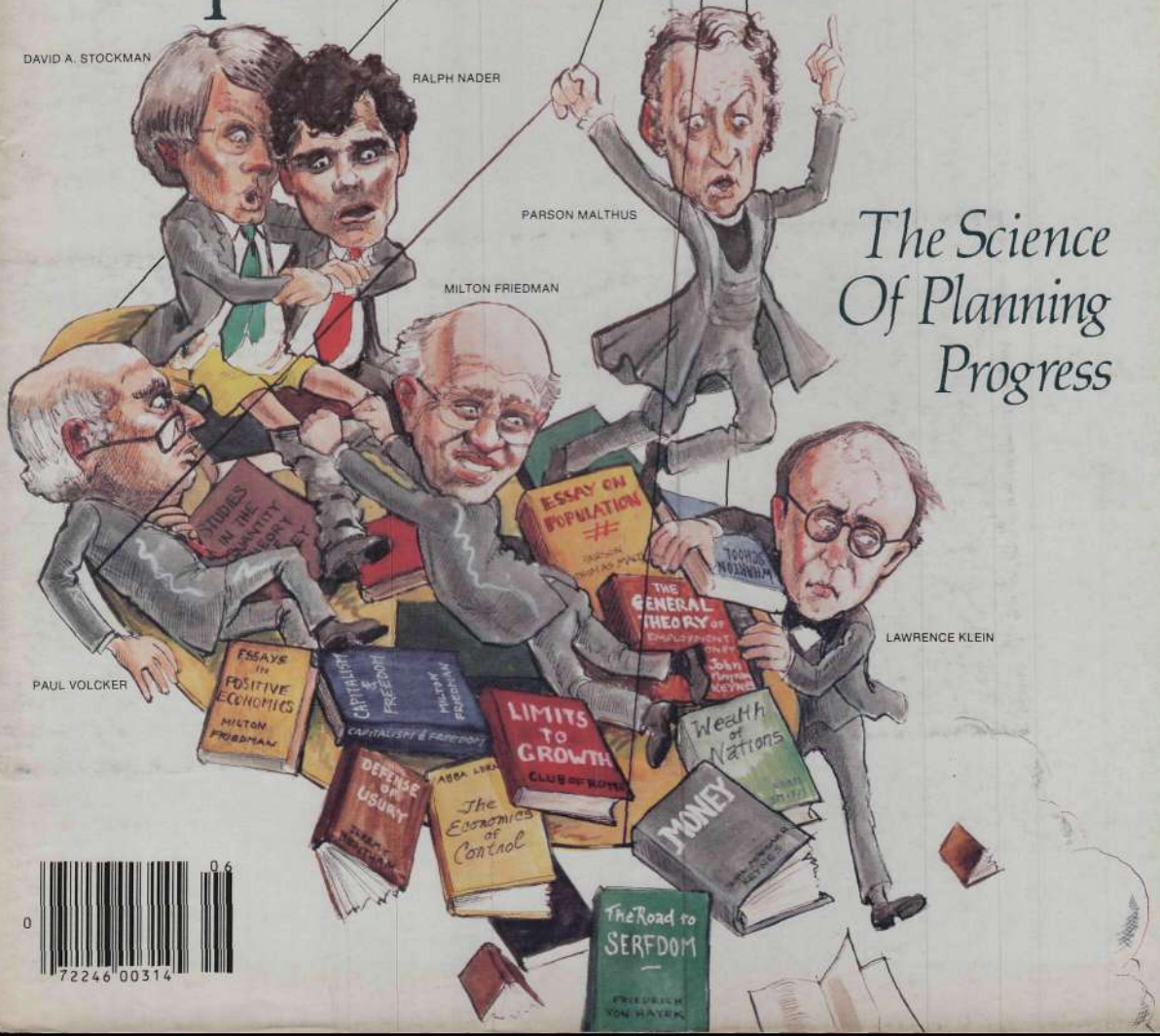
—Special Report—
Reagan's Science Budget

Overturning Equilibrium Economics



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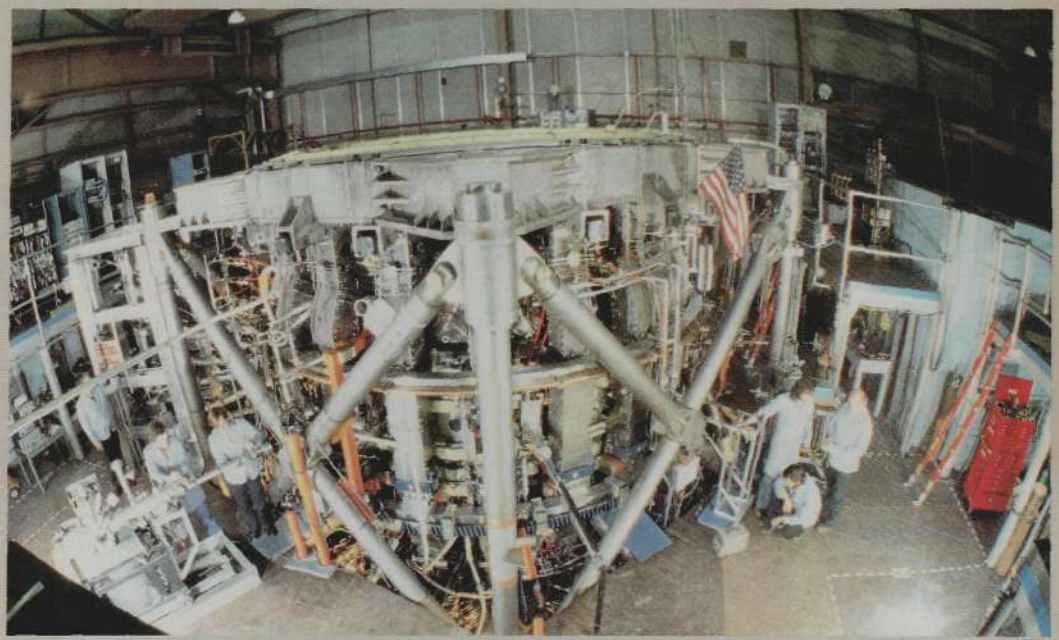

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(2) Launch an unprecedented program of scientific education for our children.

(3) Assure the funds to develop fusion power in the manner mandated by the 1980 fusion act.

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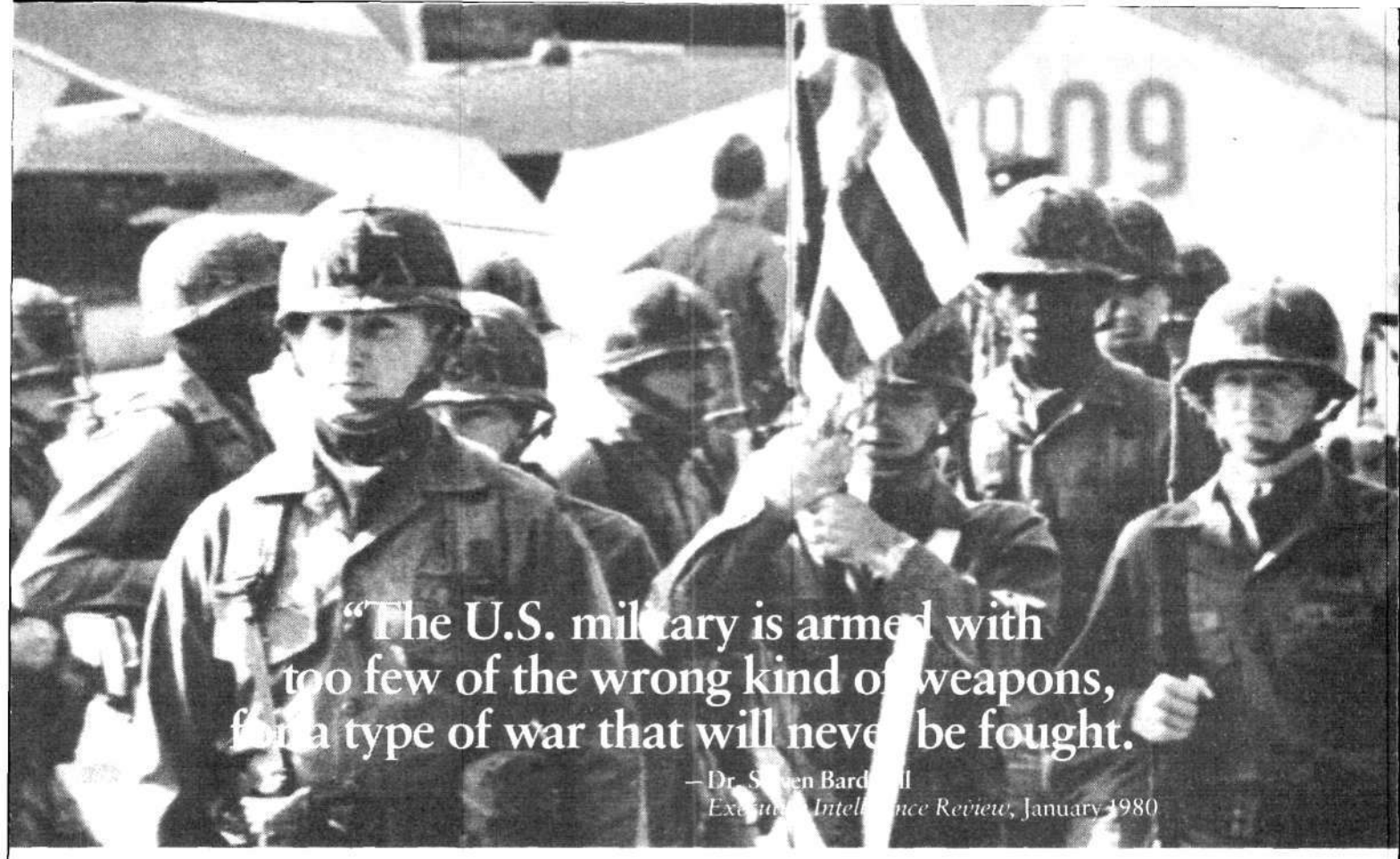

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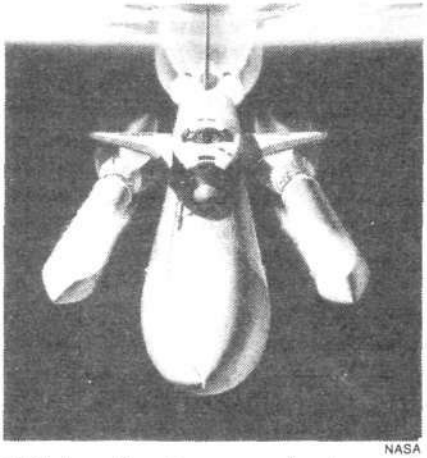
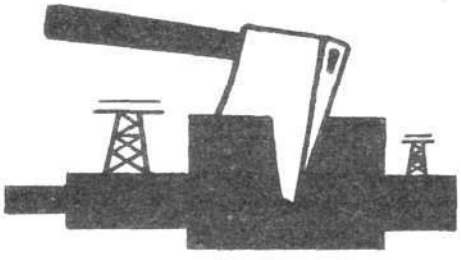


NASA

Within a decade, space shuttle travel could be as common an occurrence as commercial air travel. This issue's picture essay on the shuttle (page 37) describes some of the unique features of the most complex U.S. vehicle. Here, an artist's version of the shuttle ascending.

Features



Reagan's proposed science budget—which makes it impossible to carry out the 1980 fusion legislation—is the subject of Fusion's *Special Report (page 12). This firsthand account by Washington editor Marsha Freeman of the congressional budget hearings includes exclusive coverage of how two Carter holdovers in the DOE are leading an effort to kill the McCormack fusion law.*

News

Departments

Carlos de Hoyos

Don't miss the report on the first Young Scientist conference (page 48), the comments and scientific hypothesis by a father and son who attended, and the story of a tokamak project inspired by The Young Scientist.

From the Editor's Desk

At press time, the fate of the U.S. science budget is still up in the air, and the FEF is continuing its nationwide *science alert* to support full funding for fusion, NASA, advanced technology, and science education. The FEF policy statement on the science budget cuts (which begins in the editorial), lays out in brief what every reader needs to know to convince the "balance-the-budget" armchair economists that cutting science funding is no savings for the U.S. economy. The in-depth answers on how to run a prosperous growth economy are presented in our cover story, "Overturning Equilibrium Economics."

Two other articles round out the U.S. budget picture: Washington editor Marsha Freeman presents an on-the-spot account of the administration's budget maneuvers in the Special Report. And the second installment in our series on the *Global 2000 Report* (page 20) provides chilling evidence that the zero growthers put as little value on human life as they do on science: They are setting out to eliminate both.

We begin our coverage of the space shuttle with the picture essay (page 37). Future coverage will include an on-the-scene report of the upcoming test flight, plus an exclusive interview with shuttle pilot Robert Crippen, a *Fusion* subscriber.

Finally, we call your attention to the FEF News section and the farewell message to readers from Dr. Morris Levitt, who has been the editor-in-chief of *Fusion* magazine since its founding.

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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Fusion Energy Foundation Policy Statement

Science Budget Cuts Threaten Nat'l Disaster

Most Americans who voted for President Reagan last year did so on the basis that he promised to reverse the zero-growth policies of the Carter administration that had gutted science and industry. Yet the budget cuts proposed by the Office of Management and Budget (OMB) in the development of fusion energy and other advanced technologies, in science education, and in the NASA science programs would drastically worsen an already bad situation. Unless Congress and President Reagan reverse the budget-cut proposals by David A. Stockman of the OMB, these projected cuts in science will be a direct threat to the nation's security—as much as any military threat.

Further, delaying the development of fusion and other advanced technologies by cutting their funding will de facto institute the global depopulation and deindustrialization scenarios implicit in the *Global 2000 Report*. This report predicts global ecological holocaust—massive deforestation, dwindling water resources, and drastic changes in the biosphere—causing a massive reduction in population by the year 2000.

Prepared under the Carter administration by the U.S. State Department and the Council on Environmental Quality, *Global 2000* is supported and promoted by Carter holdovers in the government as well as key Reagan officials. Its doomsday projections are based on a denial that science and technology can transform present resources. To quote the report: "[The projections] depict

conditions that are likely to develop if there are no changes in public policies, institutions, or rates of technological advance. . . . The projections assume no revolutionary advances—such as immediate wide-scale availability of nuclear fusion for energy production."[1]

As the FEF has demonstrated using the LaRouche-Riemann econometric model, the chief factor that determines economic recovery and growth is the *rate of technological innovation.*[2] Other approaches to solving the problems of inflation and economic disintegration—Milton Friedman's "free enterprise," the supply-siders' tax-cut incentives, or "cut the fat" budget balancing—simply do not work.

Ironically, as OMB director David A. Stockman was announcing further cuts in science programs, the Soviet Communist Party Congress in Moscow was adopting an economic program along the lines of the American System, with a gear-up of frontier technologies, including fusion, the fusion-fission hybrid, and advanced technologies like magnetohydrodynamics, which can double the efficiency of coal burning.[3]

This policy statement is part of a nationwide science alert called by the Fusion Energy Foundation to mobilize the American scientific community and the majority of Americans who support science and advanced technology to turn this disastrous budget around.

The point that we intend to hammer in here is that it is not possible to support growth and development *and* be in favor of cutting the science budget. These policies are diametrically opposed—a point that has been demonstrated historically and, most recently, in the FEF econometric studies.[2]

Furthermore, we surely should be able to expect of the president and his advisors that they be able to distinguish between cutting science education, for example, and the activities of the Environmental Protection Agency.

The Proposed Cuts

In brief, the fiscal year 1982 budget cuts proposed by David Stockman are as follows:

(1) **Fusion.** A more than 10 percent cut in current dollars (or more than 20 percent in constant dollars) is proposed for the magnetic fusion budget, leaving $460 million out of the $525 million proposed in the Carter budget. This cut violates the mandate of the McCormack fusion bill, passed last year with the overwhelming support of Congress. Specifically, this means that the U.S. fusion program will not be able to begin the engineering phase mandated in the Magnetic Fusion Energy Engineering Act of 1980, which commits the nation to build an engineering demonstration reactor by 1990 and a commercial prototype reactor by the year 2000.

(2) **NASA.** A cut of $603.5 million, 10 percent of the budget, is proposed for the National Aeronautics and Space Administration with continuing budget reductions. This would reduce interplanetary exploration missions and significantly affect the space science programs and international projects.

(3) **Science education.** A cut of $200 million is planned for the National Science Foundation, about 18 percent of the total budget. Most severely affected by this is science education. The Science Education Directorate, which oversees all science education programs—curriculum development, science equipment, scholarships, teacher training, and so forth—is the hardest hit. Instead of the $112 million scheduled, in itself a bare-bones budget, it will receive $10 million, which is simply a phaseout of the graduate fellowship program.

The Policy Question

The Constitution of the United States requires that Congress "promote the progress of science and useful arts." This phrase not only contains instructions for the performance of one of the most essential tasks charged to the federal government; it also makes the crucial distinction between science and "useful arts"—a distinction whose disregard is the hallmark of the current "balanced budget" mania in Washington.

As our founding fathers understood, today's science is tomorrow's useful art; even more, today's science produces the scientists, teachers, engineers, and skilled workers who perform both today's and tomorrow's useful arts.

Continued on page 60

The Lightning Rod

My dear friends,

I understand that the government at London will not suffer our mistaken Assemblies to enforce any law preventing or discouraging the importation of *Narcotick Drugs* from the British Commonwealth tributaries in the Caribbean or elsewhere, for this kind reason: 'That such laws are against the public utility, as they interfere with the *free enterprise necessary for the development of peoples.*' Moreover, it is said, 'When administered by the *invisible hand,* the drugs in question may someday be demonstrated to possess *medicinal properties.*'

Such a tender parental concern in our Mother Country for the welfare of Her Children calls aloud for the highest returns of Gratitude and Duty. This everyone must be sensible of; but 'tis said that in our present circumstances it is absolutely impossible for us to make such returns as are adequate to the favor. I confess it; but nevertheless let us do our endeavor. 'Tis something to show a grateful Disposition.

In some of the unihabited parts of these provinces, there are numbers of these Reptiles we call *Rattlesnakes,* producing a most potent venom with remarkable effects. These creatures whenever we meet with them, we put to death, by virtue of an old law, *Thou shalt bruise his head.* But as this is a sanguinary law, and may seem too cruel; and as however mischievous these creatures are, they may change their natures; and as their venom may yet prove to effect miraculous cures in the right hands; I humbly propose, in the interest of *free trade* and *medical science,* that this general sentence of *death* be changed for *transportation.*

In the spring of the year, when they first creep out of their holes, they are feeble, heavy, slow, and easily taken;

Continued on page 6

Letters

Appropriate Development

To the Editor:

As a development agricultural economist with the Department of Energy in Washington, D.C., I was appalled by some of the misconceptions reflected in your December 1980 issue.

Mr. B. Franklin seems to find amusement in the notion that windmills have applicability in Third World irrigation projects. Actually, the appropriateness of any technology is partially a function of the capital-labor (K/L) ratio. Thus, even though engineering and econometric studies may suggest benefits for the United States in further development of nuclear power, the capital-intensive technologies may not be appropriate for a country like Chad in central Africa with a per capita GDP of about $60 and high levels of unemployment and underemployment.

The article, "Africa: Producing for Debt Payment," (same issue, p. 70) reflects some profound misconceptions with respect to the most rudimentary principles of development economics. Your staff writer made it perfectly clear that he or she didn't understand the USDA's most recent Situation Report for Africa. I defy any member of your staff to find even one agricultural economist with African experience to agree with the last sentence of the article which states: "As a result of this situation, economists at the World Bank and like-minded agencies are now saying that Africa cannot go on importing food and must become self-sufficient in food production—a recommendation that will only aggravate the starvation conditions in Africa."

Fusion magazine has historically demonstrated technical competence in many areas but agricultural economics doesn't appear to be one of them.

C. McKeen Cowles
Brookeville, Md.

The Editor Replies

A complete answer to this letter can be found in this issue's cover story on the LaRouche-Riemann model, which includes a detailed discussion of the problem of industrial development. History certainly shows that a nation cannot develop unless it simultaneously solves the problem of lack of skilled manpower and lack of capital.

The genius of high-technology investments is their high productivity—their capability to train manpower and generate large amounts of new investment funds. Windmills cannot do this.

The ultimate logic of labor-intensive investment as proposed by the World Bank *is* starvation. An op-ed in the March 9, 1981 *New York Times* states quite baldly the genocidal implications of the present investment policies in Africa: "In Africa's future there may be indeed a failure of food production for local consumption. The consequences would be horrific. Any relief program would be overwhelmed. Millions would die in weeks. My guess is that they would go silently to their graves. Then at least the problem of hunger in Africa would be solved."

Lightning Rod

Continued from page 5

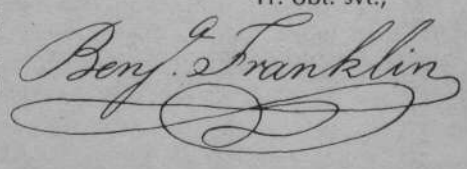
and if a small bounty were allowed per head, some *thousands* might be collected annually, and *transported* to *Britain*. There I would propose to have them carefully distributed in St. James's Park, in the Spring Gardens and other places of pleasure about London; in the gardens of all the Nobility and Gentry throughout the nation; but particularly in the gardens of the Prime Ministers, the Lords of Trade, and Members of Parliament; for to them we are *most particularly* obliged.

There is no human scheme so perfect but some inconveniences may be objected to it. Yet when the conveniences far exceed, the scheme is judged rational, and fit to be executed. Inconveniences have been objected to that good and wise policy by virtue of which *marijuana, cocaine,* and *opium* have been flooding into these Colonies. It has been said that these spoil the Morals of Youth in the neighborhoods that entertain them, and are the true perpetrators of many *horrid crimes*. But let *not private interests* obstruct *public utility*. Our *Mother* knows what is best for us. What is a little Housebreaking, Shoplifting, or Highway Robbing; what is a Son *now and then corrupted* and *hanged*, a Daughter *debauched* and *poxed*, a Wife *stabbed*, a Husband's *throat cut*, or a Child's *brains beat out* with an axe, compared with the 'free enterprise necessary for the development of peoples!'

Thus it may perhaps be objected to my scheme, that the Rattlesnake is a mischievous creature, and that the medicinal properties of his venom are a mere supposition, not yet confirmed by sufficient facts. What then? Is not Example more prevalent than Precept? And may not the honest, rough British Gentry, by a Familiarity with these Reptiles, learn to *creep*, and to *insinuate*, and to *slaver*, and to *wriggle* into place (and perhaps to *poison* such as stand in their way)—qualities of no small advantage to courtiers! In comparison of which 'development of peoples,' what is a *Child now* and then killed by their venomous bite . . . or even a favorite *Lap Dog*?

I would only add, that this exporting of *Narcoticks* to the Colonies may be considered as a Trade, as well as in the light of a *Favor*. Now all commerce implies returns; justice requires them; there can be no trade without them. And *Rattlesnakes* seem the most suitable returns to the *Venom* sent us by our Mother Country. In this, however, as in every other branch of trade, she will have the advantage of us. She will reap equal benefits without equal risk of inconveniences and dangers. For the Rattlesnake gives warning before he attempts his mischief; which the Addict does not. I am

Yr. obt. svt.,



Leo Szilard And the NSF

To the Editor:

In her article, "Piaget's Role in Wrecking U.S. Education" (*Fusion*, May 1981), Mary Gilbertson mentions that Leo Szilard's support for H.G. Wells's World Brain Project eventually led to a Wells-Piaget faction within the National Science Foundation.

I thought you and your readers would be amused to read Leo Szilard's description of the NSF in a short story called "The Mark Gable Foundation," which is included in *The Voice of the Dolphins and Other Stories*, published by Simon and Schuster in 1961.

The narrator has traveled to the future, a world dehumanized by misused science. In the following ironic passage, he talks to Mark Gable, a rich man of 2050:

" 'Would you intend to do anything for the advancement of science?' I asked.

" 'No,' Mark Gable said. 'I believe scientific progress is too fast as it is.'

" 'I share your feeling about this point,' I said with the fervor of conviction, 'but then why not do something about the retardation of scientific progress?'

" 'That I would very much like to do,' Mark Gable said, 'but how do I go about it?'

" 'Well,' I said, 'I think that shouldn't be very difficult. As a matter of fact, I think it would be quite easy. You could set up a foundation, with an annual endowment of thirty million dollars. Research workers in need of funds could apply for grants, if they could make out a convincing case. Have ten committees, each composed of twelve scientists, appointed to pass on these applications. Take the most active scientists out of the laboratory and make them members of these committees. And the very best men in the field should be appointed as chairmen at salaries of fifty thousand dollars each. Also have about twenty prizes of one hundred thousand dollars each for the best scientific papers of the year. This is just about all you would have to do. Your lawyers could easily prepare a charter for the foundation. As a matter of fact, any of the National Science Foundation bills which were introduced in the Seventy-ninth and Eightieth Congresses could perfectly well serve as a model.'

" 'I think you had better explain to Mr. Gable why this foundation would in fact retard the progress of science,' said a bespectacled young man sitting at the far end of the table, whose name I didn't get at the time of introduction.

" 'It should be obvious,' I said. 'First of all, the best scientists would be removed from their laboratories and kept busy on committees passing on applications for funds. Secondly, the scientific workers in need of funds would concentrate on problems which were considered promising and were pretty certain to lead to publishable results. For a few years there might be a great increase in scientific output; but by going after the obvious, pretty soon science would dry out. Science would become something like a parlor game. Some things would be considered interesting, others not. There would be fashions. Those who followed the fashion would get grants. Those who wouldn't would not, and pretty soon they would learn to follow the fashion, too.' "

I would be very interested in any additional observations or insights you have into Dr. Leo Szilard.

Michael Pack
New York, N.Y.

The Author Replies

The short story by Szilard is an excellent example of the gall with which the antiscience faction has historically openly admitted to their tactics. In fact, this "open conspiracy" method was perfected by H.G. Wells, who would propose a policy that would destroy real scientific progress and then write stories about how he intended to carry out this policy.

Every one of Wells's science fiction stories has this same basic plot: A scientific advance causes the destruction of society and then the heroes come in to set up an aristocracy of technocrats, who keep science the property of a small elite while the rest of mankind toils as slaves. Scientific progress is carefully controlled by this chosen group, who approach the rest of society as "magicians."

Here is some background information on Leo Szilard, Wells's disciple; the full story remains to be told:

He worked for years against American science. For example, he tried to enforce total classification of all work in nuclear physics in the U.S. and tried to take over the Manhattan Project.

In addition, he assisted Sidney and Beatrice Webb, the British Roundtable Fabians, in trying to profile and control Albert Einstein. (This same Fabian tradition, by the way, was transmitted by British Fabian leader Friederich von Hayek to the Mont Pelerin Society, which he founded, and then to the Heritage Foundation, which the Mont Pelerin Society founded. Heritage has a hand in shaping the current Reagan administration's science and education policy.)

Szilard also worked for years for the Pan European Union (PEU), which is headed by Otto Von Hapsburg, the pretender to the throne of the Austro-Hungarian Empire. Von Hapsburg publicly endorses and financially supports the antinuclear, antiscience greenies in Europe. The PEU endorses a one-worldist, zero-growth return to feudalism, in which science and technology survive only in "pockets" tied to military-security interests—the H.G. Wells policy.

Mary Gilbertson

'Scientific Civilization' Or Aquarian Technocracy?

To the Editor:

An avid reader of *Fusion* and an advocate of high technology and scientific progress, I was surprised to see "An Interview with Michel Poniatowski: At the Frontiers of a 'Scientific Civilization' " in the May 1981 issue of *Fusion*. Poniatowski's idea that "we are entering . . . a scientific civilization . . . characterized by computers and *télématique*—that is to say, not by the multiplication of man's muscular power, which is characteristic of the machine and of the industrial cycle" reminds me of the Aquarian Conspiracy, which sees the postindustrial information society replacing industrial society.

James Schlesinger's book titled *The Geopolitics of Development* and Zbigniew Brzezinski's "America in the Technetronic Age" present this same viewpoint, that "in the technetronic society industrial employment yields to services, with automation and cybernetics replacing individual operation of machines," according to Brzezinski.

If, as Poniatowski says, the scientific society will replace the industrial society, then it follows that sunset industries like steelmaking should be cut.

Schlesinger, Brzezinski, Alexander Haig, and all the futurists as represented at the World Futures conference in Canada last summer advocate a world progressively depopulated but with lots of electronic garbage and little heavy industry, a computer age of "service" economies and push-button wars.

I also question Poniatowski's attitude toward the Third World. If nuclear is too expensive for them, are they to rely solely on indigenous energy sources such as biomass? Perhaps his division of the world into the "haves" and the "have nots" on the basis of race explains this attitude, which is similar to the *Global 2000 Report*'s policy of genocide for the Third World.

This is especially ironic since Poniatowski is presented as close to Giscard, who initiated the European Monetary System, intended to supply the credits necessary for providing nuclear and other high technology to the Third World. Poniatowski, however, talks about the EMS merely as a system to regularize the international monetary system.

Contrast Poniatowski's views with those of Klaus Knizia of West Germany's Verinigten Electrizitaetswerke, who sees nuclear power as crucial for meeting world energy needs; and Helmut Schmidt, who has promoted the EMS as the vehicle for spreading high technology throughout the Third World; and Jampsin of the French Atomic Energy Commission, who has proposed technology transfer to allow countries like Mexico to reprocess nuclear fuel cheaply.

Mary Kviatkotsky
New York, N.Y.

Optimism for The Future

To the Editor:

Your publication is the first to instill in me optimism for the future of our planet. 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.

Science and the 1st Amendment

To the Editor:

I have just finished reading your article "Science and the First Amendment: Who Is Trying to Silence the FEF?" [*Fusion*, Feb. 1981, p. 51]. I must say it answered a lot of questions for me and cleared away some lingering doubts about the FEF.

You and your private investigations have missed a major link in the chain. In your article you grouped *Our Town, National Review*, Roy Cohn, and William F. Buckley on one side and Larry McDonald on the other. This seems to be an oversight.

I am enclosing supporting evidence for these statements:

Larry McDonald is a member of the John Birch Society. I believe he is on their Council, which is similar to a board of directors.

Roy Cohn is beloved as a hero to the John Birch Society because of his work with McCarthy in the 1950s.

I tie these two men together because Larry McDonald had the article in question, by Gregory Rose [an article published in *National Review* that slandered the FEF], entered in the *Congressional Record*. . . .

The John Birch Society puts out a magazine called *American Opinion*. The issue dated Dec. 1977 has an article which closely parallels Rose's.

Furthermore, to comment on the scientific prowess of the John Birch Society, I cite *The John Birch Society Bulletin*, No. 247, Oct. 1979. It states, "Albert Einstein is a fraud," and continues by arguing in nonscientific terms that the general and special theories of relativity are also false.

These two groups ["right" versus "left"] may be more closely related than you might think. So that no one gets the wrong idea, I am a member in good standing of the John Birch Society and an avid reader of *Fusion*.

Paul Everitt
Huntsville, Ala.

Lousewort Nominee

To the Editor:

It is with much glee and enthusiasm (and only an occasional hopeless sigh) that I nominate the durably irascible Sierra Club for a Lousewort Laurels Award. As reported in the Winter 1980 issue of *Tree Farm News:*

"Tree farmers in several Northwestern states have experienced disruptions of their woods operations by volcanic ash from Mt. St. Helens in Washington. . . . The volcano's initial eruption in May blew down an estimated billion board feet of timber in the 150 square mile area around Mt. St. Helens. When a Sierra Club spokesman proposed that the blown-down timber be left as a 'monument to nature's handiwork,' *The Seattle Times* responded with . . . an editorial declaring the idea as 'the most asinine thought that ever could be.' "

True conservation notes: (1) Unharvested timber blow-downs are a rich breeding ground for bark beetles (*Dendroltonus spp.*), which can infest surrounding healthy trees. (2) They also remain a fire hazard for years. (3) Why let useful wood rot anyway?

May I also cite the same organization for an additional medal—the Order of the Constipated Jackass—for sheer ornery cussedness and obstinacy in refusing (for decades) to budge from their position of hyperenvironmentalism, even when grievously assailed by the slings and arrows of scientific fact and common sense?

I can only hope that Ralph Nader, Cleveland Amory, and Jane Fonda can be present when you bestow this richly deserved award.

Lt. Col. Merrill J. King, Jr., M.D.
Togus, Maine

Viewpoint

Space Supporters and the High-Technology Frontier

Dr. Charles Sheffield

There have been more words written and spoken on behalf of space in the past year than in the previous 10, yet we now face tremendous cuts in the U.S. civilian space program.

Conclusion: space supporters must be doing something wrong.

I believe that this is a fair conclusion, and we do not have to look far to discover what the problem is. Every month, the American Astronautical Society receives letters that say, in essence, "I am in favor of the space program, but I am strongly against nuclear energy." Others write to say, "Space is for the birds, a complete waste of money. Let's use our resources and our brains to solve energy problems here on earth."

It is hard for me to understand the presumed thought processes behind such letters. The U.S. space program and the fusion and fission energy programs are both built on a common base, that of a strong and innovative U.S. technology. In all the glowing talk of the high frontier that space can provide, some people seem to forget that this is a *high-technology* frontier, or it is nothing at all.

You do not go into space by rubbing two sticks together, and you do not build a fusion reactor on a potter's wheel.

Space, energy, computers, particle physics, communications, medicine, and engineering research programs serve two key purposes: They stimulate the general development of science and technology within this country, and they serve as the pacemakers and monitors by which the status of that science and technology can be readily measured. If the revitalization of the American economy is an objective of the Reagan administration, the stimulation and support of technology must be one of the first priorities. Without it, a reborn economy will weaken and lose ground to European and Japanese competition.

Modern technology in all its different expressions is a set of strongly coupled and interdependent activities. If government funding for space, energy, and other leading-edge technologies arose from idealism and wishful thinking, a failure to recognize their interdependence would not matter too much. In practice, however, funding follows the conventional political processes. Space and fusion must compete for government funds and favors with butter and banking and guns and oil and insurance. Unfortunately, there is one big difference. On Capitol Hill, insurance can be relied upon to speak with a single voice. The industry is organized and the priorities have been established before a lobbyist sets foot in a congressman's office. Squabbles are conducted away from the public eye.

United We Stand

Contrast that with science and technology, where there is no lobby and where differences are emphasized more than shared interests. Our efforts cancel instead of complementing each other, and we have not yet learned the old lesson, "United we stand, divided we fall."

We are divided, and we are falling—in budgets and influence, if not in public interest.

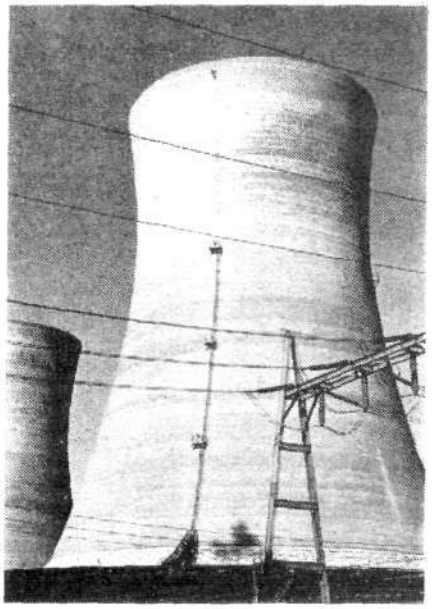
Advocates of particular technologies must learn that they are all on the same side of the argument. Instead of fighting over the distribution of a shrinking pie of funding, we must unite to make the pie grow. We must learn to separate the argument of the disposition of funds from the process of increasing funds for U.S. technology development.

For the next four years, I would like to see the pro-space groups of this country set these goals:

- Stop the arguments of manned versus unmanned programs, of exploration versus exploitation of space, of space colonies versus Mars missions versus solar-power satellites. Replace them with the statement that space development and other high-technology efforts are good for the U.S. economy, with high ultimate returns on investment.
- Build better linkages to other groups outside the space program, with similar interests in technology development.
- Make sure that our words are heard in the right political arena, as much as they are heard by the general public. Lobby for the general program, not for isolated goals within that program.

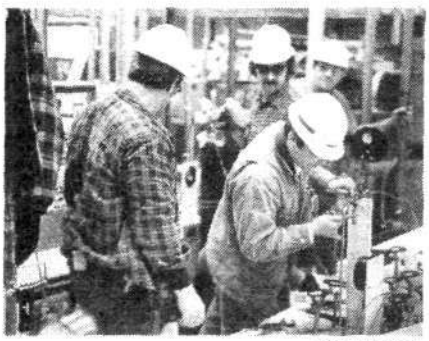
Unless we begin to think in these terms, I think there will be more cuts from space, fusion, and other research in the next few years—and I think that will be our own fault.

Dr. Charles Sheffield is a vice president of Earth Satellite Corporation and the outgoing president of the American Astronautical Society. Born in England and educated at St. John's College, Cambridge, he has been involved in the U.S. space program since 1965, as a consultant to NASA Headquarters, as a NASA principal investigator, and as an expert witness to both House and Senate space committees. In addition to about 50 technical papers and monographs, his publications include two novels and two short-story collections.



Carlos de Hoyos

TMI 1: It costs Pennsylvania residents $14 million a month to keep it shut down.



Carlos de Hoyos

Technicians working on the cleanup of TMI 2, installing a pump to begin pumping out contaminated water.

News Briefs

FEF CAMPAIGNS TO OPEN UP U.S. NUCLEAR PLANTS

The FEF launched a campaign this spring to lower electricity rates across the country by opening up nuclear plants that had been stalled or shut down by the Nuclear Regulatory Commission under the Carter administration. The leading edge of this drive is a campaign to reopen the undamaged Unit 1 at Three Mile Island, the reactor that was down for routine refueling at the time of the accident at Unit 2 in March 1979. The FEF circulated a dossier, titled "Prevent The GPU Rate Increase: Put TMI 1 Back on Line," in Pennsylvania and New Jersey in March, showing that GPU's customers in those areas have been paying an additional $14 million per month for electricity because of the NRC's refusal to license TMI 1.

Ongoing studies by the FEF show that the rise in electricity rates, which is reaching crisis proportions in many areas of the Northeast and Midwest, is in almost every case directly related to the closing of a functioning nuclear plant or holding completed ones off line.

TMI TWO YEARS LATER

A *Fusion* reporter and photographer were among the 60 press representatives who toured the twin reactors at Three Mile Island March 18 at the invitation of General Public Utilities Co. and the TMI staff. The comprehensive tour took reporters right inside TMI 2's auxiliary building and showed them videotapes from the day before of six crewmen entering the damaged reactor's containment building. The technicians were shown greasing and lubricating the valves and installing a pump in the floor below in order to begin the process of pumping out the 600,000 gallons of contaminated water.

The highlight of the tour was a demonstration of TMI 1's advanced control panel technology, developed and installed by the TMI staff and outside consultants. This includes a new computer system that picks out priority alarm signals (this system was about to be installed in both units at the time of the TMI 2 accident); a safety valve monitoring system that shows the position of every valve in the plant; and a panel that gives operators a complete pictorial image of the plant's entire feedwater system at every moment.

In spite of the inch-by-inch firsthand inspection of the facilities afforded to the press, the questions were mostly of a provocative nature, such as "What are the evacuation plans during the cleanup?"

SABOTAGE OF FRENCH NUCLEAR PLANT FEARED

Reliable banking sources in Frankfurt, West Germany fear there may be an incident of nuclear sabotage in France on the eve of the April 26 presidential elections, *La Lettre de la Fusion* reported in March. The monthly newsletter is the new French-language publication of *Fusion*'s cothinkers in France.

According to the banking sources, violent opponents of France's nuclear energy program are preparing a sabotage operation against a nuclear installation in the hopes of provoking a panic over nuclear energy—a French version of Three Mile Island—and influencing the outcome of the French elections. Their desire is to prevent the reelection of President Giscard, who has been strongly pronuclear, in favor of a candidate more amenable to the ecologists and to abandoning France's nuclear push.

SOVIETS SET PRIORITY ON FUSION, FAST BREEDER

At the 26th Communist Party Congress of the Soviet Union in February, which discussed Soviet economic goals for 1981-90, Soviet President Leonid Brezhnev stressed the obligation of the sciences to continually revolutionize technology and production. "Science must itself constantly disturb the peace," he said, "showing which sectors have been stagnating and lagging behind and where the modern level of knowledge enables one to move forward faster." This theme was elaborated in a newspaper article Feb. 21 by Soviet Academy

of Sciences President A.P. Aleksandrov. Writing in *Izvestia* just before the party congress opened, Aleksandrov said the main task of the program is to create a nuclear power industry that "will be supplied with fuel indefinitely. . . . Science has found a radical method: It is possible to create fast breeder reactors which make it possible to utilize uranium reserves more fully." However, the fast-breeder technology may not be sufficient to ensure the necessary growth rates in the power industry, he continued. "In this event science is also preparing a solution: the merging of 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." Aleksandrov added that in parallel with fast-breeder and fission-fusion hybrid reactors, the Soviet nuclear power industry will proceed by developing large capacity fusion reactors—the next stage of science and technology.

As striking evidence of the Soviet commitment to this perspective, Atommash, the nation's mass production facility for nuclear plants, turned out eight reactors in 1980, a year in which the U.S. nuclear industry produced none.

CARTER ADMINISTRATION BLOCKED POT-KILLING FUNGUS

A marijuana eradication technique with the potential to destroy the drug globally was suppressed by officials of the Carter administration's Drug Enforcement Administration (DEA) and State Department since 1978, *Fusion* learned recently. The technique, developed by Professor Arthur McCain of the department of plant pathology at the University of California at Berkeley, uses the plant pathogen Fusarium Oxysporium f. Cannabis (fusarium wilt) as a biological warfare agent against cannabis plants. The fungus, which occurs naturally in Italy, was tested by McCain on a large number of plants and found to be completely specific to marijuana; it therefore poses no danger to crops or wildlife.

When McCain wrote to DEA director Peter Bensinger in July 1978 recommending fusarium wilt as a substitute for the terminated paraquat program, Bensinger referred him to Mathea Falco, Secretary of State for International Narcotics Control. McCain told a *Fusion* reporter recently that Falco, and later her assistant John Linneman, answered his letters, claiming—with no substantiation—that the fungus might be a toxin or mutagen.

Further investigations have revealed that the MITRE Corp., which was asked by the State Department to do an environmental impact study on fusarium, in fact, never did any testing, but just sent back a list of possible objections to the use of the fungus. Another factor suggests that a conflict of interest might have been involved. Before her appointment to the Carter State Department, Mathea Falco was a member of the advisory board of the National Organization for the Reform of Marijuana Laws (NORML).

USDA

Marijuana—one crop the Carter administration wanted to protect. Here, a marijuana plant dying after being infected with the fungus.

LOUSEWORT LAURELS TO CANADA'S PROJECT AEOLUS

This month's lousewort laurels award goes to the Canadian government for committing $17.6 million to build the world's largest windmill in eastern Quebec and to the Canada Press news service, which reported on this quixotic undertaking with uncritical national pride. Canada Press quotes John Roberts, minister of state for science and technology, stating that the vertical-axis windmill, dubbed Project Aeolus after the ancient god of wind, will put Canada into the forefront of wind turbine technology and could open vast markets at home and abroad, with domestic sales of windmills reaching $1 billion by the year 2000. The windmill, Canada Press boasts, will provide enough power (3.8 megawatts) to meet the nonheating electrical demands of 600 households.

The clincher is that in the same article Canada Press reports Roberts's announcement of the government's decision to fund simultaneously at $18.7 million an experimental tokamak fusion reactor in Varennes. Comparing this to Aeolus, Canada Press says, "The minister acknowledged that the tokamak fusion reactor, to be built within three years for $15 million, will likely have less immediate benefits."

Reagan's Science Budget:

Gutting the U.S. Recovery Capability

by Marsha Freeman

DOE Repudiates Fusion Law

In a foolish move that has antagonized Congress, the scientific community, European allies, and industry, Department of Energy representatives have proposed delaying the implementation of the Magnetic Fusion Energy Engineering Act of 1980, passed nearly unanimously by Congress last year. This landmark legislation commits the nation to operate a fusion engineering device by 1990 and a commercial prototype reactor by 2000.

In testimony before the Energy Research and Production Subcommittee of the House Committee on Science and Technology Feb. 25, and later before both the House and Senate Appropriations subcommittees, DOE acting director of the Office of Energy Research, Dr. N. Douglas Pewitt, announced that contrary to the law: "The department is not proposing to embark on a commitment to the Fusion Engineering Device [FED] or the Cener for Fusion Engineering at this time. The fiscal year 1982 program proposes to undertake exploratory study and initial design activities to enable us to build and operate a successful FED at some later time, if appropriate."

Pewitt continued: "Faced with the need for fiscal constraint, we are not proposing to take the steps that would imply such large future year expenditures. . . . Before the nation undertakes such an expensive effort, it is essential that thorough analysis and assessment be undertaken. The department plans to review this situation with great care. . . ."

As Pewitt and others in the administration are well aware, there is no lack of review of the fusion effort. Over the past two years, the magnetic fusion program has been thoroughly and carefully reviewed by both the DOE and Congress. Both scientific reviews concluded that the program is ready for engineering development and, in fact, these reviews led to the 1990 deadline in last year's fusion legislation for operation of a Fusion Engineering Device. This 1990 milestone is required if a commercial demonstration fusion power plant is to be on line before the year 2000, as specified in the law.

Permissive?

Under persistent questioning by members of three congressional committees, Pewitt admitted that the DOE had "no intention to make a commitment to get an engineering device by 1990" and characterized the fusion act as a "permissive piece of legislation."

"Congress might want to change the law," Pewitt arrogantly commented.

Pewitt and another Carter administration holdover, DOE acting undersecretary Ray Romatowski, have put themselves in an embarrassing position, however: Their new boss does not back them up.

The day after Pewitt's first appearance before Congress, Energy Secretary James Edwards gave a press conference and was asked about the DOE's plans to "restructure" the fusion program. A long-time supporter of the fusion program, Edwards replied: "We believe strongly that fusion is one of those long-term, high payoff technologies that we should continue to push forward with and we certainly hope that America at least can maintain its leadership in that part of nuclear energy development. . . ."

"This is a 20 to 30-year-away project," Edwards continued "and one of the things I wonder about, if it can be done in 30 years, why can't it be done in less time? We got a man on the Moon in 10 years, but I've been told that this is something that has to go step-wise. . . . I'm a rather impatient person and I want to see it done yesterday."

More Retrenchment

When the fiscal year 1982 budget was made public March 10, it was evident that the Department of Energy not only was trying to change the policy for the fusion program laid out by Congress in the 1980 fusion legislation, but also was proposing to fund the program at so low a level that it would not be possible to carry through the mandated timetable.

At a budget briefing at DOE headquarters March 10, acting undersecretary Romatowski announced that the request for magnetic fusion for fiscal year 1982 would be $460 million. This was considered a "compromise" because the initial DOE request under Romatowski was $440 million, although the OMB was willing to put as much as $475 million into fusion. The request in the Carter DOE budget was for the full $525 million authorized in the fusion legislation.

When I questioned how the DOE expected to carry out this retrenchment of the program, contrary to the accelerated development of fusion spelled out in the law, Romatowski replied: "Substantial legislation passed in the last few years is incompatible with our budget recommendations. . . . We will be recommending changes in these statutes during 1982."

This disregard for the will of Congress has not sat well with the legislative branch.

During the course of the hearings it became more and more obvious that Pewitt and Romatowski, the acting representatives of the department, did not accurately reflect the

views of Secretary Edwards. Sources in Washington indicate, in fact, that the antifusion views expressed by Pewitt and Romatowski were the result of input from the DOE designate for deputy secretary, W. Ken Davis.

Reportedly, Davis, a vice president of the Bechtel Corporation, has been so eager to make sure that the administration carries through on its commitment to build the Clinch River Breeder Reactor, that he has shortsightedly tried to prevent fusion engineering from going forward. The rationale here is that accelerating fusion will give the antinuclear movement a ready excuse to say that the breeder is unnecessary.

But it is a rationale that Congress won't buy. Congress will no more go along with pitting fusion against the breeder than it will turn its back on the commitment made to fusion last year by passing the McCormack bill with a vote of 365 to 7 in the House.

Acting Director of the DOE Office of Energy Research Dr. N. Douglas Pewitt: The McCormack bill is "a permissive piece of legislation."

Marsha Freeman

DOE Acting Undersecretary Ray Romatowski: "We will be recommending changes in these statutes [the McCormack bill] during 1982."

Congressional Rejection

Congresswoman Marilyn Bouquard, a Tennessee Democrat who chairs the Energy Research and Production subcommittee of the House Committee on Science and Technology (formerly headed by Mike McCormack), stated her view unequivocally on the fission versus fusion question. In preliminary DOE hearings Feb. 24, Bouquard told Secretary Edwards, "This committee is on record in support of the fusion bill and will maintain a positive posture on this option as well as advanced fission."

"I don't expect that my subcommittee or the full committee will make a choice between the breeder and fusion. Each is in different stages of development," and both are needed, she said.

Bouquard, whose subcommittee has authorizing responsibility on the House side for both nuclear and fusion, restated her strong commitment to a well-rounded nuclear program again March 18 when the subcommittee held its second round of fusion budget hearings.

Reminding Pewitt that he had said in the earlier hearings that the renewed administration commitment to get fission going "makes fusion development less urgent," Bouquard said: "I do disagree in the strongest possible way that fusion is not urgent at this time. Nongovernment witnesses from industry testified last week that without a commitment to the Fusion Engineering Device, there is no government commitment to fusion after 1984."

"We must chart a steady course for the fusion program," she continued. "We believe strongly in following the fusion law."

Pewitt and Romatowski's statements that the DOE would not comply with the 1980 fusion legislation went over like a lead balloon with other congressmen. At House Appropriations subcommittee hearings March 5, John Myers, an Indiana Republican, grilled Pewitt on this question.

According to the fusion legislation Myers told Pewitt, "The secretary is required to meet the date for an engineering device no later than 1990."

A stammering Pewitt responded, "It is not the intent of the department to commit to meet all of the goals set forth in the act."

"You mean you'll pick and choose what parts of the law you want to obey?" Myers asked incredulously.

"The act is a permissive piece of legislation," Pewitt replied. "It was the past administration and past president that signed the law."

Finally, in utter frustration, Myers said: "Something should be gotten from the secretary's office in writing saying that he is not going to carry out the law. Even the president can be wrong. I voted for him, but it doesn't mean we will march in lockstep with a policy" with which we do not agree.

The Senate Appropriations Committee was as unimpressed with Pewitt's presentation before its Energy and Water Development Subcommittee as the House was. Subcommittee chairman Mark Hatfield, an Oregon Republican, reminded Pewitt: "Last year you indicated there would be a change in the direction of the fusion program from basic research toward engineering development. The conclusion of the Buchsbaum DOE review [a study of the fusion program commissioned by the DOE's Energy Research Advisory Board] was that the

program is ready now for engineering development. Does the administration's view concur with the Buchsbaum report? I assume you represent the administration."

After Pewitt stated that the program would have to be reassessed because of the budgetary situation, Hatfield forced Pewitt to admit that even without the so-called budgetary constraints the DOE proposes to review the fusion program again. The "apparent reticence" he sensed in Pewitt's statements, Hatfield said, was quite unlike the spirit behind the Manhattan Project during the war, another project of great national importance.

Subcommittee member and former Apollo astronaut Senator Harrison Schmitt, a New Mexico Republican, then followed the same line of questioning. Schmitt compared the fusion effort to the Manhattan Project, the building of the Panama Canal, and the Apollo Moon landing.

Pressured by this hostile congressional reaction, at one point Pewitt said he didn't approve of "crash programs" because they "waste a lot of money."

Hits Fusion Budget

Representatives from the industrial organizations working in fusion development reacted with appropriate anger to the Pewitt-Romatowski proposals to set the fusion program back for the next four years.

In hearings before the Bouquard subcommittee March 3, Dr. Stephen O. Dean, president of Fusion Power Associates, an industry group, stated: "The Congress did not pass the fusion act as a substitute for pursuing the fission breeder reactor. Nor does the nuclear industry consider such a choice . . . to be necessary or desirable. This committee should be on guard against those who would create an artificial conflict between the development of fusion technology and that of the fission breeder."

Dean concluded: "The new administration has urged the country to return to traditional American values. One such value is to unleash our scientific and technical creativity. This is not the time to rethink again our fusion commitment. It is time to capitalize on our scientific successes."

The industry commitment to develop all the nation's potential advanced nuclear resources was supported by Thomas Latham of the Atomic Industrial Forum. Latham stated that breeder technology is further advanced than fusion but that fusion "is ready for engineering development."

"We believe both the fission breeder and fusion should be developed as rapidly as possible as the technology permits to confirm their potential for meeting our long-term energy needs," Latham said.

Representatives of McDonnell Douglas and Airco Superconductors, major contractors in the fusion pro-

gram, expressed their concern at the hearings about keeping industry involved in fusion if the commitment to next-step devices is not made.

Airco representative Dr. Douglas Koop stated straightforwardly: "Airco's planning for its superconductor business is premised upon the levels of funding and the timetable contemplated by the Magnetic Fusion Act. This act calls for a doubling of funding in each of fiscal year 1982 and fiscal year 1983.

"We believe it to be critical to the continuation of our operations that the plans for the Fusion Engineering Device and Center for Fusion Engineering proceed in accordance with the timetable spelled out in the act," Koop said.

Calvin J. Blattner, vice president for engineering of the McDonnell Douglas Astronautics Company reflected the "can-do" attitude of the U.S. aerospace industry in his testimony:

"Being a company that participates fully in the U.S. space program, we see a number of parallels between accomplishing space goals and accomplishing fusion power goals. . . . The enormous technical advances that came from the space program spawned new technology and industries that gave a surge to our nation's capabilities and helped the United States remain in the forefront of technology for two decades."

"There are distinct parallels to achieving fusion power, . . ." Blattner said. "Meeting this challenge will yield enormous benefits in new capabilities and stature for our nation. . . . McDonnell Douglas is solidly in the fusion program and investing in its future. We recommend, with other members of industry, that this well-managed program be supported and further implemented at an aggressive pace."

The McCormack Testimony

The most eloquent statement on the critical policy decisions in fusion was given by the initiator and primary sponsor of the fusion law, former Washington congressman Mike McCormack: "We must approximately double our present domestic

Continued on page 59

Europeans Protest Science Cuts

Thirty European scientists and engineers sent this telegram to President Reagan in mid-March:

President Reagan:

We Europeans have long admired the United States dedication to the development of science and technology, enbodied in the Apollo landing of man on the Moon, and, more recently, in the admirable McCormack fusion bill for the rapid realization of controlled nuclear fusion as an unlimited energy source for mankind.

The well-being and security of the entire world depends on such a continuing commitment of the United States.

We therefore urge you to reverse the ill-advised and dangerous policy of massive budget cuts in fusion research, in the NASA space program, in science education, and other vital areas of R&D, proposed in the budget drawn up by Office of Management and Budget Director David Stockman. Besides doing irreversible harm to U.S. scientific potential, these cuts will inevitably greatly undermine European research efforts in the same areas.

Such a policy is particularly ill-advised at a time when the Soviet Union, as revealed in the recent Soviet Party Congress, is committed to stepping up its already massive R&D programs—not least in the domain of fusion and most certainly in the field of revolutionary applications of fusion and other basic research. Adventurist forces in that country will not fail to read a reversal of decades of U.S. leadership in basic science research and advanced technology as a decisive sign of weakness.

Would not a reversal of the present high interest rate policy of Federal Reserve Chairman Volcker, which is costing the United States tens of billions in additional interest payments as well as seriously injuring our European economies, be a more prudent way of bringing the U.S. budget and economy into order?

Signatories:

Switzerland

Professor Walter Seifritz, Institut fuer Reaktorforschung, Wuerenlingen

West Germany

Professor Hans Martin Klinkenberg, Director, Historisches Institut, Technische Hochschule, Aachen • *Professor Ulrich Hanser*, Director, Physikalisches Institut, Koeln Universitaet, Cologne • *Dr. Klaus D. Leuthaeuser*, Director, Institut fuer Naturwissenschaftlich-Technische Trendanalysen, Euskirchen • *Professor Loeb*, Institut fuer Weltraumforschung, Universitaet Giessen • *Professor Hermann Bothe*, Botanisches Institut, Universitaet Koeln, Cologne • *Professor Christian Groeber*, Physikalisches Institut, Universitaet Frankfurt • *Betriebsratsvorsitz Kurt Brunner*, Hochtief Ag, Frankfurt • *Betriebsratsvorsitz Ave Marie*, Holzmann Ag, Frankfurt • *Betriebsratsvorsitz Ditmann*, Versuchsatomkraftwerk Kahl, Frankfurt • *Engineer Robert Sutcliffe*, Hamburg • *Engineer Gerlach*, Hamburg • *George Galauner*, Hamburg

France

Professor Marcel Felden, Director, Institute for Plasma Physics, University of Nancy • *Professor Jean-Marie Arnaudies*, Professor of Special Mathematics, Lycée Kleber, Strassbourg • *Dr. Emmanuel Tremblay*, Professor of Demography, Ecole des Hautes Etudes Sociales de Paris, National Chairman of Laissez-les Vivre, Paris • *Engineer Philipe Goudal*, Research Department, Electricité de France, Paris • *Axel Casadesus*, Mathematics Professor, Paris • *Jacques Houbart*, Editor, Industrie et Techniques, Paris

Italy

Dr. Ing. Franco Capetti, Executive, Studio C Industrial Consulting, Turin • *Dr. Claudia Cattoretti*, Milan • *Dr. Giovanni Provasoli*, Institute for Research on Macromolecules, Milan • *Dr. Ing. Leonardo Caravaggi*, Commercial Director, Innocenti S. Eustachio, Milan • *Professor Camillo Gamba*, Professor, Pedagogy of Science, Bari University, Milan • *Dr. Professor Enzo Menapace*, Comitato Nazionale Energia Nucleare, Bologna • *Dr. Professor Giovanni Spada*, Director, Institute for Technology and Studies of Outer Space Radiation, Bologna, • *Dr. Cesare Guaita*, President, Tradate Astronomical Group, Varese • *Roberto Crippa*, Vice President, Tradate Astronomical Group, Varese • *Patrizia Gaiani*, Secretary, Tradate Astronomical Group, Varese • *Carlo Rivadossi*, Manager, Rivadossi Designing Firm, Brescia

Will Reagan Go with Advanced Isotope Separation?

The U.S. Advanced Isotope Separation program, a direct spinoff of the 1970s fusion effort, has been put on hold, in line with the present *sin novedad* ("do nothing new") malaise of the Reagan administration's science and technology policy.

Separating the various isotopes of an element is necessary for technologies ranging from nuclear-fuel production to radioisotope treatment of cancer tumors. Yet the Advanced Isotope Separation (AIS) program was almost completely suppressed by the Carter administration on the ground that it would increase nuclear proliferation.

When Exxon started building a pilot plant for AIS in the late 1970s, the Carter administration intervened and classified Exxon's research as "top secret," despite extensive scientific reviews demonstrating that AIS would tend to decrease nuclear proliferation by making the United States the main source of cheap uranium fuel. In addition, alternative applications of AIS would lead to improved, safer, proliferation-proof reactors—for example, reactors in which fuel rods do not have to be replaced every four years.

So far, the Reagan administration has taken no definite action on AIS, providing funds for Exxon's research at Jersey Nuclear on a month-to-month basis. The economic consequences of axing the AIS program would be considerable, since it is a new technology that could have an immediate large effect on the availability and cost of energy, while leading simultaneously to entirely new scientific and technological developments.

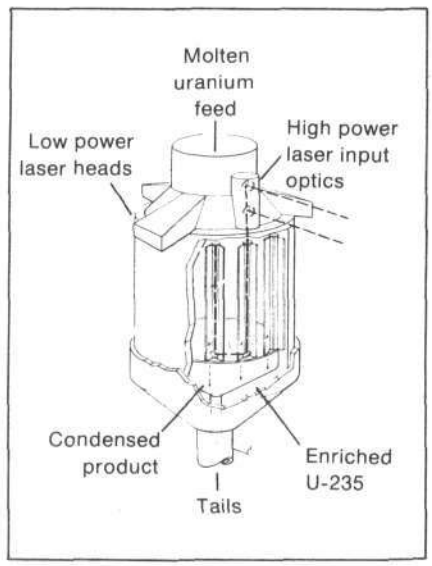
More important, AIS demonstrates how long-term research efforts like the fusion program can produce technological spinoffs of incalculable benefit for society.

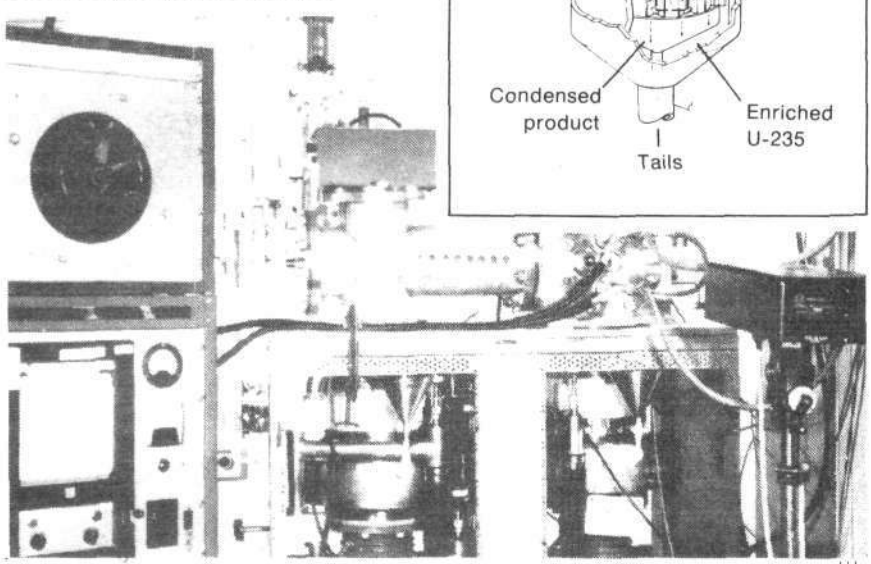
The methods currently in use to separate isotopes involve gaseous diffusion through a barrier, a costly, time-consuming procedure that adds significantly to the cost of medical testing and other areas of application. AIS, on the other hand, uses laser technology and magnetic fields to separate isotopes at a total cost that is 88 percent lower than gaseous diffusion.

All chemical elements consist of families of isotopes with the same chemical properties but different nuclear properties and weights. The number of protons in an atom determine its identity, but the number of neutrons can vary, creating different isotopes of the same element. For example, naturally occurring hydrogen is a mixture of the most common isotope H-1, with 1 proton and no neutrons; and H-2, heavy hydrogen or deuterium, with 1 proton and 1 neutron. The isotope H-3, tritium, with 1 proton and 2 neutrons, is much rarer because it is radioactive.

Nonchemical means must be used to separate these isotopes from each other, since chemically they are identical. But these methods are quite costly. For example, to obtain fuel for nuclear reactors it is necessary to isolate U-235 from the prevalent nonradioactive U-238 in uranium ore. To develop the technique for atomic bombs in the Manhattan Project, it took billions of dollars. And even today the barrier gaseous diffusion method used is extremely costly.

During the 1970s two new approaches to isotope separation were developed as a result of the magnetic and inertial-confinement fusion research efforts. Promising to be much more versatile and economic, these AIS approaches will greatly reduce





LLL

The differentially pumped molecular beam apparatus shown above is used to study uranium reactions yielding charged particles, a line of investigation that is critical for developing laser photochemical processes for isotope separation. The inset depicts a model of a laser isotope separation oven, in which laser beams are used to excite and ionize molten uranium, allowing the concentration of U-235.

the cost of nuclear fuel as well as make it more readily available. In addition, alternative applications of various isotopes could be developed rapidly, in three major areas:

(1) Separation of radioactive isotopes. Various radioactive isotopes are needed for medical and biological research and technology. These isotopes have already found wide use for cancer treatment; advanced medical diagnostics; remote heat, power, and light applications such as luminescent signs; and isolating valuable materials such as platinum from nuclear waste.

(2) Isotope tailoring of materials can greatly enhance their usefulness in nuclear applications. For example, by using isotope separation to remove from metal alloys those isotopes that readily undergo nuclear reactions, the purified metal alloys can be made to withstand an intense nuclear-bombardment environment for much longer periods of time without failing. The numerous applications of this include design of nuclear fusion and fission reactors so as to greatly decrease the cost and vastly improve the safety and durability.

(3) Purification of elements. Although purification of elements is usually accomplished with ordinary chemical technology, AIS techniques could prove to be much easier and cheaper in some cases. This would affect the biomedical, electronics, and metals industries.

How AIS Works

AIS techniques were developed as spinoffs of the U.S. fusion program. The advances in laser technology and study of the plasma physics involved in laser-matter interactions led to new techniques in which the coherent laser light, which is very finely tuned, can be used to deposit energy in only one of two mixed isotopes, with both isotopes in atomic or molecular form. The energized isotope then reacts chemically with other elements, since it is excited, and can thus be separated out easily.

The second AIS approach was realized shortly after the laser method and is based on magnetic fusion research technology and scientific advances. This AIS system is called the Plasma Separation Process (PSP).

In PSP, material comprising the two isotopes is vaporized in a chamber containing a strong magnetic field. The plasma consisting of the two isotopes is then confined by the magnetic field, and the ions of the isotopes gyrate around the magnetic field lines in spiral orbits. The frequency of this gyration depends on the atomic weight of each ion, which is different for each isotope since it is the combined weight of the protons and neutrons in each atom.

By tuning radio waves to the frequency of the gyration of one isotope, energy can be deposited selectively into that isotope and not the other. As a result, the radius of the spiral orbit of this isotope will increase greatly. By using a "filter" whose dimensions are smaller than the radius of the larger orbit, the plasma can be partitioned into regions containing only one of the isotopes. The desired isotope can then be collected on an electrode.

Cost-Effectiveness

According to the Nov. 1980 DOE Energy Research Advisory Committee's review of AIS, these laser and magnetic plasma techniques for separating uranium isotopes would have capital costs ranging from one-tenth to one-sixth those of the current gaseous diffusion technology and from one-fortieth to one-tenth the energy consumption rate. In terms of total annual cost, including operating and capital costs, the AIS approaches would cost between one-ninth and one-sixth that of gaseous diffusion.

Furthermore, the new AIS approaches would extend the usefulness of existing stocks of uranium and avoid new mining by making use of uranium tails (uranium ore in which most of the desirable U-235 isotope has been removed already).

Given the resources, full-scale industrial plants using AIS could be brought on-line by the end of the 1980s. Since private industry has already demonstrated its interest in this project, all that is now needed is the go-ahead from the Reagan administration.

Los Alamos Zeta Scores Success

After just two days of experiments with their modified ZT-40, a reversed-field toroidal zeta pinch, researchers at Los Alamos National Scientific Laboratory in New Mexico reported extremely promising results in February.

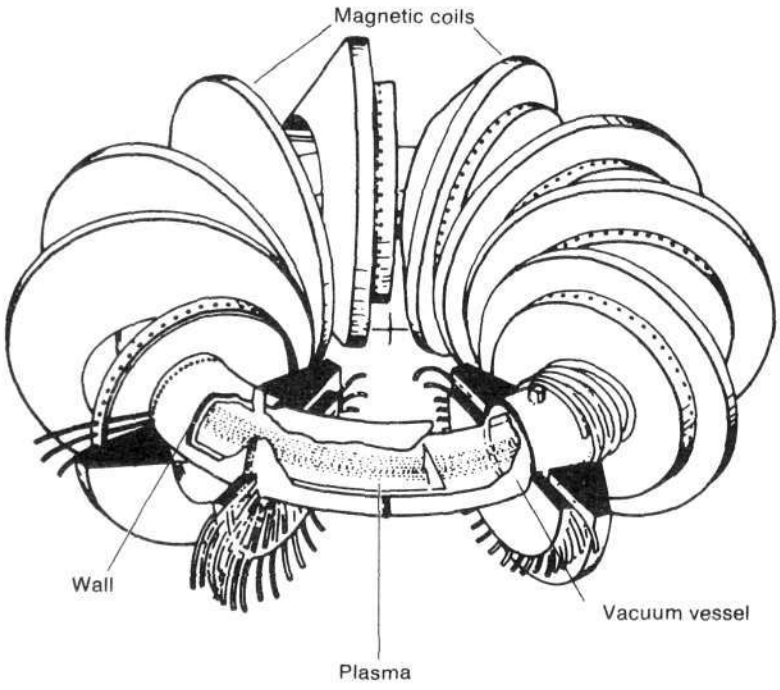
On the 30th experimental shot, the ZT-40 plasma overcame the problem of impurities from the wall of the chamber that decrease the plasma temperature and energy. The plasma was transformed into a stable magnetic field-reversed configuration with quiescent periods of plasma stability lasting several milliseconds.

These initial results appear to confirm the analysis presented in the Jan. 1980 issue of *Fusion* (p. 54, "The Zeta Moves into First Place in Fusion").

In addition to confirming the validity of the existing reversed-field pinch program and demonstrating the immediate need for a proof-of-principle experiment, the continuing ZT-40 experiments promise to advance the theoretical understanding of how magnetic confinement of plasmas works. This is particularly true for the reversed-field pinch since it is based on a self-organized plasma structure.

And, as with the Voyager observations of Saturn, the reversed-field pinch plasma structures were totally unexpected because they violate the widely held Newtonian view of physics. In fact, when the first large toroidal zeta-pinch experiments were carried out more than 20 years ago, the unforeseen field-reversed plasma configuration that developed was almost overlooked and was not generally appreciated until the 1970s.

In addition, the simple magnetic field geometry, large plasma volume allowing easy access for diagnostics with lower resolution, and manageable time scales of the zeta pinch make it ideally suited for experiments to answer the most profound questions about the structure of the magnetic field and the dynamic plasma structure, as well as more general questions about microscopic processes and macroscopic order.



The donut-shaped (toroidal) vacuum vessel and magnetic coils for the ZT-40, a reversed-field toroidal zeta pinch, are shown diagrammatically in this figure. The distinctive feature of the ZT-40 is the configuration of strong plasma currents that confine the plasma in the volume indicated by the dotted lines within the vacuum vessel. This uniquely efficient plasma confinement results from the reversal of the magnetic field that occurs near the wall of the torus.

These latest ZT-40 results concur with the results from the smaller Eta Beta II experiments carried out at the University of Padua in Italy and with recent Japanese results from the toroidal zeta-pinch experiment TPE-1R(M).

They also confirm the original observations of the British Zeta reversed-field pinch, which was among the largest fusion experiments ever built, operating in the 1950s and 1960s. The British declared the Zeta a failure because they could not comprehend the self-organizing structures that arose in the plasma.

How the Zeta Pinch Works

In the zeta pinch, a donut-shaped vacuum chamber is filled with a small amount of hydrogen gas. Then a rapidly increasing electrical current is passed through an external transformer, generating an electric field. This field first ionizes the hydrogen gas, turning it into a plasma, and then induces an electrical current in this plasma.

The toroidal plasma acts like a one-turn transformer. The induced axial plasma current generates the circular magnetic field that, in turn, confines, compresses, and heats the hydrogen plasma. There is no upper limit on the electrical current that can be induced, as there is in the more complicated magnetic geometry of the tokamak. Furthermore, the pinch can be heated to ignition by ohmic heating from the electrical current alone, with no need for complicated and expensive alternative heating systems such as neutral beams and microwaves.

The Kink Effect

The magnetic structure formed by the induced axial current is unstable. But, as was discovered in the original 1960s Zeta, the plasma instability is a twisting of the plasma column to form

a kink that moves around the donut. As this kink travels around the donut and reacts with the electrically conducting wall of the vacuum chamber, it causes the outer shell of the confining magnetic field to reverse directions. This field reversed configuration proves to be quite stable, and the kink disappears.

The spontaneous appearance of the kink demonstrates the self-organizing tendency of a plasma to form ordered structures, vortices and solitons. This is why the pinch experiments, which allow access to this structure formation, will help the understanding of what is going on in tokamaks and other large, less accessible plasma experiments.

Besides being stable, the pinch configuration is quite efficient since it has a high plasma beta. Beta is a measure of the ratio of the plasma pressure to the pressure exerted by the magnetic field and indicates the efficiency of a fusion device.

A large portion of the total cost of building a magnetic fusion reactor involves the cost of the magnetic system used. The power density of a fusion plasma is generally proportional to the fourth power of the plasma beta, and the cost of a magnetic system per volume is generally proportional to the magnetic field pressure. Therefore, high betas are quite important for economical reactors.

The Eta Beta II

The original ZT-40 was designed with a very fast rise-time to full electrical current because it was believed that the higher temperatures thus attained would allow the plasma to burn through the impurities present. This, in turn, would decrease the plasma electrical resistance, permitting higher plasma currents at a given voltage.

The success of the Eta Beta II, however, was achieved with slower rise-times. The shock wave associated with the fast rise-time tends to increase the influx of impurities from the chamber wall by setting up a temperature difference between the "cold" electrons and the "hot" ions and a new electric field that pulls in nonhydrogen atoms.

The ZT-40, which is about twice as large as the Eta Beta II, at first tried to duplicate the Eta results with a slightly modified, fast-rise-time machine, but this did not succeed. The ZT-40 was then rebuilt along the Eta Beta lines, particularly in having included a metal conducting shell. Within a few days of the mid-February completion of this modified ZT-40, long stability periods similar to those seen in the Eta Beta II were obtained.

Frascati Tokamak Approaches Fusion Conditions

Preliminary, unofficial reports from the Italian Frascati laboratory indicate that their compact experimental tokamak, the FT, has recently obtained density-confinement time products on the order of 10^{13} particles-sec/cm^3, just a factor of 10 below that needed for a working fusion reactor. Previous results from the Massachusetts Institute of Technology's Alcator C had reached the record of about 10^{13}, but the Frascati results are even higher.

Both the Alcator and the FT are small, compact tokamaks that use reduced dimensions, high densities, and high magnetic fields to achieve "thermonuclear plasmas," that is, plasmas in which the fusion reaction dominates. In larger tokamaks like Princeton's PLT, external systems like neutral beams and microwaves are used to heat a plasma at lower density, but the beams from these heat sources dominate the plasma unevenly and keep it from closely resembling a true thermonuclear plasma, in which the heat source is primarily from the alpha particles generated by the fusion reactions. This is why small prototype devices such as the FT and the Alcator are so important in investigating the conditions that will prevail in an actual working reactor.

The Frascati tokamak is based on the high-density, high-magnetic-field approach pioneered by Dr. Bruno Coppi, who initiated the MIT Alcator program and played a leading role in the development of the FT.

The preliminary FT results are actually the initial results of this new fusion team, and were achieved using only a fraction of the device's full capacity. The toroidal magnetic field used was only 60 kG (kG = 1,000 gauss), whereas 100-kG fields will be used eventually. In addition, the plasma current in the present experiments is on the order of only several hundred thousand amperes, whereas the full capability is projected at 1 million amperes (MA).

The Coppi approach of using high-density tokamaks opens up the possibility of achieving fusion ignition without external heating sources; that is, all of the heating comes from the ohmic heating caused by the electrical currents flowing in the plasma itself.

Density Scaling?

It has recently been reported (*Fusion*, Nov. 1980, p. 11) that confinement time scaling with increased plasma density is no longer found in the latest generation of tokamaks, such as the Alcator C. But this view may be an oversimplification. As Coppi developed in an article last year for *Comments on Plasma Physics*, ohmically heated tokamak confinement-time scaling is actually a complex function of density, temperature, current, and machine radius. The full spectrum of results from the FT, the Oak Ridge National Laboratory's ISX, and the Alcator appear to corroborate this theory.

Although the Coppi formulation does not hold for externally heated tokamaks, the qualitative nature of ignited fusion plasmas needed for reactors should be close to that of ohmic-heated devices. In addition, the small, high-density devices like the FT will allow a more thorough investigation of true thermonuclear plasmas.

For a more thorough discussion of these questions, see "Thermonuclear Ignition by Means of Compact Devices," B. Coppi et al., International Journal of Fusion Energy, *Vol. 2, No. 4, 1981, p. 1.*

The State Dept.'s Office of Population Affairs:

Depopulating by 'War and Famine'

The May issue of Fusion *reported on the efforts by the Carter administration holdovers in the State Department and the Council on Environmental Quality (CEQ), working with the cooperation of Secretary of State Alexander Haig, to foist the zero-growth doctrines of the* Global 2000 Report *on the Reagan administration ("Global 2000: Will the Zero-Growthers Capture the White House?").*

Global 2000 *was commissioned by President Carter on May 23, 1977 in his environmental message to Congress as a study of "probable changes in the world's population, natural resources, and environment through the end of the century." The State Department and the CEQ coordinated the study, which was released last spring.*

Continuing investigations have located the government's zero-growth planning center in the State Department's Office of Population Affairs, or OPA. This report focuses on the OPA and its population control policies—policies admittedly designed to force depopulation *by means of war and famine. The extraordinary interviews with OPA officials and others that are excerpted here appeared in full in the weekly* Executive Intelligence Review *during March.*

"There is a single theme behind all our work," said Thomas Ferguson, the Latin American case officer for the State Department's Office of Population Affairs (OPA). "We must reduce population levels. Either they [Third World governments] do it our way, through nice clean methods, or they will get the kind of mess that we have in El Salvador, or in Iran, or in Beirut. Once population growth is out of control, it requires authoritarian government, even fascism, to reduce it."

Ferguson's OPA is the State Department unit that had principal responsibility for drafting the spring 1980 *Global 2000 Report to the President,* the report that warned that if world population continues to grow at present rates, "the world will be more vulnerable both to natural disaster and disruptions from human causes."

Recent interviews with Ferguson and his coworkers in the OPA and the National Security Council Ad Hoc Group on Population Policy leave no doubt that the technocrats and policymakers behind the *Global 2000 Report,* including former secretaries of state Henry Kissinger, Cyrus Vance, and Edmund Muskie, not only expect but welcome regional wars, mass starvation, and ecological breakdown as a means of attaining the goal of population control.

Again to quote Ferguson: "El Salvador is an example of where our failure to lower population by simple means has created the basis for a national security crisis. The government of El Salvador failed to use our programs to lower their population. Now they get a civil war because of it. . . . There will be dislocation and food shortages. They will still have too many people there."

Civil wars are somewhat drawn-out ways to reduce population, Ferguson added. "The quickest way to reduce population is through famine, like in Africa, or through disease, like in the Black Death." All of these factors might develop in El Salvador, he predicted.

Kissinger's OPA Baby

The OPA has a budget of $220 million in fiscal year 1981 and this could be doubled if the *Global 2000* recommendations are adopted. In 1975, the OPA was brought under a reorganized State Department Bureau of Oceans and International Environmental and Scientific Affairs (OIESA), a body created by then secretary of state Henry Kissinger. The OPA was the bureau division assigned to carry out the directives of the newly created Ad Hoc Group on Population Policy of the National Security Council (NSC).

According to an NSC spokesman, Kissinger initiated both the OPA and Ad Hoc Group after intensive discussions with leaders of the Club of Rome during the 1974 world food and population conferences in Bucharest and Rome. The Club of Rome had already issued its *Limits to Growth* report in 1972, denying the positive effects of science and technology on the economy and calling for a global zero-growth regime.

> *"To reduce population quickly, you have to pull all the males into the fighting and kill significant numbers of fertile, child-bearing age females."*

Dr. Kissinger's depopulation project has survived intact through three administrations. The NSC-State Department group promoting the Club of Rome doctrine gained its strong foothold in large part as a result of the weakening of the U.S. presidency during Watergate, an operation that NSC director Kissinger and his protégé, then White House chief of staff Alexander Haig, directed from the inside, advising President Nixon to resign. This same group is today trying to increase the power of Secretary of State Haig in directing important foreign policy matters.

Making Depopulation U.S. Policy

According to OPA case officer Ferguson, Kissinger initiated an about-face on U.S. development policy toward the Third World.

"For a long time people were timid," Ferguson stated. "They lis-

tened to arguments from Third World leaders that said the best contraceptive was economic reform and development. So we pushed development programs. Look at what we accomplished: We improved water supplies, sewage treatment, we cut down disease—and we helped create a population time bomb.

"We are letting people breed like flies without allowing for natural causes to keep population down. We raised the birth survival rates, extended life spans by lowering death rates, and did nothing about lowering birth rates.

"But that policy is finished. We are saying with *Global 2000* and in real policy that you must lower population rates. Population reduction is now our primary policy objective—then you can have some development."

The Civil War Method

Civil war is one of the most elaborated means of reducing population. The NSC Ad Hoc Group's April 1980 report, *U.S. International Population Policy,* predicted that the world's "population crisis" areas would soon erupt in civil wars. There is "an increased potential for social unrest, economic and political instability, mass migration and possible international conflicts over control of land and resources," the report stated.

It then cited "demographic pressures" as key to understanding "examples of recent warfare in India, Pakistan, Bangladesh, El Salvador, Honduras, and Ethiopia and the growing potential for instability in such places as Turkey, the Philippines, Central America, Iran, and Pakistan."

"El Salvador is an example of a small country with serious population and political problems," the report continued. "Rapid population growth—the birth rate has remained unchanged in recent years—aggravates its population density, which is already the highest on mainland Latin

C. Chauvel/Sygma

Some of the dead and wounded caught in the cross fire and stampede after the assassination of the Archbishop of El Salvador on March 23, 1980 by right-wing forces.

America. While a population program exists on paper, it has not been pursued with a strong commitment, and contraceptives remain unavailable."

Is the continuous civil war in El Salvador simply the inevitable outcome of natural "demographic pressures"? The facts indicate otherwise.

The Paddock Plan

William Paddock, author of *Famine 75!* and a population policy consultant to government and private industry, has stated openly that the U.S. State Department should consciously support an "endless cycle" of civil war in El Salvador as a means of reducing its population.

Speaking at a Georgetown Center for Strategic and International Studies seminar on "The Demographic and

Henry Kissinger, former secretary of state under President Nixon:

"Any country that tries to industrialize too fast will become an Iran."
(to a Mexican journalist, 1978).

National Security Implications of the Salvador Revolution" Feb. 27, Paddock said: ". . . unchecked population growth has led to a process of continuous turmoil and civil strife in El Salvador. There is no other solution to this problem [of overpopulation]."

Therefore, he continued, "U.S. policy should be to support the current military dictatorship, but we should also open up contacts with the opposition, because they will eventually come to power. . . . And as we do that, we should work with the opposition to the opposition."

In fact, since the U.S.-backed rightist coup in El Salvador in Oct. 1979, there have been continuous defections back and forth between the government and the opposition; the civil war has destroyed the country's economy and directly killed some 13,000 people.

Zbigniew Brzezinski, former National Security Council director:

"New forms of social control may be needed to limit the indiscriminate exercise by individuals of their new powers."
(from the 1967 document "America in the Technetronic Age").

For the State Department's population reduction unit, however, the destruction has not been great enough.

"The civil war can help things," OPA's Ferguson commented, "but it would have to be greatly expanded. To reduce population quickly, you have to pull all the males into the fighting and kill significant numbers of fertile, child-bearing age females."

In El Salvador, he said, "You are killing a small number of males and not enough fertile females to do the job on the population. . . . If the war went on 30 to 40 years like this, then you might accomplish something. Unfortunately, we don't have too many instances like that to study."

The Iran Case

In the case of Iran, the NSC Ad Hoc Group's policy report commented that the best efforts of the former shah to institute "clean programs" of birth control failed to make a significant dent in the country's birth rate. More significant, the promise of jobs through the country's industrialization program encouraged migration to "overcrowded cities" like Teheran.

Incredibly, the report noted there is new hope under the Khomeini regime, the regime that was favored by former NSC director Zbigniew Brzezinski as a "bulwark against communism" and by former U.S. Attorney General Ramsey Clark for its "anti-autocratic," anti-Western character.

Secretary of State Alexander Haig

"A closet environmentalist,"
according to CEQ staffer Nicholas Yost (to a journalist, Feb. 1981).

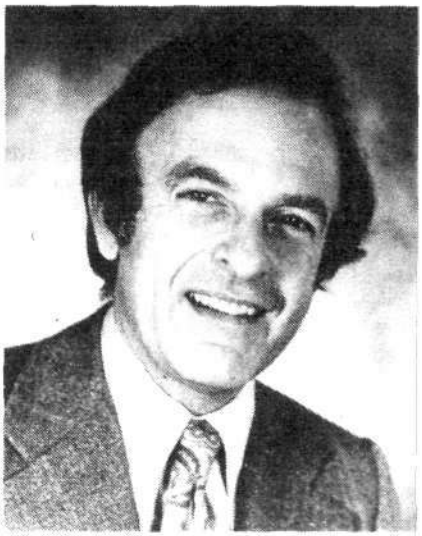
The Khomeini government may make progress with the problem of overpopulation, the Ad Hoc Group's report stated, because it has a program "to induce up to half of Teheran's 6 million residents to relocate, as well as possible measures to keep rural migrants from moving to the cities."

The ideological underpinning for the State Department's depopulation project is an extreme Malthusianism that denies the most basic premise of human history—that science and advancing technology create the basis for increasing population densities.

The *Global 2000 Report*'s dire warnings about deforestation, dwindling water resources, global pollution, and the like follow directly from the study's explicit assumption of "no changes in public policies, institutions, or rates of technological advance." More specifically the report states, "the projections assume no revolutionary advances—such as the wide-scale availability of nuclear fusion for energy production." (On the other hand, *Global 2000* confidently predicts that increasing scarcity of fuel wood in Third World countries will necessitate the shift of "growing amounts of dung and crop residue . . . from the field to the cooking fire.")

In tandem with *Global 2000*'s denial of the possibility of technological advance is an overriding determination to preserve what it calls the environment no matter what the real cost to the population. Thus, since its founding, the State Department's Bureau of Oceans and International Environmental and Scientific Affairs, which oversees OPA, has played a major role in blocking the transfer of nuclear technology and chemicals (like DDT) to the Third World—"for environmental reasons." This policy not only has enforced poverty and disease in the developing sector, but also has depressed advanced-sector industry by cutting off its potential export markets.

(This same Bureau of Oceans and International Environmental and Scientific Affairs, curiously enough, has also squelched inertial fusion research via its semisecret ad hoc committee on inertial confinement.)



Rep. Richard Ottinger (D-N.Y.):

"[HR 907] declares a national policy of eventual population stabilization."
(Congressional Record, Feb. 5).

William Paddock, consultant on population policy:

"Technology is not the solution, it's the problem."
(Georgetown CSIS seminar, Feb. 27).

Population consultant William Paddock goes even a step further in attacking technology-based progress:

"There is an economist at the University of Colorado," Paddock told an interviewer, "a very famous economist, Kenneth Boulding [a member of the U.S. Association for the Club of Rome and former president of the American Association for the Advancement of Science], who has an 'utterly miserable' theorem, which says that if the only check on the growth of population is starvation and misery, then any technological improvement will have the ultimate effect of increasing the sum of misery, because it permits a larger portion to live in precisely the same state of misery and starvation as before."

John Oakes, former senior editor, *New York Times:*

"A threat to the national security . . . springs from the unprecedented pressures of global population increase."
(*New York Times* op-ed, Feb. 17).

Population Control at Home

The "Population Policy Bill" of Rep. Richard Ottinger (D-N.Y.), HR 907, aims to impose "eventual population stabilization" in the United States. "In our foreign policy, we force stabilization on other countries," an aide to Ottinger explained, "but we haven't taken appropriate measures at home."

Cosponsors of the bill are Reps. Robert Garcia (D-N.Y.), Matthew McHugh (D-N.Y.), Robert Edgar (D-Pa.), Paul McCloskey (R-Calif.), Les AuCoin (D-Ore.), Tony Coelho (D-Calif.), and Daniel Akaka (D-Ha.).

Other congressmen who have recently expressed their support for the Global 2000 doctrine include Rep. James Scheuer (D-N.Y.), Sen. Claiborne Pell (D-R.I.), and Sen. Charles Mathias (R-Md.).

To bring constituency pressure to bear against the Global 2000 policies, call these congressmen at (202) 224-3121.

West German Chancellor Confronts Antinuke 'Greenies'

Faced with a growing antinuclear movement, which has turned to violence, West German Chancellor Helmut Schmidt showed new determination in the early months of 1981 to sweep the "greenie" environmentalists aside and govern on the basis of the broad support for his own pronuclear, growth policies.

Schmidt's new decisiveness on nuclear energy follows a year of weak characterizations of nuclear as a stopgap, statements prompted by Schmidt's desire to attract leftist voters to his Social Democratic Party (SPD) in the 1980 election year. However, now the chancellor is taking on the environmentalist wing in his own party.

At an extraordinary meeting of the SDP's executive committee Feb. 11, called to discuss the deepening left-right split in the party, Schmidt argued for a repeal of the SPD's 1979 resolution approving nuclear energy only as a last resort after coal and "alternative sources."

The *Mainzer Allgemeine Zeitung* newspaper reported Feb. 13 that in the executive debate on nuclear energy, Schmidt "indicated that he is committed to the party resolution, but over and above that he is responsible to the whole population and is bound by his oath of office to prevent damage to the German population. And Eppler's policy [Erhard Eppler is a leader of the party's environmentalist left wing] would damage the German population."

A National Mandate

When the party executive, headed by SPD Chairman Willy Brandt, rejected his demand for the repeal of the resolution, Schmidt went on national television Feb. 13 to announce that as chancellor his responsibility was to the welfare of the entire nation, not merely the Social Democratic Party. If his own party's policies contradicted that, Schmidt said, he would appeal over the heads of the party leaders to the federal parliament as a whole, calling for a vote of confidence in his government.

"The federal chancellor and the federal government have a constitutional mandate that they must uphold," Schmidt said in an interview with ARD television. "Naturally they govern themselves as much as possible by the views of their own party, as expressed by party congresses. But their mandate goes beyond that. . . . I have sometimes thought of calling a vote of confidence in the Bundestag [the federal parliament]. This occurred in past years, and might become necessary in the future."

Schmidt emphasized in numerous subsequent interviews with the West German news media that he favors the long-stalled construction of the Brokdorf nuclear plant in the northern state of Schleswig-Holstein. The antinuclear leadership of the SPD in the nearby city of Hamburg has demanded a three-year moratorium on construction of the plant, even though the city is committed to help finance the project and would have to pay up to a billion deutschemarks ($500 million) in penalties for breaking the contracts.

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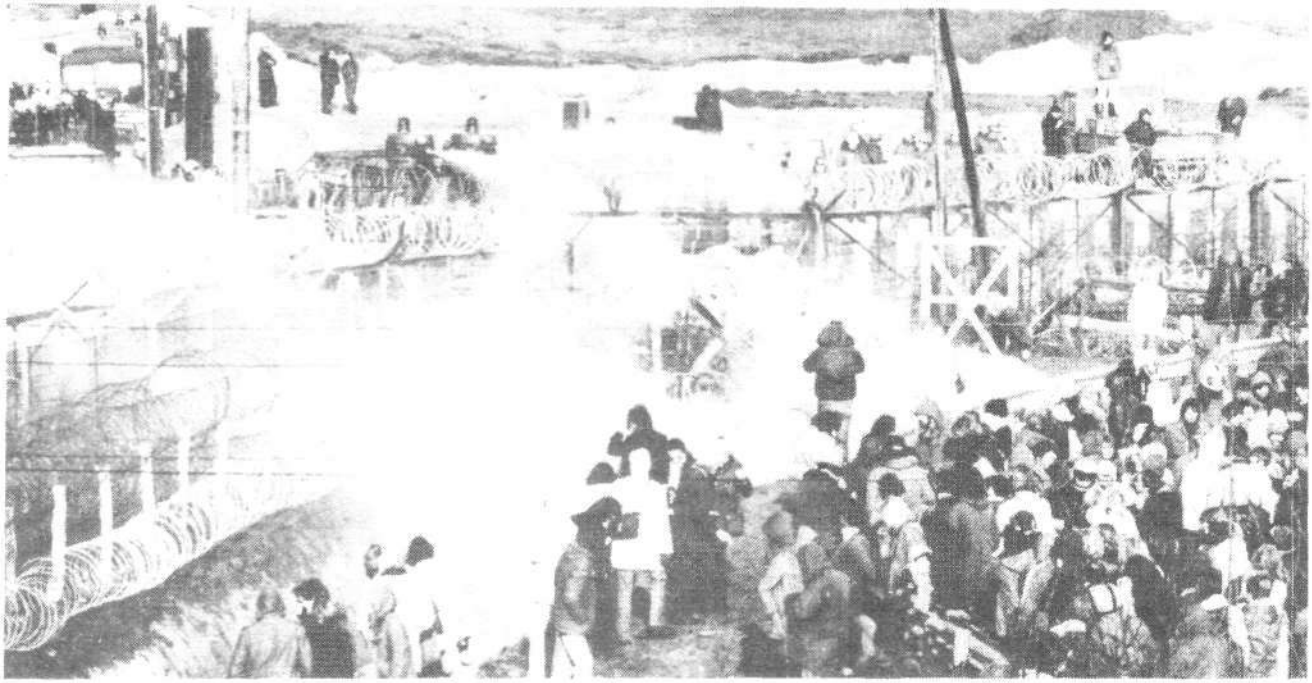


The first demonstration against West Germany's Brokdorf nuclear facility in 1977, which halted work on the plant and became the model for future antinuclear violence around the world.

Technological progress is impossible without rising living standards; but rising living standards depend on technological progress. Fusion *editor-in-chief Dr. Steven Bardwell resolves this apparent paradox and others in a report on the "alpha, beta, gammas" of the LaRouche-Riemann econometric model.*

Overturning Equilibrium Economics

The Physical Laws of Economic Development

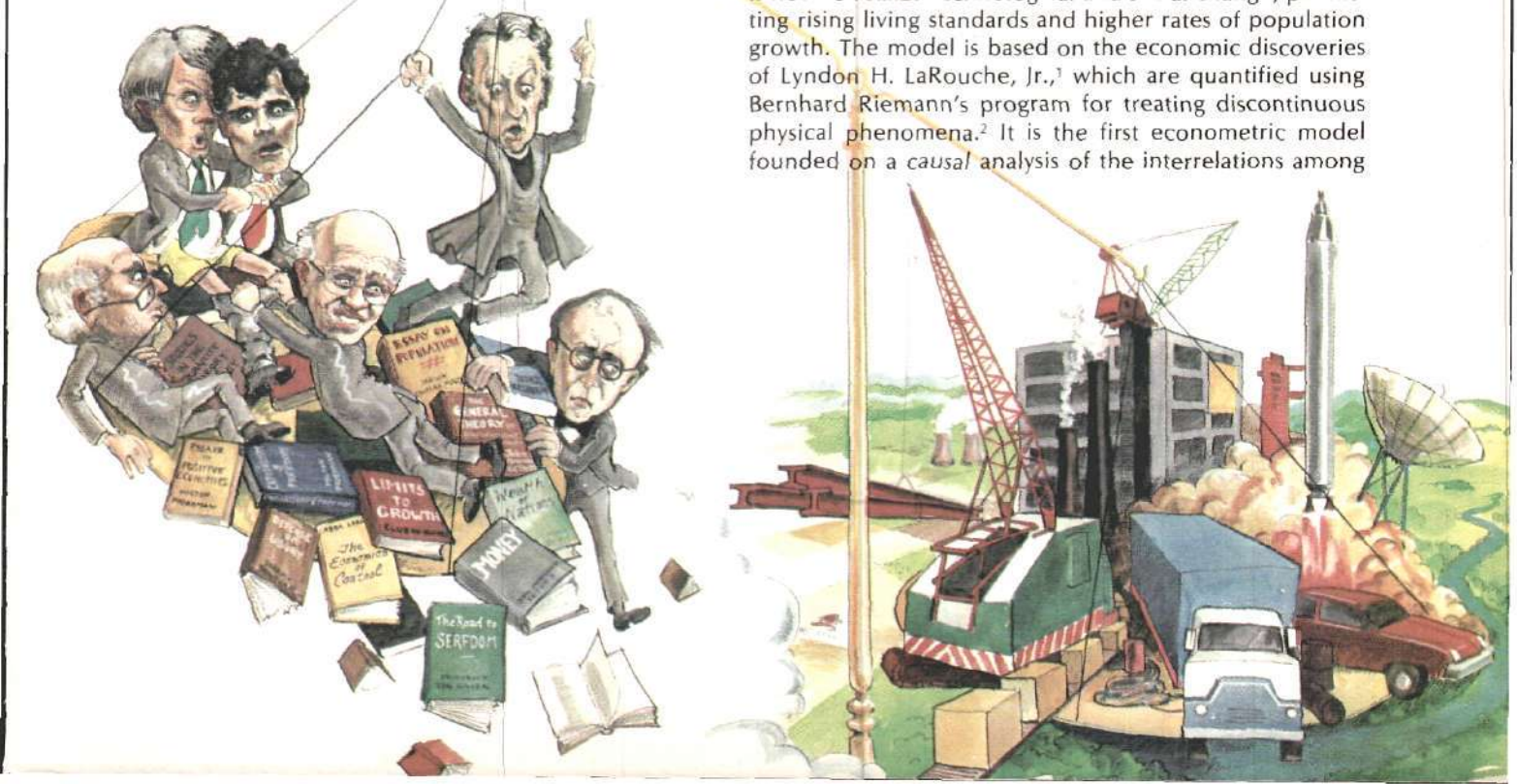
by Dr. Steven Bardwell

THE DOMINANT TENDENCY during the past 100,000 years of human history has been toward larger population, higher rates of global energy consumption, and higher levels of per capita consumption—in short, toward progress. A quantitative picture of this tendency is shown in Figure 1, measured in terms of population growth and per capita energy consumption; both curves increase at a faster-than-exponential rate.

As obvious as the fact of human progress is, however, its ontological importance has been denied by all but a handful of economists throughout history. The standard dogma in economics is that economic growth and development are perturbations of the more fundamental equilibrium state of stable technological levels and fixed population size. This assumption underlies the economic theories of both the liberal Keynesian school and the opposing Friedmanite school, now in the ascendancy—despite the latter group's apparent support for technology and growth "unshackled from government interference."

The fact is that not only is it false to presume that an equilibrium state is primary, but also it is false to assert that there is any stable, equilibrium state for human society. Society either advances or it retrogresses into periods of severe breakdown.

Over the last two years, a new econometric model has been developed that reformulates economics as a science of progress and development—the LaRouche-Riemann model. The central problem the model attempts to solve is how to realize technological and social change, permitting rising living standards and higher rates of population growth. The model is based on the economic discoveries of Lyndon H. LaRouche, Jr.,[1] which are quantified using Bernhard Riemann's program for treating discontinuous physical phenomena.[2] It is the first econometric model founded on a *causal* analysis of the interrelations among



productivity, energy usage, capital investment, and technological development in an economy. The explicit subject of the model is progress.

The Laws of Economic Development

Work on the LaRouche-Riemann model began with an in-depth engineering study of the cause-and-effect relations that determine economic reproduction. It is not enough to describe the current state of an economic system. What defines an economy is not its present state but how it reproduces itself—what the economy is doing in the current production cycle to ensure its future existence at a higher technological level.

This work led to the formulation of three cause-and-effect relations that are the basic laws of economic science:

(1) *Energy consumption = resource base.* The energy and other resources an economy consumes in the production process are not "natural" but are created by the technologies available to utilize them. Specifically, the state of development of a given technological level—its energy intensity—defines the resource base accessible to the economy at that level. It follows that resources are not finite in the sense that is usually meant. The physical finitude of oil, for example, is economically significant only in that it indicates the rate at which oil must be consumed to ensure the development of the successor resource—nuclear energy.

(2) *Capital investment = productivity.* An economy consumes technology in a mediated form—as capital such as machinery and labor. Given the primitive state of technology today, machinery is economically active only as an extension of human labor, whose power it amplifies. As such, capital is the primary determinant of the productivity of labor.

In fact, capital investment is only "economical" when it raises productivity. Since capital is not in itself economically active, it always represents a deduction from investments that are directly economically active; as we shall see, capital investment bears a close relationship to the process of entropy in a heat engine.

(3) *Technological development = living standards.* There is a close, often ignored link between the technological level of an economy and the cultural and educational level of its population. The causality works in both directions in this relationship: An advancing level of technology is the precondition for a more highly skilled and educated workforce.

It is well known that one of the most effective and rapid ways of acculturating a primitive rural population is by absorbing its members into urban industrial employment. The example of the South Korean economy clearly demonstrates the impact of relatively advanced technologies on the standard of living and educational level of a rural population.

But living standards also determine possible rates of technological innovation. In most underdeveloped countries, the lack of even a small skilled workforce is a major obstacle to industrial development. In the longer sweep of human history, technological development and investment in the development of manpower have been inextricably linked. Neither one has proceeded without the other for an extended period of time.

It is perhaps incorrect to call this relation a cause-and-effect law, since it has more of a teleological nature. The end of progress is not growth for its own sake, but human realization—the creation of conditions in which every individual has the material prerequisites to realize his or her creative potential. The point of the third law is that material wealth is a necessary means to the end of human development.

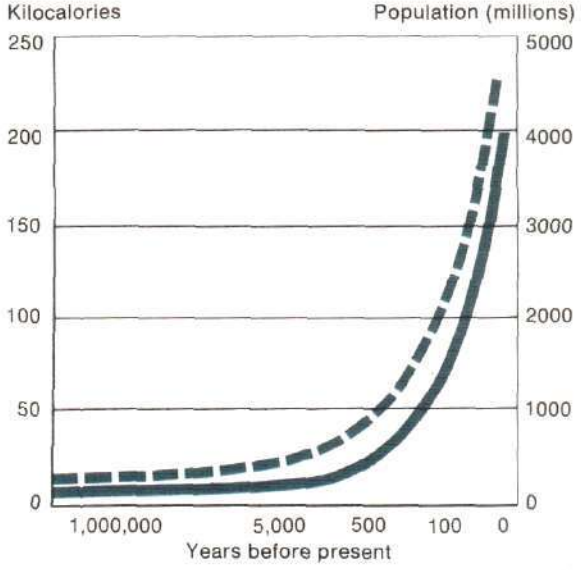


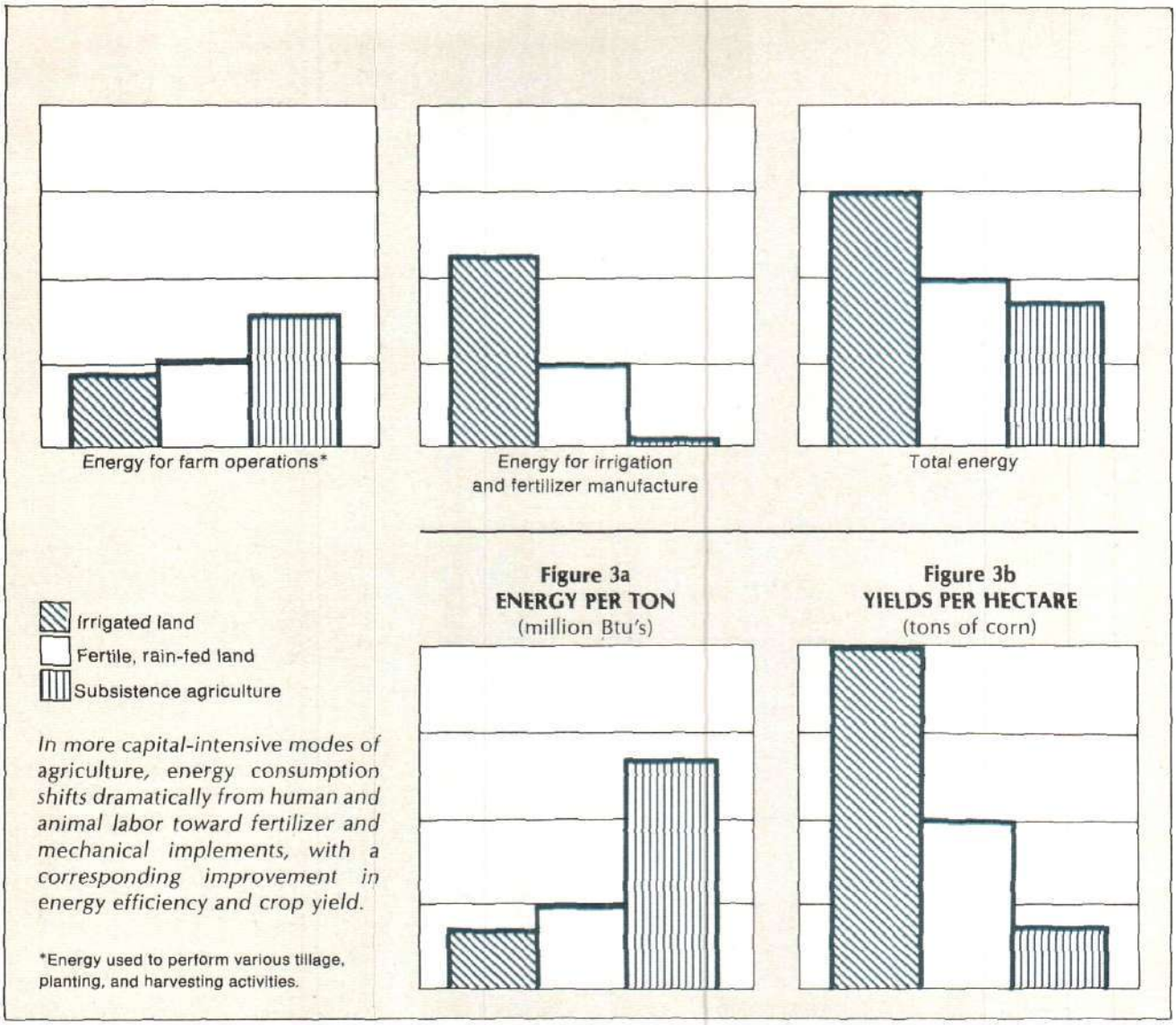
Figure 1
PER CAPITA ENERGY CONSUMPTION
Per capita consumption of energy (solid line) has increased through the years in direct proportion to population growth.

A Case Study from Agriculture

A study of the interrelationship of technology, energy usage, and productivity in agriculture provides an interesting empirical demonstration of the three laws of economics. Figure 2 shows energy consumption in the three major end uses in agriculture—cultivation, fertilizer, and irrigation—in corn cultivation in Mexico. The energy consumption figures are given for three types of agriculture: mechanized, irrigated production; production on rainfed, but good quality land; and subsistence agriculture, the most labor-intensive mode.

In the more capital-intensive modes, there is a pronounced shift from energy consumed in the form of human and animal labor toward energy consumed in the form of fertilizer and mechanical implements. However, the total amounts of energy consumed in the three modes of production are not very different when measured in terms of energy applied per land area. The advanced mechanized form of production uses only about 30 percent more energy per hectare than subsistence agriculture.

What is significant here is the change in the *quality* of



In more capital-intensive modes of agriculture, energy consumption shifts dramatically from human and animal labor toward fertilizer and mechanical implements, with a corresponding improvement in energy efficiency and crop yield.

*Energy used to perform various tillage, planting, and harvesting activities.

Figure 3a
ENERGY PER TON
(million Btu's)

Figure 3b
YIELDS PER HECTARE
(tons of corn)

energy applied. In fact, it is quite misleading to compare Btu's of energy in the form of human or animal labor and of fertilizer; they are so qualitatively different in their impact as to be incommensurable.

The use of human energy in subsistence agriculture represents a decline in the economy's global productivity, as well as in the quality of human livelihood. The shift to the higher quality forms of energy consumption represented by fertilizer use and mechanization, on the other hand, has the dramatic effect on productivity shown in Figure 3. Energy used per ton of food is significantly lower; yields measured in output per energy consumed are twice as high for mechanized agriculture, while yields per hectare are even higher.

Another case of the same phenomenon is shown in Figure 4, which compares energy consumption in the production of rice for countries of varying states of technological advancement. As the graph shows, it takes more than twice as much energy to produce a ton of rice in India as in Japan, yet Japan uses only about 25 percent more energy per hectare than India. However, the internal composition of the energy is dramatically different in the two cases. The intense application of high-quality energy in Japan, mediated through more advanced agricultural technology, results in the higher productivity.

Describing Interrelated Processes

The six components of the verbal equations formulated above are highly interrelated. A similar chain of cause and effect describes both economic progress and the process of depression and economic collapse, in which insufficient capital investment and rates of energy consumption reduce living standards and productivity, further retarding the rates of technological change and productivity growth, setting off a downward spiral.

As one might suspect, it takes a unique kind of mathematics to describe a highly interactive, self-reflexive process whose evolution—or devolution—occurs in discontinuous spurts. The mathematical methods that must be used are those that were developed by the 19th-century mathematician Bernhard Riemann to describe what he recognized to be a universal feature of evolution—the fact that it occurs in steps, by progress through what he called different manifolds connected together by mathe-

Figure 4
ENERGY USE PER HECTARE IN RICE PRODUCTION IN VARIOUS COUNTRIES*

	India	China	Taiwan	Japan	U.S.
Installed horsepower per hectare, farm machines and draft animals only	0.7	0.7	0.5	1.6	1.5
Energy for farm operations (million Btu's per hectare)**	20.0	20.0	10.0	10.0	7.0
Energy for irrigation and fertilizer manufacture (million Btu's per hectare)	6.5	12.0	22.0	22.0	25.0
Total energy input per hectare	26.5	32.0	32.0	35.0	32.0
Rice yield (tons per hectare)	1.4	3.0	4.0	5.6	5.1
Energy intensity (million Btu's per ton of rice)	19.0	10.7	8.0	6.2	6.3

*Total grain production depends not only on seed variety, soil quality, and so forth, but also on the mix of grains grown. Therefore, comparing a single grain gives a better comparison of the energy intensity of various farming methods.

**Energy used to perform various tillage, planting, and harvesting activities.

Source: Arjun Makhijani, *Energy and Agriculture in the Third World*, Cambridge, Mass.: Ballinger, 1975, p. 17.

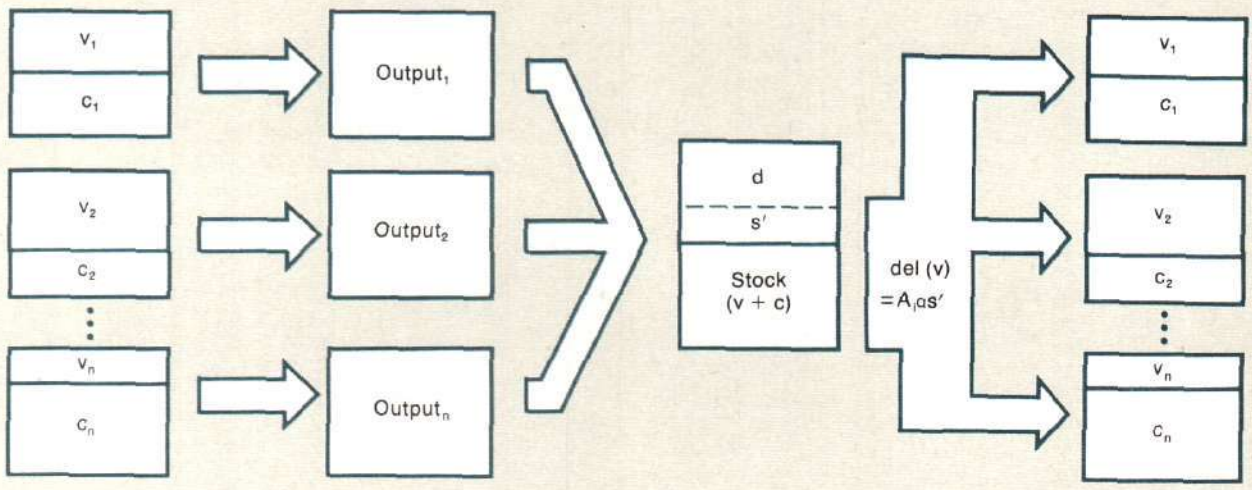


Figure 5
FLOW CHART OF FIRST-GENERATION LAROUCHE-RIEMANN MODEL

The model begins with the inputs to a cycle of economic production divided into the tangible goods necessary for reproduction of the productive workforce (labeled v_i, for the tangibles consumed by the productive workforce in the i-th sector) and the tangible goods required for the reproduction of plant, equipment, and raw materials (labeled c_i). These inputs are consumed in the production process, resulting in output from each sector.

Each sector produces surplus ("value added") in proportion to the productivity of that sector; causally, the employment of productive labor creates profits. The model then pools the output from each sector and divides the total output into three categories: first, the stocks necessary for an exactly equilibrium reproduction of the labor force and capital goods of the economy (this will equal the sum of the v_i and c_i of the next cycle of production); second, the surplus invested in the expansion of v and c in the next cycle (this reinvestment goes either to an expansion in scale or quality of the economic process); and third, the other "overhead" expenditures (labeled d) out of which are met the stock of tangibles both necessary (health, education, some services, some parts of government, and so forth) and unnecessary. The successful reproduction of an economy depends on the relative size of the productive compared to the nonproductive expenditures. On this basis, the model defines a "free-energy ratio," $s'/(c + v)$. If this ratio is increasing at an increasing rate, then the economy is progressing.

matical singularities. Riemann formulated a kind of mathematics that defines functions in terms of their singularities and manifolds in terms of the types of functions that they support.

It is important to note that there is a very strong converse to Riemann's approach in mathematical physics called the H-theorem.[3] This rigorous mathematical result states that if a system is restricted to a single, singularity-free manifold, then evolution toward states of higher complexity is impossible. The H-theorem proves that *devolution* is a necessary consequence of the assumption of continuity and linearity. It is only a Riemannian mathematical approach, in fact, that can describe the most basic feature of economics—progress.

Figure 5 represents in flow-chart form the first generation of the LaRouche-Riemann model. The model begins with the inputs (measured in monetary terms) to a cycle of economic production divided into the tangible goods required for the reproduction of the productive workforce (labeled v_i for the tangibles consumed by the productive workforce in the *i*-th sector) and the tangible goods required for the reproduction of plant, equipment, and raw materials (c_i). These inputs are consumed in the production process, resulting in output from each sector.

A fraction of each sector's output is surplus ("value added" in a rigorous sense) in proportion to the productivity of that sector. Causally, the employment of productive labor in each sector creates profit ascribable to that sector.

The model then pools the output from each sector and divides the total output into three categories: first, the stocks necessary for an equilibrium reproduction of the labor force and capital goods of the economy (this is approximately equal to the sum of all the v_i and c_i from the previous cycle of production); second, the portion of the total surplus invested in either v or c during the next cycle of production (this reinvestment goes for an expansion in scale or quality of v and c); third, the portion of surplus reinvested in "overhead" expenditures (labeled d), which are met out of the stock of tangibles. These overhead expenditures represent both necessary expenditures (health care, education, some services, necessary government spending, and so forth) and unnecessary ones.

Productive Versus Nonproductive

The distinction between productive and nonproductive consumption is absolutely fundamental. Most economic theories fail to make the distinction, however, and lump

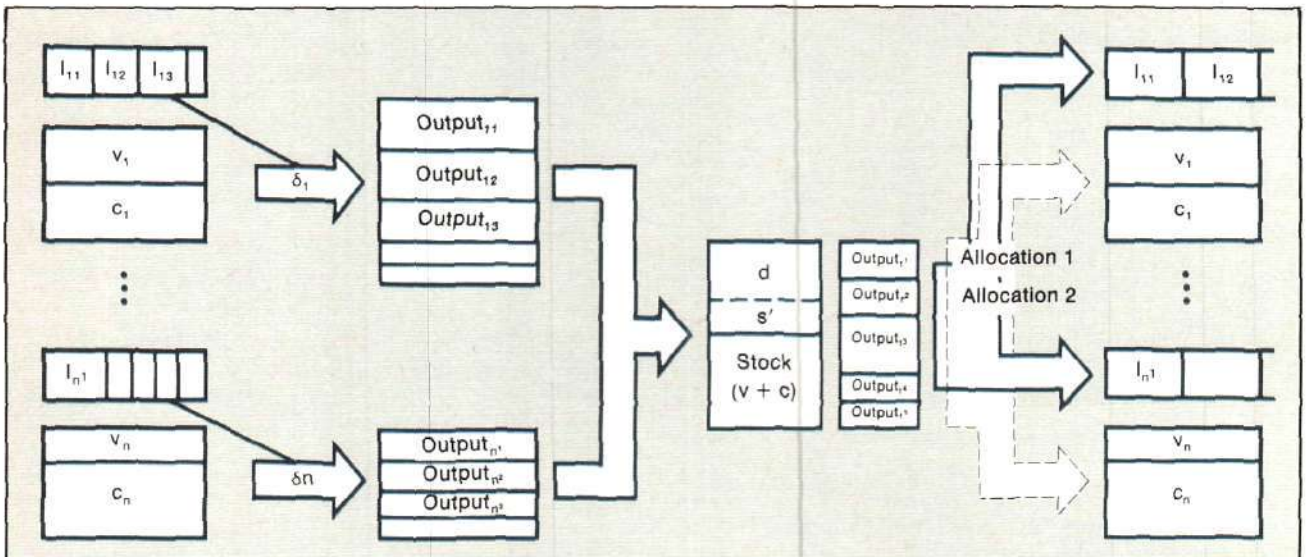


Figure 6
FLOW CHART OF THE THIRD-GENERATION LAROUCHE-RIEMANN MODEL

A real economy functions on two levels simultaneously, only one of which is treated by the model shown in Figure 5. In addition to the flows of tangibles tracked in the first-generation model, the economy's reproduction depends on the material composition of these flows. Thus, a certain mix of labor, capital, energy, and new technologies implies reproduction in the next cycle at a certain productivity. In the third-generation model, this composition is taken into account by a productivity measure that functionally depends on the input-output vectors for that sector. This allows the modeler to determine the productivity of a given sector by varying the inputs to that sector (its energy intensivity, for example).

Once the production cycle is completed, two allocations must be made. The first of these replicates the financial allocation of reinvestment to each sector parallel to that in the first chart. In addition, the surplus product must be allocated in its material form. This latter allocation is especially critical in bottleneck areas like machine tools where a small shift of investments from one sector to another can greatly affect the overall productivity. (The second-generation model, not shown, includes fixed capital and depreciation.)

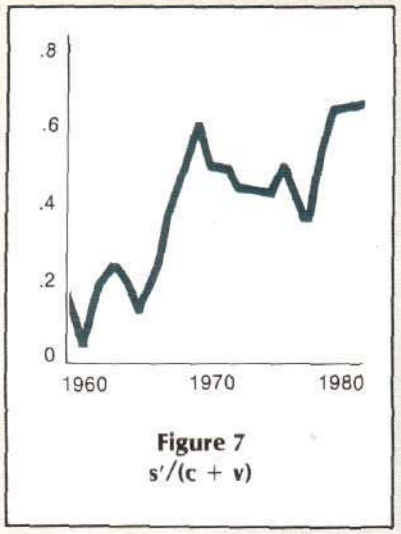


Figure 7
$s'/(c + v)$

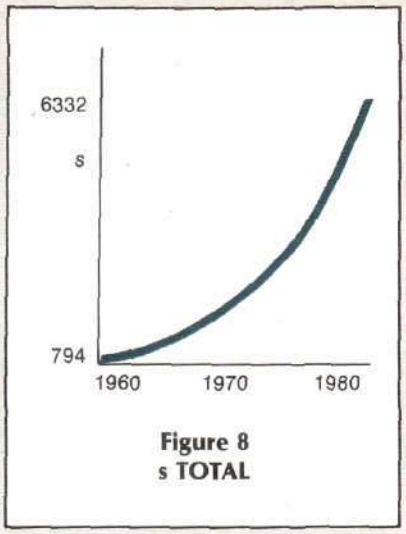


Figure 8
s TOTAL

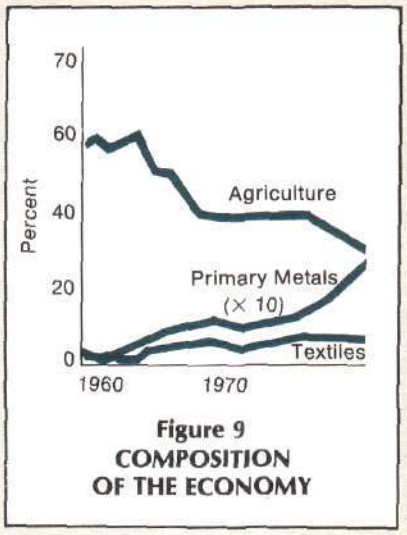


Figure 9
COMPOSITION OF THE ECONOMY

Glossary of equations*

The differentials

$ds'/dt = \alpha\delta s' - \alpha\gamma s' + \dot{\delta}v - \dot{\gamma}v,$

$dv/dt = \alpha s',$

$dc_1/dt = (1 - \alpha)\eta s',$ and

$dc_2/dt = (1 - \alpha)(1 - \eta)\epsilon s',$ where

α = composition of reinvested capital = $\Delta v/s'$

δ = productivity = s/v

γ = nonproductive expenditure = d/v

η = circulating to fixed capital ratio = $\Delta c_1/(1 - \alpha)s'$

ϵ = depreciation rate

v = output required for replacement of productively employed workforce

c_1 = output required for replacement of productively consumed raw materials

c_2 = output required for replacement of productively employed plant and equipment

s = total output $(v + c_1 + c_2)$

s' = that section of s invested in new productive capacity (i.e., next year's v, c_1, or c_2)

$d = s - s'$

*Notice that this system of equations is a slight generalization of the previous Riemannian models, in which equations (1) and (2) have not been changed, and (3) and (4) subsume the old equation for c.

together in equivalent economic categories the construction materials used in building a steel mill, for example, and those used in building a gambling casino. The same "effective demand" may be generated by both investments, but the economic significance of the investments is totally different when measured in terms of their impact on future economic activity. The construction of a steel mill increases an economy's capacity to produce tangible goods, which is especially significant today when insufficient steel capacity is a critical bottleneck in almost every developing nation. The construction of a casino, on the other hand, is a net tax on the economy that made the investment. The materials and labor used are lost to further economic activity, and, worse, the moral and cultural level of the population is lowered as a result of the casino's construction.

The LaRouche-Riemann model classifies investments in the expansion of the productive workforce and capital as net additions to the labor stock and capital of an economy, and it classifies nonproductive investments as net deductions from the economy's gross profit. The model quantifies these considerations through two ratios:

δ = *productivity.* Although output per manhour is a useful measure of productivity, it obscures the actual energy relations in economic production. The LaRouche-Riemann model uses a more rigorous measure of productivity given by the ratio s/v, or the surplus produced by a given investment of productive labor.

This ratio differs in two crucial ways from conventional measures of productivity: First, the base is the manhours or wages of only the productive workforce—both white-collar workers and necessary service operatives are excluded. Second, the numerator is not gross output but gross profit or surplus. Since productive labor "passes along" the value of the production inputs with which it began, its real productivity is obscured if those raw materials are included in a measure of labor's productivity. Hence, a more accurate measure of the content of labor's activity in a cycle of production is given by counting only the surplus or gross profit it generates.

The South Korean Economy: 1960-1980

The South Korean "economic miracle" is already a classic case study in economic development. Economic historians are astonished by the transformation of a country whose population was poorer and less urbanized than India's 20 years ago into an almost fully industrialized nation.

The figures here show some of the most outstanding features of a series of unique, qualitative changes in the South Korean economy over the last 20 years. Figure 7 shows the change in $s'/(c + v)$ from 1960 to 1980. Tangible goods production grew at an average annual rate of 18 percent—a 25-fold increase in 20 years—and, as the figure shows, that growth rate was even higher in some years. Figure 8 shows the change in gross profit, s, over the same period.

A comparison of the two figures shows the diagnostic capability of the ratio $s'/(c + v)$: The two low points in Figure 7 are the years when South Korean political factions allied to the World Bank imposed investment policies favoring labor-intensive sectors of the economy. The high rate of growth in other years was a direct result of the capital-intensive and energy-intensive investment policies that have generally prevailed in the South Korean economy since 1960.

Figure 9 shows the effect of investment patterns on economic growth by comparing the total gross profit ratio in South Korean economic sectors representing relatively labor-intensive production (agriculture), light industry (textiles), and heavy industry (metals). The development of the South Korean economy over the last 20 years shows in a very dramatic way the results of concentrating investment in technologically advanced sectors: marked increases in productivity, urbanization, and capital use.

γ = *nonproductive expenditure rate*. Parallel with productivity, there is an "unproductivity ratio" given by U/v, which measures the average rate of overhead per wage unit of productive labor. All nonproductive investment, whether necessary or unnecessary, is included in the numerator of this ratio. Of course, a rising γ may reflect very different states of economic activity: If the increase in U is the result of rising educational and cultural levels, then the productivity ratio will also be rising. However, if the overhead expenditures are largely unnecessary expenditures, then productivity will be falling.

In either case, it is the difference between the productivity and "unproductivity" ratios that determines the sign and magnitude of s'. Since gross surplus less overhead equals net investment, net investment per productive wage is given by the difference between δ and γ. If the rate of nonproductive investment is greater than the increase in productivity, then the economy has a negative net investment. This is not just a mathematical possibility, for, as we shall see, the U.S. economy has been in precisely such a state since the mid-1970s!

The difference between δ and γ is measured by a closely related ratio called the free-energy ratio, or $s'/(c + v)$. This is the ratio between productively reinvested surplus, s', and the tangible goods that are necessary for equilibrium reproduction of the economy, $(c + v)$. The free-energy ratio is a measure of the efficiency of a given economy in employing its productive capacity $(c + v)$ in the production of reinvestable surplus (s'). The behavior of this ratio is the most sensitive gauge of the success or failure of an investment program.

The Problem of Allocation

On every level of the economy, from the single private or state firm to the national economy, the central practical question of economic planning is the mix of reinvestment—the disposition of s'. Should I expand by adding another shift? Should I construct a new plant? Should this plant duplicate my present facility or should it use newer technologies? Should I go into another industry?

The model quantifies such investment decisions in a second set of ratios, which are almost totally determined by policy decisions. They are:

α = *composition of investment*. This ratio is the investment in new productive labor (v) divided by the total reinvestable surplus (s'). An increase in α reflects a proportional increase in investment in labor; a decline means that a higher proportion of s' is being reinvested in plant, equipment, and raw materials. The magnitude of this ratio reflects almost solely investment decisions.

The interpretation of changes in α is complex.

A rise in α reflects a more rapidly growing workforce and, as a first-order effect, the production of more surplus, simply because more people are working. However, the growth of α also reflects a slower growth of capital-investment rates, which lowers the productivity of the employed workforce. This tradeoff between a larger (or better quality) workforce and capital accumulation is the oldest and most difficult paradox of economic progress.

The LaRouche-Riemann model, however, provides a criterion for making an optimal allocation of s', as we shall see, based on the maximization of rates of increase of $s'/(c + v)$, the free-energy ratio.

In addition to the allocation affecting the internal composition of s', the economy's pool of net surplus must be divided up by sector. The inter-sector allocation of investment is determined by a fraction A_i of total s', which is invested in the i-th sector; the amount of investment in a given sector is A_i times the total s'. The result of the allocation process is a set of differential equations that describe the time rates of change of s, v, and c for each sector of an economy, in terms of productivity, nonproductive investment, and the externally determined ratios governing allocation of investment (see box for a listing of these equations).

This set of differential equations—numbering 76 in the case of the model of the U.S. economy—is solved year by year or quarter by quarter on a computer. The computer provides as output the values of gross tangible surplus (s), productive workers' wages (v), and capital inputs (in the

first generation of the model, all capital is lumped together; in the second generation, raw materials and energy are distinguished from plant and equipment), along with the overhead expenses for the entire economy and, most important, the free-energy ratio. Two case studies from recent economic history and one development plan prepared using the LaRouche-Riemann model are summarized in accompanying boxes.

The Economy As a Machine

If the science of economics is governed by a set of cause-and-effect laws, then economies must have an underlying structure, one whose surface manifestations are the observed lawfulness and mathematical regularity. This is indeed the case, and an understanding of this deeper level is essential if we are to be able both to understand current economic history and to ensure the successful continuation of human progress.

Even intuitively, one thinks of an economy as a machine of sorts, albeit, a very complex one—a mechanical device that must be maintained, that requires fuel and other inputs, and that produces a useful output. Most important, the fundamental problem that motivates both economics and thermodynamics, the science of machinery, is that of maximizing the efficiency, the useful energy or what in thermodynamics is called the "free energy," of the engine or economy.

In both systems, the amount of accessible energy is less than the total energy. Thermodynamics and economics are (or should be) directed toward minimizing the difference, the wasted energy. Specifically, we are interested in *maximizing* the ratio of free energy to total energy—a quantity we call the free-energy ratio.

The distinction between total energy and free energy can be seen from an example cast in thermodynamic terms. If we have 4 gallons of water at 0 degrees Celsius and 1 gallon at 100 degrees Celsius, in a room at 20 degrees (ambient), useful work can be extracted from the temperature differences between the two bodies. (We could change all the internal energy into electricity with an ideal engine, for example.)

The total internal energy of the system is the sum of the energy of the two parts. Now, if we mix the 5 gallons of water together, we will have 5 gallons at 20 degrees Celsius, a mixture with the same total energy we started with—but with no "free" energy. Since the temperature difference between the water and air is zero, no work can be done with the total (internal) energy in the water. The free-energy ratio has changed from 1 to 0!

It is clear that the free-energy ratio will be intimately related to both the economic and technical aspects of the economy; in some sense, it must measure the appropriateness of the economic superstructure to the underlying mode of industrial production. A fall in the free-energy ratio indicates the transition of the economy into a state of "inappropriate" economic reproduction. A rising value

India's Development Strategy

Using the LaRouche-Riemann model, the Fusion Energy Foundation created a 40-year development strategy for the Indian economy. The program calls for an 11 percent per annum increase in industrial capacity and an 8 percent per annum increase in per capita consumption over the 40-year period. At these growth rates, India's industrial base will increase 51 times, per capita consumption in rural areas will increase 26 times, and per capita consumption in the industrial sector will increase 10 times.

Figure 10 shows the quantitative aspects of the development plan, with s expressed logarithmically. Figure 11 shows the ratio $s'/(c + v)$ for the

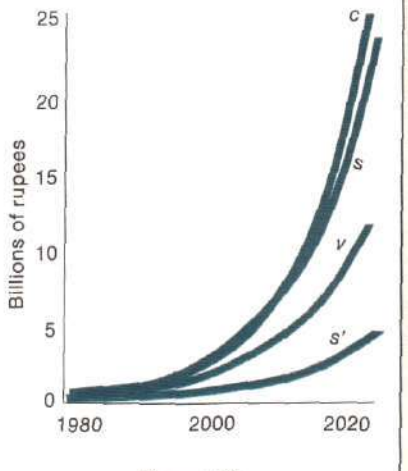


Figure 10
TOTAL PRODUCTION

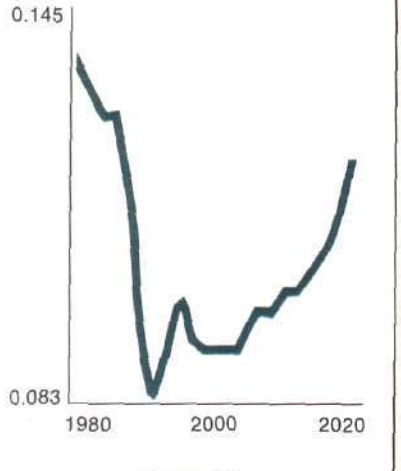


Figure 11
$s'/(c + v)$

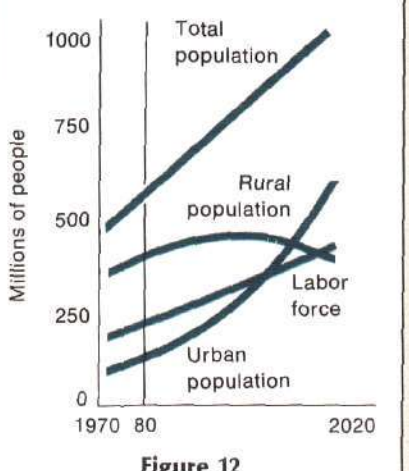


Figure 12
LABOR FORCE PROJECTIONS

of the ratio, on the other hand, indicates an "appropriate" economic superstructure, whose investment pattern is enhancing the productivity of the labor force, and, in turn, fostering capital formation. Zero or negative values of this ratio are also possible, indicating a net *destructive* effect of the economic activity on the physical economy. A value of 0 for this ratio is a "crucial point" in thermodynamic terms, measuring the onset of a phase transition or other singular phenomena (in economic terms, a depression).

Thermodynamic Parallels

The first step in a thermodynamic analysis of an economy is to find the parallels to the two laws of thermodynamics; the first, an energy balance law, and the second, a cause for dissipation or impossibility of attaining a free-energy ratio of 1. (Sometimes the first law is erroneously called the conservation of energy; it is clear from its economic version that it actually describes the law of energy transfer.)

The economic first law (which is derivable from the differential equations in the Riemannian model), is:

ΔE = change in total output
= $\delta W + \delta Q$ (where W is work and Q is energy)
= increment of capital consumed and reproduced continually + increment of capital not consumed and replaced annually.

That is, there are two distinct forms of economic value added by the production process. The first is that portion of production that is consumed (and reproduced) continually in the economic process. In this category belongs, for example, productive workers' wages (v), raw materials, and so on. The dynamics of this portion is basically different from the second category, which includes all economic production "lost"—for whatever reason—from continued production. This portion includes all waste, nonproductive expenditures (military, most bureaucratic expenses, and so on), and that portion of plant and equipment not consumed during a given production period (that is, the nondepreciated part of gross capital stock).

As is the case in thermodynamics, the worklike term represents totally useful energy exchange. This component of the free energy turns out to be the product of the productivity and the rate of increase of the workforce. Mathematically, it is α times δ times the change in the size of workforce. This formula is analogous to the thermodynamic analysis of an engine, where the work is the product of the pressure times the change in the volume of the working fluid in the engine. In the case of the economy, the equivalent of the size of the working fluid is the size of the productively working population, and the pressure that moves this workforce is the product of the productivity of the workforce and the investment made in it (α). This first result is quite reasonable, since it

entire program. After a decade or so a singularity develops, and economic development takes off. During the first 10 years, however, there is a "regrouping" of economic resources emphasizing infrastructural capital investment, for which there is no immediate return. These investments result in increases in v and c, but they do not yield an immediate increase in productivity. Once the infrastructural development is almost completed, the economy enters a qualitatively different phase, reflected in sustained growth after 1990 and an accelerated increase in the ratio $s'/(c + v)$.

Figure 12 shows the growth of different sections of the population over the 40 years. Figure 13 shows the changes in the composition of the Indian economy during the same period. The year 1990 is also an inflection point in this aspect of the program, where industrial output surpasses agricultural. At this point the economy is transformed from a rural into an essentially urban economy.

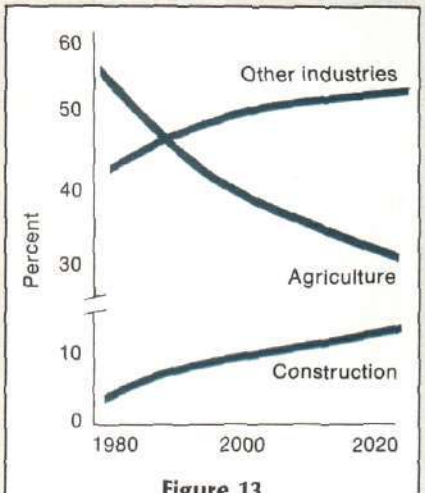
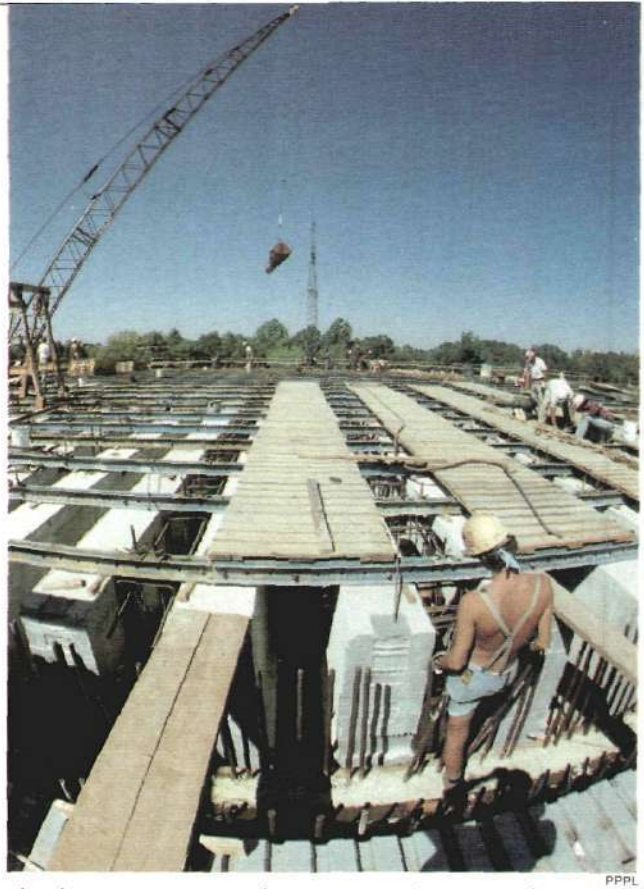


Figure 13
COMPOSITION OF THE ECONOMY

Uwe Parpart

Successful economic development in India or any developing nation depends on assimilating successive layers of the population into a modern scientific workforce.



PPPL

The key to reversing the erosion of U.S. productivity is increased investment in leading-edge areas of technology like fusion. Here, construction work on the TFTR tokamak at the Princeton Plasma Physics Laboratory.

the combination of both productivity and continued investment in manpower that "drives" the economic contribution of the productive workforce.

The heatlike term in the energy balance is the sum of two contributions. First, all of an economy's overhead is lost to further economic production and therefore is part of the heat; this "energy" is not accessible and is a deduction from total energy. Besides this, a portion of the investment in plant and equipment is also lost to further production; it is necessary for continued production, as is at least part of the overhead, but it does not contribute directly to the increase in output (or useful energy output). This part of the lost heat energy is inversely proportional to the depreciation rate. The faster that capital turns over (or is written off), the smaller is the part removed from economic activity, and the smaller is the lost heat energy. In the thermodynamic analogy, both of these terms correspond to effects like friction in an engine. Some of the total energy will be lost, unavoidably, because of effects like friction; overhead and undepreciated plant and equipment are in that category.

At this point, the second law of thermodynamics can be formulated for economics. In the case of an engine, the second law of thermodynamics states that no transformation of energy can take place with 100 percent efficiency (with a free-energy ratio of 1); some of the energy will be lost to friction and other effects. For an economy, the second law states the simple but important result that economic production cannot proceed without overhead

The U.S. Economy: 1970-1980

The unusual behavior of the U.S. economy over the last 10 years makes sense only if the economy is analyzed thermodynamically, in terms of the "phase change" that occurred some time in 1975. By means of the differential equations used in the LaRouche-Riemann model, we can find the economic equivalent of useful work ("free energy"), as well as efficiency with respect to time and a series of "state variables." These allow us to completely specify the economy's thermodynamic state—its present efficiency and its ability to produce free energy in the future. We can also derive what in thermodynamic terms is called the "equation of state"—the relationship between the variables defining possible states of an economy and the paths linking them.

The first graph, Figure 14, shows a phase plane for a modern capitalist economy like the U.S. economy. The three relevant thermodynamic state variables are $\alpha \times \delta$ (productivity times investment in the labor force), v (total tangible product consumed by the labor force), and R (the rate of depreciation). It can be easily shown that for a constant R, $\alpha \times \delta$ and v are inversely related and generate the hyperbolas shown in Figure 14 (when R is sufficiently large).

However, if the depreciation rate is smaller than R_c, the hyperbolas become distorted and an inflection point develops. The area around this distortion (the shaded region) shows the development of a singularity separating two different phases of the economy: this is similar to what happens with water and steam in the phase diagram of a simple thermodynamic system such as water. When the combined values of $(\alpha \times \delta)$, v, and R move into the shaded area, the economy is about to undergo an abrupt and qualitative change, a depression. Different dynamic laws and different equations of state apply in this region.

Figure 15 shows the path followed by the U.S. economy over the last 10 years. In the early 1970s, during the period in which the U.S. economy was still running on the momentum generated by the space program of the previous decade, s' decreased below zero because of the accelerated obsolescence of fixed capital and the oil price increases of 1974. The U.S. economy has been in a state of disinvestment since 1975; the economy's productive base has been shrinking for six years. This trend put the U.S. economy on the path shown in Figure 16, where the shaded area indicates states in which s' is negative (net disinvestment). The highly unstable behavior of the U.S. economy beginning in 1974 is the result of an imminent phase change.

and fixed capital expenditures. This part of the total output may be minimized, but it will never be zero.

In more precise terms, the entropy, or disorder in the economy, is proportional to the accumulated nondepreciated stock of plant and equipment. The efficient operation of an economy requires that that stock be depreciated as rapidly as possible.

Capital is in fact depreciated by new technologies that make the old investments obsolete. This result might appear somewhat paradoxical from the standpoint of the individual firm, since it would seem that the individual firm would benefit from extending the life of its capital as long as possible. Obsolescence *from an accounting standpoint* is not bad since it represents a savings of capital investment. However, this is not actually the case.

The higher the depreciation rate, the lower the entropy of the production process and the more efficient the economy. High depreciation rates ensure this. As Samuel Insell is reported to have said, "The scrap heap is the capitalists' greatest asset."

The danger to the economy comes from a discrepancy between the economic (tax or legal) rate of depreciation and the actual, technologically determined rate. If the legal rate of depreciation is lower than the technological rate for any extended period of time, the observed rate of profit will fall secularly—or, to prevent this fall, a nominally larger amount of capital will chase a fixed or declining amount of profit, generating inflation. In either case, the conflict between the economic superstructure and the industrial underpinnings will push the free-energy ratio toward or below zero, causing a depression.

The occurrence of depressions—or singularities—in an economy can be represented thermodynamically by a "phase diagram" that plots the relationship between the "pressure" and "volume" in an economy as a function of the "temperature" (the depreciation rate). The phase plane for a capital-intensive economy is shown in Figure 16 and a discussion of its application to the U.S. economy is shown below.

Planning Investment Strategy

We can now answer the practical question posed by investment: What is the best way to spend available profit? The LaRouche-Riemann model prescribes a two-step process. First, determine the desired end-state of the investment program. For an economy as a whole, an investment strategy must first specify a goal, either in terms of consumption, output, or growth rates. In the case of an individual firm, a business plan has the same function. The model demonstrates whether a goal is possible. An investment plan that specifies a final state with lower energy consumption than the initial state is impossible; a singularity will be reached first that will destroy the economy. An equilibrium end-state, for similar reasons, is not accessible.

Using a phase-plane analysis to map out the current state of an economy and the proposed goal, a global picture of the trajectories between these states can be

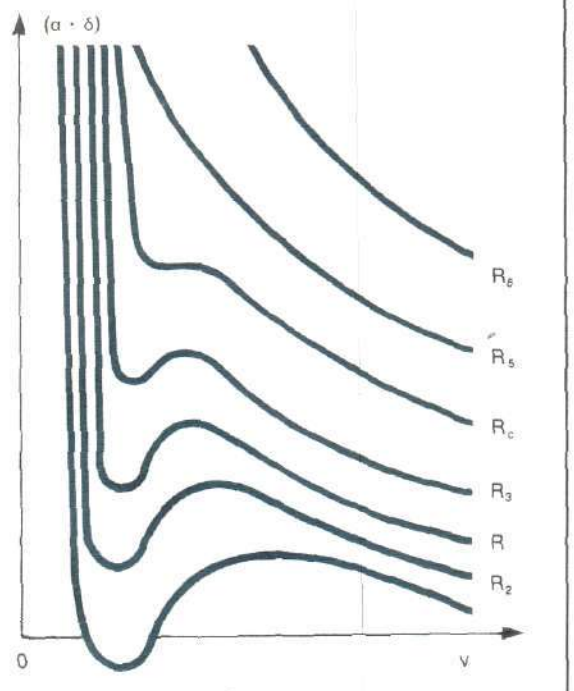


Figure 14
PHASE DIAGRAM OF THE U.S. ECONOMY

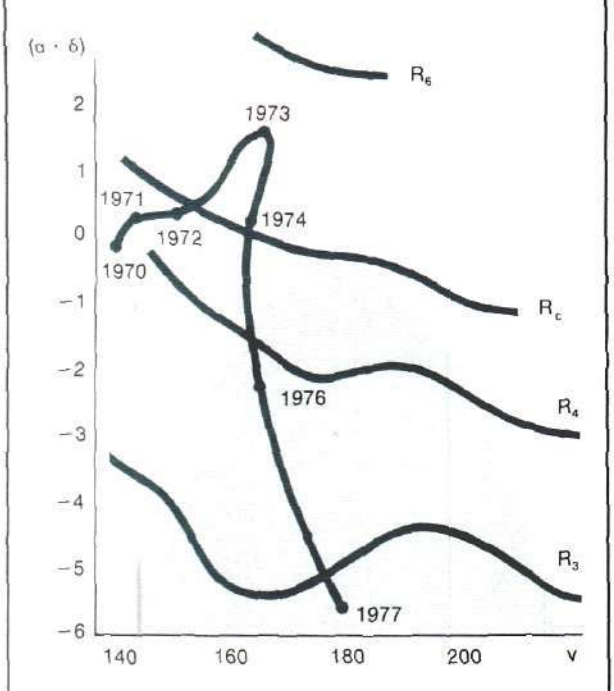


Figure 15
THE U.S. ECONOMY

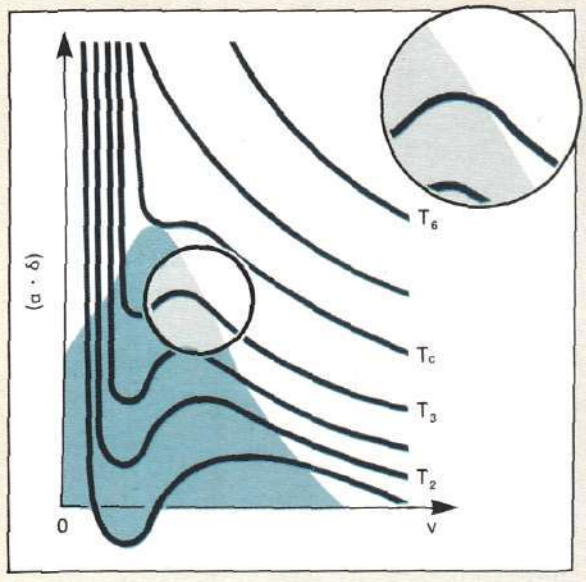


Figure 16
PHASE DIAGRAM FOR AN ECONOMY

By the same arguments that underlie classical thermodynamics, it can be shown that a capital-intensive economy has a phase diagram similar to that for a real gas, where pressure is replaced by $\alpha \cdot \delta$ *(see text) and volume by v (variable capital—tangible goods required for the reproduction of productive labor). The depreciation rate corresponds to temperature. Thus, the hyperbola shown above for* T_6 *expresses the fact that for a given depreciation rate (that is, capital investment and composition of investment) the size of labor force and productivity required to maintain that depreciation schedule are inversely related. And, as in the case of a gas, lowering the depreciation rate corresponds to cooling of the economy, a process that can be carried on for only a finite amount of time before a phase change occurs. In the case of the economy, this corresponds to a depression. The inset shows in greater detail the dynamics of this phase change. It is known that some gases have the property that they can be supercooled below their nominal condensation point predicted by the phase diagram. In this case, the isotherm (the path at constant temperature) changes sign in slope. In the case of the economy, this property characterizes the present situation in which a phase change has yet to occur, but during which the dynamics of the economy are opposite from their normal behavior. The usual methods for dealing with inflation, for example, not only do not work, they make the problem worse, precisely because of the inflection in the phase diagram.*

The trajectory of the U.S. economy over the last 10 years does not follow an isotherm, but a trajectory taking it from near the curve T_6 *to that near* T_3 *as the productivity-composition product (the vertical axis) has decreased, and the labor force increased.*

represented. Such an analysis shows that there is no viable investment path to global economic development without a large growth of the workforce and a manyfold increase in consumption. There is no slow path to development.

It is clearly not enough to specify a goal, however. We must also determine whether a goal is attainable and what the most efficient way of getting there is. In mathematical terms, we must solve two interconnected problems: Does a trajectory exist that connects the economy's present state with that where we would like to be?—that is, an existence theorem must be proved. Second, what is the shortest-time path between those two points? There is a powerful mathematical technique for answering these problems called optimal control theory, and it has been used in conjunction with the LaRouche-Riemann model to calculate the shortest, most efficient path for the development of an economy.

This same theory can be used to formulate a general result, moreover, which allows us to characterize in general such a shortest path, or geodesic, in economic space. We would like to find a way of turning the global (and not very useful) criterion for investment provided by the shortest path (that is, get there the fastest) into a "local" criterion that can be applied to any particular investment decision. We need a way of judging immediately whether a specific investment is a good investment without waiting 20 years to see whether it got us where we wanted to go. Optimal control theory allows us to turn the global minimum-time specification into a local maximization criterion; it says maximize $s'/(c + v)$ at every point. Since the free-energy ratio is the instantaneous growth rate, it is reasonable that the shortest path (in time) is the one that maximizes the rate of growth at every point. Practically, this means that a successful investment policy must implement what a cause-and-effect picture of an economy implies:

- maximize productivity, using capital and energy-intensive technological innovations
- maximize the rate of turnover of capital, by encouraging rapid depreciation (in thermodynamic terms, operating the economy at a high temperature)
- continually accelerate scientific discovery as the means and end of truely human existence.

That is progress.

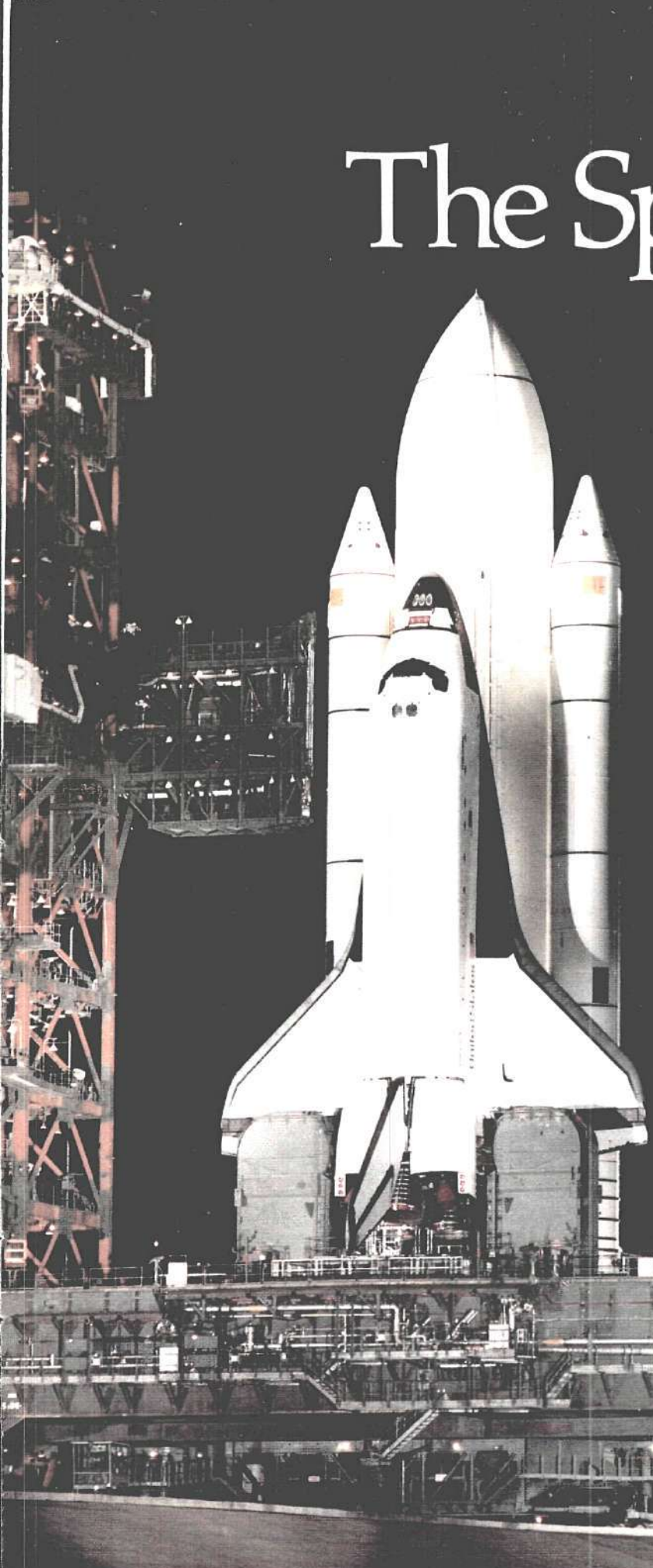
Dr. Steven Bardwell, a plasma physicist and the new editor-in-chief of Fusion, *was one of the leading developers of the LaRouche-Riemann econometric model.*

Notes

1. Lyndon H. LaRouche, Jr., *Dialectical Economics.* Boston: Heath, 1975. *The Theory of the European Monetary System.* New York: Campaigner Publications, 1978.
2. Bernhard Riemann, "On the Propagation of Plane Air Waves of Finite Amplitude," *International Journal of Fusion Energy,* Vol. 2, No. 3, p. 1 (1980). Felix Klein, *Riemann's Theory of Algebraic Functions.* New York: Dover, 1963.
3. For more details, see Morris Levitt, "Linearity and Entropy: Ludwig Boltzmann and the Second Law of Thermodynamics," *Fusion Energy Foundation Newsletter,* Vol. 2, No. 3 (1976). For another viewpoint, see N. Georgescu-Roegan, *The Economic Process and the Entropy Law.* Cambridge, Mass.: Harvard University Press, 1960.

The Space Shuttle

Making Space A Scientific Laborato



by Marsha Freeman

By the mid-1980s the space shuttl system will take man into space as ation, much like a scheduled comm will make the zero-gravity, near-vacuum ment available to experimenters, medical scientists of all kinds on a weekly basis.

The shuttle will be a multipurpose reusa can launch satellites, repair objects alread and transport provisions between Earth in orbit.

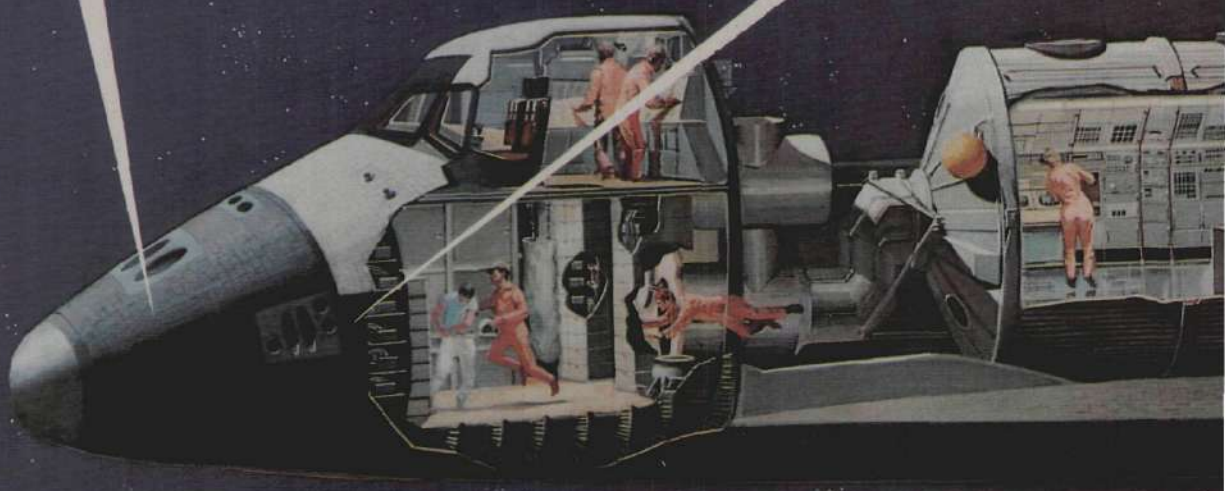
The most complex craft ever designed, t has technical constraints unlike those of vehicles. It will be launched vertically lik either from Cape Canaveral in Florida o Air Force Base in southern California, bu landing like an airplane.

Upon ignition the shuttle orbiter will b by three engines on the orbiter and tw boosters on either side of the orbiter craft engines and boosters will deliver approxim pounds of thrust to lift the shuttle thro atmosphere. (This is the equivalent of a power engine.)

About two minutes after lift-off, the t

1. APPLICATION OF TILES

2. AVIONICS



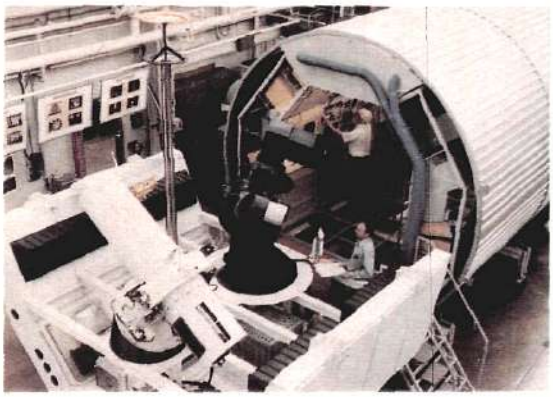
boosters will separate from the orbiter and parachute down to Earth to be recovered and reused. Approximately 8 minutes into flight the huge external fuel tank will also separate; at an altitude of about 70 miles, it will burn up as it careens through the Earth's atmosphere. The fuel tank is the only nonreusable part of the shuttle transportation system.

One of the most exciting capabilities the regularly scheduled shuttle will provide is an in-orbit space laboratory that can be used by scientists, not just astronauts. A prototype of Spacelab is shown in picture 3. The experiments can be altered or results brought back to Earth as often as necessary, which means that changes can be made as the experiment develops.

This model of the Spacelab that will be located in the shuttle cargo bay illustrates two separate capabilities of the laboratory. The rounded white structure in the background is a pressure laboratory outfitted to do many kinds of biological, chemical, and other experiments. The open white structure in the foreground is a pallet that is exposed to the space environment directly when the cargo bay doors are opened, about 90 minutes after lift-off. The pallet can be arranged in numerous ways to accommodate telescopes, antennas, and other large experimental equipment, or experiments that need direct space exposure.

Spacelab is being built and supplied to NASA by the European Space Agency and will be available to teams of international specialists.

The space shuttle has three subsystems that were especially challenging to the scientists and engineers at Rockwell International and subcontractors: the shuttle engines, the avionics, and the thermal insulating tiles.



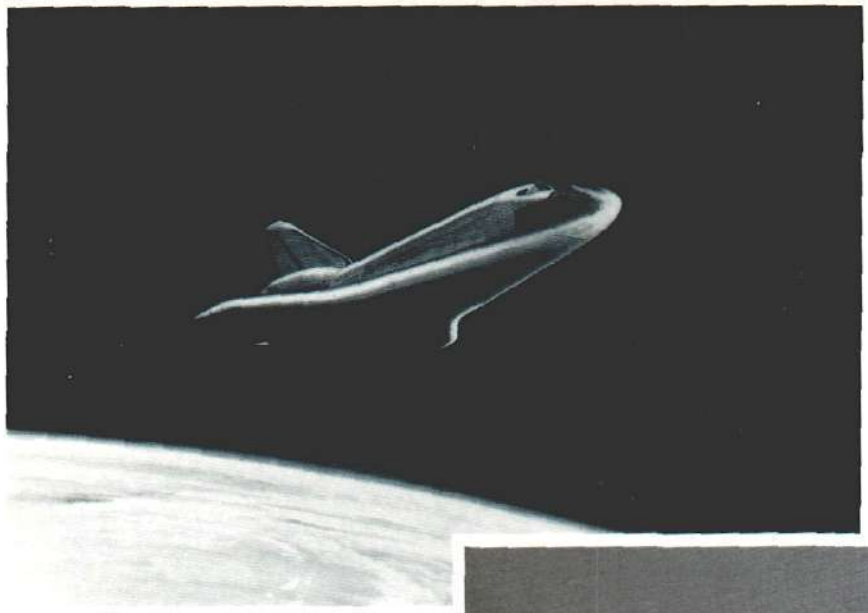
3. SPACE LAB

4. COLUMBIA ENGINE

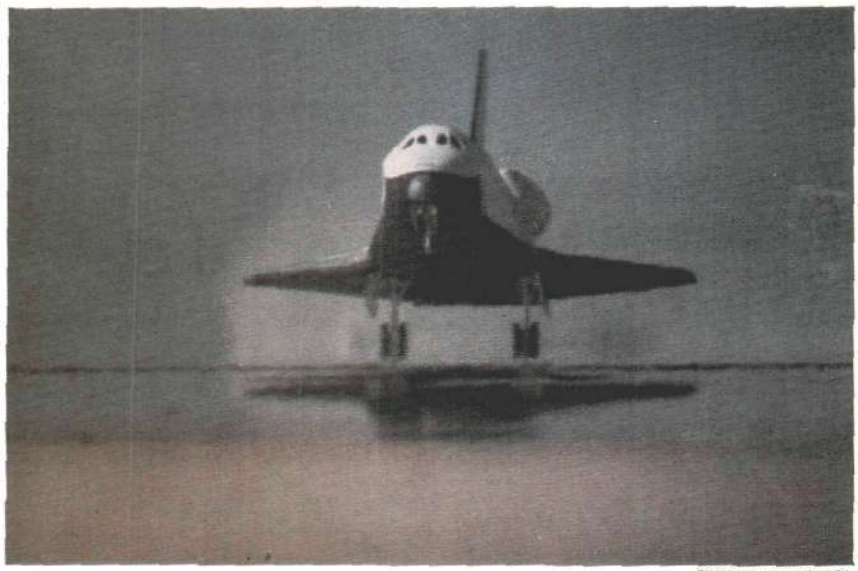
Picture 4 shows one of the three engines that will fly on the first orbiter to be launched, the Columbia. The Rocketdyne division of Rockwell International had the formidable task of designing an engine with a thrust-to-weight ratio that is 200 times that of a car engine and two-thirds greater than NASA's Saturn rocket engine, which launched the Apollo lunar spacecraft.

To do this Rocketdyne had to go to temperatures and pressures never before attempted in an engine. In addition, the engine had to be designed to withstand more than 50 firings on successive trips to make it reusable. The main combustion chamber, burning liquid hydrogen at only 14 degrees above absolute zero, will reach 6,000 degrees Fahrenheit during combustion.

In addition, it will reach about 32,000 pounds per square inch of pressure, four times that of any previous rocket



This photograph (below) of the landing of the orbiter Enterprise after its test separation and glide-down from an airplane demonstrates the orbiter's aerodynamic design as a plane. The landing gear that is lowered just before the orbiter touches the runway is the only hardware on the ship that is controlled by the flight crew and not the on-board computers.



Photos courtesy of NASA

engine. The combustion pressure determines the efficiency of the fuel burn.

Like the engine development program, the avionics, or aviation electronics (picture 2), are unique—the most complex ever flown. Nothing can be done by the crew without first going through the series of on-board computers; not even turning on a light or a fan. The quadruple-redundancy computer system involves four data systems that check and reach agreement on any command from a crew member.

If there is a dissenting computer vote, that computer is taken out of service and declared disabled. The computers check the command itself for errors, do the job required, and report back the results to the crew.

During the Apollo missions much of the data processing and evaluative computer work was carried out by mission control on the ground. The shuttle is designed to be entirely self-sufficient, to be able to perform its duties with virtually no direction from the ground.

One of the six pieces of computer hardward on board, the General Purpose Computer, can perform 450,000 operations per second, which is 40 times as fast as the Apollo system. The on-board main engines will be the first that have a "brain," or are computer controlled.

Much has been made of the problem of the insulation tiling on the orbiter Columbia, but the complexity of the tile system is rarely described. The thermal insulation is to protect the vehicle and crew from heat upon reentry to the Earth's atmosphere; therefore, it is a "life support" system.

Picture number 1 shows the application of the 34,000 ceramic tiles on the orbiter that can withstand up to 2,300 degrees Fahrenheit. Each tile is unique in terms of shape, thermal stress, and treatment and has been tracked by computer through the fabrication and application process.

Previous NASA manned spacecraft protected the crew during reentry heat by shedding glowing bits of the heat shield itself. For the shuttle, NASA commissioned the development of insulation materials that could last through 100 missions before replacement—and this was accomplished. As hot as the outer surface of the tile bricks may become, the other side protecting the orbiter's body remains cool enough to touch.

The space shuttle will make going into space a daily occurrence. Scientists and technicians will go routinely into Earth orbit to perform vital research and will not need years of astronaut training to do it. They can perform biological and chemical experiments and then return them to Earth for further analysis.

The space shuttle can also be used as a mobile service station for repairing other orbiting craft and can launch future experiments and satellites above the Earth.

Most important, the space shuttle puts man back into the space picture; for despite the knowledge gained from the recent planetary space probes, it is only by putting man in space that we will have the potential to spread human civilization and make new discoveries.

Schmidt Vs. Greenies

Continued from page 24

Schmidt's new feistiness comes not a moment too soon if the industrial future of the Federal Republic of Germany is to be preserved. Already, $40 to $60 billion in investments have been postponed as a result of court-ordered moratoria on nuclear plant construction and threats of violence by environmentalists.

These threats were actualized at the antinuclear Brokdorf demonstration Feb. 28 where violent demonstrators injured 130 policemen, including one who was set on fire.

The Brokdorf demonstration, which had the full support of the left wing of the SPD, drew 50,000 demonstrators and marked a turn to violence in the radical protest movement that sharpens the challenge to Schmidt to stick to his policy of industrial growth. The leaders of the new environmentalist grouping include prominently the former and current head of the SPD's youth organization, Gerhard Schroeder and Willi Piecyk, who are operating with protection from party chairman Willy Brandt. The SPD officials have made no bones about their goal to topple Schmidt's government and wreck the possibility of a "labor-industry" alliance.

In addition to the SPD'ers, the regrouped environmentalist movement is composed of the "greenies" who demonstrated against Brokdorf and other nuclear projects in 1977 and a "ban-the-bomb" group, which has recently vowed to hold mass demonstrations against siting NATO nuclear missiles in West Germany.

Antinuke Media Support

The environmentalists are getting extensive media support for their antigovernment, antiindustry campaign. The Feb. 16 issue of *Der Speigel*, the weekly magazine that helped topple the Adenauer government in 1963 and then launched West Germany's rock and porno youth culture in the 1960s, spent 15 pages reviling nuclear energy as a profit-making scheme of big industry and insisted that the high-temperature reactor is not feasible.

This was accompanied by an editorial by the magazine's editor Rudolf Augstein, who claimed that mankind unfortunately has before it only two alternatives—nuclear war or the destruction of the biosphere by polluting industry. Augstein said that the latter form of doomsday is the more dangerous one, and he endorsed the resistance of the radical environmentalists to "industrialism."

Pronuclear Alliance

On the other hand, Chancellor Schmidt's decision to move against the antigovernment environmentalists has been bolstered by a de facto cross-party alliance of pronuclear forces. Leading Christian Democrat Gerhard Stoltenberg, governor of the state of Schleswig-Holstein in which Brokdorf is slated to be built, is strongly in favor of the project and has given numerous interviews citing the need for a broad coalition spanning all parties, industry, and the trade unions to ensure the industrial future of West Germany. Stoltenberg has in particular urged Chancellor Schmidt to take an aggressive stance against the antinuclear saboteurs in his own Social Democratic Party.

—Susan Welsh

Mexico Conference Calls for Transfer of Nuclear Technology

American Nuclear Society president Dr. Harry Lawroski joined with scientific representatives from advanced and developing nations in calling for the transfer of nuclear technology to the developing world, at a nuclear energy conference in Acapulco, Mexico Feb. 16.

Lawroski told the Third Nuclear Conference of the Pacific Basin that it is in the mutual interests of Mexico and the United States to exchange oil for nuclear technology, and he noted that the Reagan administration plans to review the Carter nonproliferation policy, which blocked the export of nuclear technology to developing nations like Mexico.

The meeting was attended by representatives of the United States, France, and Japan—all potential suppliers for Mexico's future nuclear needs, Indonesia, and the Philippines, as well as Mexico.

The Mexican delegation to the conference was equally direct on the need to revise U.S.-Mexican nuclear relations. The head of Uramex, Mexico's state uranium company, told the assembled scientists and energy officials that failure to reverse the Carter administration's antiproliferation law "would hold back Mexico's development." Francisco Vizcaíno Murray added that he was pleased that "everything points to an improvement in nuclear energy relations with the United States."

France, the nation that has been pioneering the oil-for-nuclear approach in relations with Mexico, was also well-represented at the Acapulco conference. Bernard Jampsin of the French Atomic Energy Commission stated that nuclear development is not an "alternative" energy source for the developing nations but a necessity. "There are many poor countries who are going to need energy to survive," he said, and no other source will be realistically available.

Taking a jab at former U.S. Energy Secretary Schlesinger, who held up delivery of enriched uranium for Mexico's first nuclear plants, Jampsin gave reassurances that his country would never resort to such "black-

mail" tactics. In March 1979, France offered to supply whatever enriched uranium was being denied to Mexico on "nonproliferation" grounds, thus pushing the Carter administration to reverse itself and allowing Mexico to move ahead with its nuclear program.

Franco-Mexican Accord

While Jampsin was telling the Mexicans in Acapulco, "We need oil, you need technology," Mexican Industry Minister José Andrés Oteyza was arriving in Paris to sign accords based on this principle.

As negotiated in outline in reciprocal state visits between Mexican President José López Portillo and France's Giscard d'Estaing over the past two years, Mexico is providing France with 100,000 barrels of oil per day in exchange for the transfer of technology from France, with nuclear in the forefront.

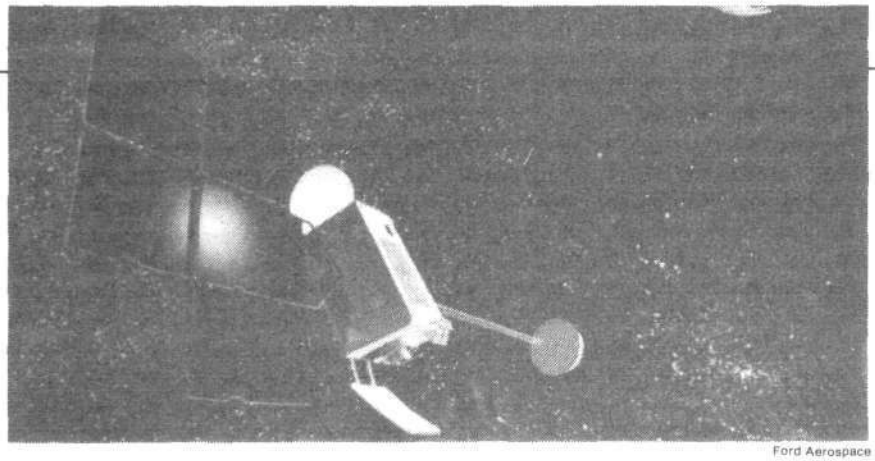
Press dispatches on the final accords signed Feb. 20 noted that the new technology agreements spanned "agroindustry, energy and mines, capital goods, and transport."

In Acapulco, France additionally offered Mexico special aid to develop the capability to independently enrich uranium—an advanced process currently limited to a few of the industrialized powers. French scientific attaché Olivier Massenet declared that "France has dedicated great efforts to achieve its own technological independence. It therefore understands very well that Mexico wants the same. And France has a great interest in going to great lengths with Mexico in terms of technology transfer."

U.S. Nuclear Bid?

Alberto Escofet Artigas, head of the Mexican Electricity Commission, announced at the conference that Mexico will soon accept formal bids for the construction of Mexico's next generation of nuclear reactors, and he mentioned Sweden, France, West Germany, Canada, and the United States as potential bidders. This was the first time in a decade that the United States has been named as a potential partner in Mexico's nuclear development.

—Timothy Rush



Ford Aerospace

An artist's drawing of one of the INSAT domestic communications satellites that India will have by 1983. The satellites will hover in orbit about 22,000 miles above the Indian subcontinent, providing a vast array of telecommunications functions.

INSAT: India's 'Teacher in the Sky'

A joint program of the Indian Department of Space and the U.S. National Aeronautics and Space Administration will provide India with two domestic communications satellites, called INSAT, by 1983.

The satellites, to be built by Ford Aerospace Corporation at a cost of $60 million, are the outgrowth of an experiment called SITE, Satellite Instructional Television, that began in 1975 and continued for a year.

In the SITE program, 2,400 villages across India received four hours of instructional television programs covering agriculture, health, education, and culture. The television programs were transmitted from Earth stations in Ahmedabad and New Delhi to NASA's ATS-6, the Applications Technology Satellite, which, in turn, rebroadcast the programs to the village television receivers.

Known as "the teacher in the sky, the SITE program also included an intensive training session for a group of teachers in science, mathematics, language, and teaching methods. The success of the SITE experiment and its potential to reach millions of Indians in remote rural areas convinced the Indian Space Research Organization of the Department of Space to order the two INSAT satellites.

India from Earth Orbit

The INSAT satellites will hover in geostationary orbit about 22,000 miles above the Indian subcontinent. Each 1,279-lb. satellite will be equipped with instrumentation to provide Indian scientists with important meteorological data, capabilities for telephone service, telecommunications, and direct TV broadcasting to community receivers. The satellites will cover more than 1 million miles of surface and will benefit more than 600 million people.

INSAT-1 will carry a very high resolution radiometer that will furnish visible and infrared images every half-hour. The satellite observations of weather systems including cyclones, sea surfaces, and cloud-top temperatures, snow cover, and so on should enable the detection of tropical cyclones 12 to 24 hours in advance of other available methods.

The spacecraft will also relay data from more than 100 unattended land and sea-based collection platforms providing meteorological, hydrological, and oceanographic data, to the Earth station in Delhi.

Using INSAT's direct broadcast TV capability, early warnings will be possible. Snow cover pictures should result in better regulation of reservoirs for irrigation, flood control, and power generation, and sea-surface temperature mapping should improve monsoon forecasts and fisheries planning and utilization.

Shipping, agriculture, and aviation will also benefit from more scientific weather forecasting.

All meteorological data will be transmitted to the New Delhi data center where it will be processed, analyzed, stored, and transmitted over telecommunications links, including INSAT links, to forecasting offices of the Indian Meteorology Department.

Telephone Access

The INSAT system will provide more than 8,000 two-way long-distance telephone circuits potentially accessible from any part of India, even the most remote. This capacity will supplement key long-distance trunk lines and provide outlying areas short-term or interim and emergency phone communications with the rest of the country.

Five of the telecommunications stations will be large facilities on the scale of those used by Earth stations worldwide that are hooked up to the Intelsat international satellite system.

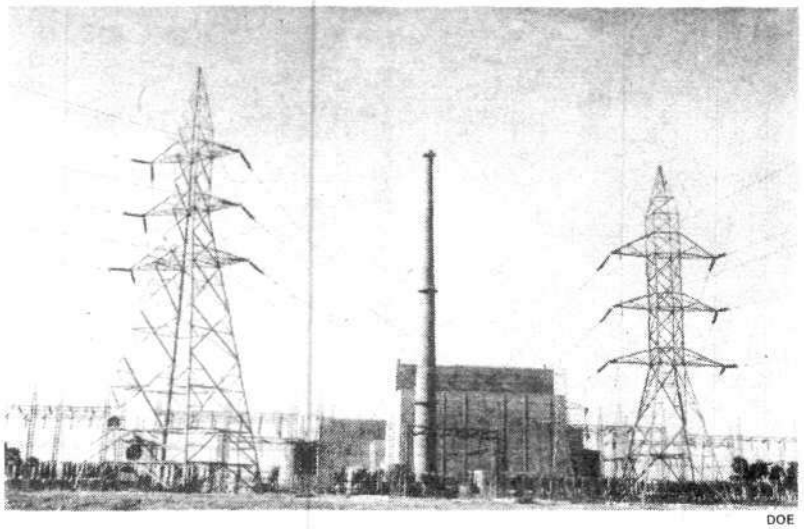
Twelve medium-size Earth stations will provide trunk telephone and television service, while twelve remote terminals will be used for telephone service only. Six mobile terminals—four road-transportable and two that can be airlifted—will provide emergency phone and television service.

TV Broadcasts

Each INSAT includes the capability to transmit on two direct-broadcast television channels. This TV coverage will be accessible to single-unit village TV sets nationwide. Plans are to supplement educational programs with important national and international event reportage as well as disaster warning.

India is preparing a very ambitious indigenous space development program for the 1980s that will include continued work on a domestic rocket launch system, satellite production and servicing, and, in the future, manned space flight. More than 10,000 scientists, engineers, and technicians are working on this ambitious program that is planned to place India alongside the United States and other industrialized nations in the scientific exploration and use of space—using the technology of the space age to get there.

—Marsha Freeman



DOE

A view of India's U.S.-supplied Tarapur Atomic Power Station. The plant now has the capacity to reprocess its own fuel.

India Achieves Reprocessing Capacity

India now has the independent capability to keep its U.S.-supplied Tarapur atomic power plant running, should the United States renege on its 1963 agreement to supply the facility with enriched uranium fuel, top officials of India's Department of Atomic Energy announced in February.

Speaking to a group of U.S. and European journalists touring the Bhabha Atomic Research Center in nearby Trombay Feb. 3, Dr. Homi Sethna, chairman of the atomic energy agency, reported that India has finished construction of a fuel-reprocessing facility at Tarapur, which could be used to extract plutonium from the spent fuel to make a mixed-oxide fuel to keep the plant running.

The issue of reliable supplies of enriched uranium fuel for the Tarapur plant emerged as a major point of controversy between India and the United States after the passage of the 1978 Percy-Glenn Nuclear Nonproliferation Act and its adoption as a major foreign policy plank by the Carter administration. For the past three years the two General Electric-designed light water reactors at Tarapur have been operating below capacity because of delays in the shipment of fuel from the United States.

Although India is bound to use American-supplied enriched uranium fuel for the Tarapur power station, there is nothing in the treaty stipulating that it cannot reprocess its own spent fuel.

According to the original agreement, Sethna stated, "The irradiated fuel always has and always will belong to us." India has signed the necessary protocols and safeguard agreements with the International Atomic Energy Agency (IAEA) to guarantee the safety of the reprocessing facility. All India would have to do now if it wishes to reprocess the spent fuel is to inform the IAEA.

Sethna emphasized, nevertheless, that India would prefer to have the United States follow through on its commitment to India. "We have an agreement which has the force of a treaty, and we hope the U.S. honors it," he said. "If it breaks it, then we have to look around and see what our next step is."

War on Cancer Makes Progress

Recent statistics on the increasing rate of cancer cures, as well as advances in basic biology that have tremendous potential for cancer cure and prevention, totally refute the charge that the "War on Cancer," the federally funded cancer research program, is getting nowhere. The cancer research program that was established by Congress through the National Cancer Act of 1971, in fact, is one of the success stories of government-sponsored research.

In a recent review of advances in chemotherapy treatment, Dr. Vincent DeVita, the head of the National Cancer Institute, reported that more than 38,000 cancer patients are benefiting from treatment each year. There has been nearly a 25 percent improvement in cure rates for a large group of cancers over the last 10 years, and Dr. DeVita estimates that an increase of this magnitude could be realized for all serious cancers by 1985.

The improvement in the survival rate for all serious cancers to 41 percent (as of 1976) has allowed physicians to talk of "curing" cancer, something that was not possible a decade ago.

The improved outlook for cancer treatment and prevention has resulted in a dramatic change in attitude on the part of the medical scientists involved in cancer research. DeVita himself was once a critic of the government-sponsored program, but has been turned around by the notable improvement in cure rates.

Dr. Paul Marks, another early opponent of the war on cancer, now supports it because of the advances in basic biological research that have resulted from the program.

Basic Research Key

On the basic research front, breakthroughs such as recombinant DNA and monoclonal antibody techniques promise to lead to new diagnostic and curative methods for cancers within the next several years. These techniques have already proven invaluable in opening the door to the production of insulin, interferon, and growth hormones, which are critical to new therapies for a variety of diseases. These breakthroughs also have the potential to eliminate the Third World killers malaria and measles.

Genex

In the case of cancer, some researchers believe that interferon will be important as a curative agent. Another major avenue of research takes off from the breakthroughs in monoclonal antibody techniques, a branch of genetic engineering in which large quantities of antibody specific to a certain disease are produced from a cloned cell.

Researchers have succeeded in attaching toxins to antibodies. The hope is that the "tagged" antibodies will kill the cancer when they combine with the cancer cell antigens.

This technique would enable physicians to direct chemotherapy agents against cancer cells with high specificity; it would reduce the side effects of chemotherapy treatment, increase its effectiveness, and, most important, find cancer cells that have metastasized and treat them while they are still small.

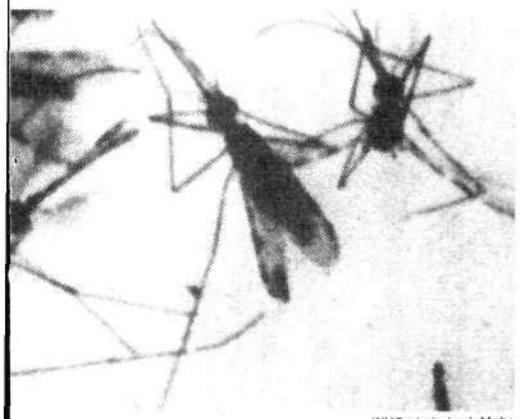
A successful "war": The money invested in cancer research has paid off in medical advances, and the same principle holds for other medical breakthroughs like the just-discovered malaria vaccine. Left, research on recombinant DNA; above, mosquito larvae (left) and full grown mosquitoes in the laboratory.

Breakthroughs In Biology Key To Ending Malaria

Two recent breakthroughs in basic biological research—the recombinant DNA and monoclonal antibody techniques—hold the promise of reducing and even eliminating the incidence of malaria, a disease that afflicts millions and kills hundreds of thousands of people each year, primarily in Third World nations.

Although all previous attempts to produce a vaccine to combat the disease have failed, the new genetic engineering techniques are making it possible to isolate and produce the antigen needed for an antimalaria vaccine. It must be emphasized that the techniques involved are so new that the production of this vaccine would have been impossible even two years ago.

The promising work comes at a critical time because of the recent increase in malaria worldwide. The disease was almost totally eradicated in the 1960s through the use of DDT, which killed the *Anopheles* mosquito



WHO photo by J. Mohr

that carries the malaria parasite. However, the subsequent ban against the pesticide resulted in a resurgence of the disease, and the parasite strain is more virulent and resistant to drug therapy than ever before. The production of a vaccine will permit the inoculation of vulnerable Third World populations and prevent the further spreading of the disease.

Previously, the obstacle to the production of an antimalaria vaccine was the inability to isolate the molecule or molecules that would act as antigenic agents in forcing the human body to form disease-fighting antibodies.

Monoclonal Antibodies

Now, through the use of monoclonal antibody techniques, the antigen on the surface of the malaria-producing parasite has been isolated. In this genetic engineering technique, large quantitites of a specific antibody are produced by cells cloned from a single antibody-producing cell. The production of antibodies specific to the malaria antigen enabled researchers to isolate the antigen.

This accomplishment has made it possible to determine the structure of this antigen (a protein) and, working backwards, to decipher the genetic chain of DNA that codes for the protein's biological production. Once the DNA chain has been determined and then put together, it is a straightforward task, albeit a very sophisticated and difficult one, to use recombinant DNA techniques to manufacture this antigen in the laboratory. The antigen will then be used to vaccinate the populations susceptible to malaria.

Lack of Pesticides Spreads Medfly Blight

The infestation of California's valuable fruit and vegetable crops by Mediterranean fruit fly, or Medfly, is threatening to become a national disaster because the state of California failed to take obvious steps to eradicate the blight with pesticides.

Originally confined to a 2-mile region in Santa Clara county, which has only limited agricultural production, insect attacks on citrus fruits and some truck farm crops have now spread over a 200-mile radius; and the lack of adequate plans to control the infestation means that the destruction may not be contained in this area.

The original infestation spread after California Governor Jerry Brown's administration decided against spraying the infested area with malathion, a safe and effective pesticide. Instead, the state deployed 500 youth from California's Civilian Conservation Corps to the area and directed them to stamp out the Medfly by stripping the fruit off every tree in the area—a tactic reminiscent of Mao Zedong's campaign to rid China of flies.

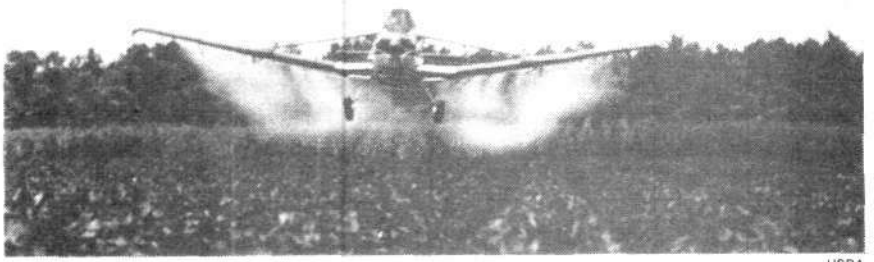
This backward approach to the problem has already cost the state $159 million in lost crops, with another $160 million thrown away on the fruit picking and attempts to sterilize the insects—and the blight is still spreading.

$1 Billion Loss

Taiwan has embargoed California fruit, and Japan has said it will follow suit if the insect reaches California's San Joaquin Valley. Texas has also imposed a 30-day quarantine on unfumigated produce grown in California, which alone could cost the state $100 million in lost sales. All told, there could be an estimated $1 billion year's loss for California growers.

The Brown administration's failure to eradicate Medfly is all the more criminal in view of the insect's known susceptibility to DDT, a fact that was pointed out to *Fusion* by a leading entomologist. The use of DDT, one of the most effective and safest pesticides known, is currently banned by the Environmental Protection Agency. However, there is a provision in the EPA's DDT ban that permits the use of the pesticide to protect public health; for example, that provision is invoked to allow the present use of DDT in the southwestern states to eradicate the plague-bearing fleas that infest rodents.

As the entomologist noted, it is not unreasonable to argue that the danger Medfly poses to the major agricultural states is a threat to the nation's health, and that the use of DDT is therefore in order.



USDA

California, the state with the most modern and productive agriculture in the world, has been fighting the Medfly with its bare hands instead of pesticides, thanks to Governor Brown.

The Eccentric Drill Collar:
Innovation in Gas and Oil Drilling

With worldwide exploratory drilling activity reaching record levels in the search for major new reserves of oil and gas, there is an increasing premium placed on development of technologies to enhance this effort. One advance that is rapidly gaining acceptance by U.S. exploration companies and, increasingly, among Mideast operating companies is an eccentrically weighted drill collar designed to drill straighter wells and drill them more rapidly.

The advanced drill collar, marketed as the Woodpecker Drill Collar, was patented by James F. Arnold of Houston, Texas. The collar is playing an increasing role in field applications because it not only corrects the deviation that occurs in today's deeper wells, but also increases the life of the drill bit and feet/hour drilled. Using the Woodpecker, total drilling time has been reduced by as much as 21.1 to 44 percent.

Xplor Drilling Company

The Arnold unbalanced drill collar shown here uses low-frequency vibrations to reduce wall contact and friction and overcome deviation.

Harmonic Vibrations

The unbalanced drill collar uses the physics of inducing harmonic vibration down a long drill string of connecting pipe sections to increase the rigidity of the shaft and create an added lateral force to the low side of the hole, so that the shaft will not deviate from the straight-line path to the projected oil or gas pay zone. With well depths today ranging from 1,000 to 30,000 feet, a major problem is "dog-legging"—deviation of the drill string under changing strata density and angle to the horizontal plane.

Put simply, the hole does not continue with absolute "plumb-line" trueness. In one well, for example, deviation required plugging and redrilling at an approximate cost of $18,000 above the area's normal drilling cost for a 4,000-foot well.

Combining a unique mix of 34 years in oil-drilling activities with what one scientist called "sheer raw genius" in approaching mechanical-engineering problems, inventor James Arnold applied a principle of induced mechanical vibration in rotating machinery that had been noted in an unrelated field. Dr. J.P. Den Hartog of the Massachusetts Institute of Technology had discovered that a controlled, deliberately unbalanced shaft becomes *more rigid* under rotation, within a select frequency range, than a perfectly balanced shaft. As a simple laboratory demonstration, Den Hartog used a shaft in a lathe and compared one that had been drilled on one side, making it eccentrically weighted although concentric in construction, with a normal shaft.

The Woodpecker Drill Collar

In applying this principle to oilwell drilling, Arnold used a specially weighted drill collar (see photo) of 30-foot steel that fits just above the drill bit as it cuts into the ground. A predetermined number of countersunk holes along one side unbalance the drill collar, creating a vibration similar to that of an automobile wheel that vibrates at certain precise rotational frequencies or speeds, and not others. The unbalanced drill collar also has an optimal frequency range of rotation in which, within a certain tolerance, the straightness of the hole and the feet drilled per hour will be optimized.

During a recent interview, Arnold explained how the Woodpecker Drill Collar produces extraordinary gains in drilling rate with a minimum of deviation. "Gravity constantly exerts a downward pull on any drill bit and string," Arnold said. "When the hole is angled or leaning, gravity tries to pull the bit and drill string back to vertical center, very much like a pendulum attempts to find its vertical center. This gravitational pull is not strong enough in a hole drilled using standard drill collars, however, to overcome the dynamics of the formation which causes the drill bit and string to deviate."

But, as Arnold explained, the combined effect of gravity and rotational inertia of the eccentric collar corrects substantially for this deviation. In addition, by reducing the amount of contact between the drill collar and the sidewalls of the hole, the unbalanced collar increases the speed of drilling and maximizes the weight placed on the bit, with an overall increase in efficiency.

In a recent test by Clarence Michael of the Michael Exploration Company in Pratt, Kansas, 10 wells drilled using the Woodpecker collar averaged 50.16 feet per hour drilling speeds, while 42 wells close by without the unbalanced collar averaged only 40.35 feet per hour. The Arnold collar brought hole deviation back from 4.5 degrees at 3,000 feet, in a typical case, to 1.5 degrees at 4,086 feet, where it remained until the total depth of 4,150 feet was reached. Control of deviation can often mean the difference between a successful well and a dry hole.

Recent successful application of the Woodpecker Drill Collar in the Middle East dramatically reduced measured torque from 150 to 40 in a 17¼-inch-diameter well drilled to 2,500 feet. The induced harmonic vibration of the eccentric drill collar reduced friction by an average of 60 percent with no "twist-offs" on the drill collar, results previously unheard of in the area.

—William Engdahl

'Mexico in the Year 2000'

Seminar Challenges Low-Growth Economic Models

The FEF and the Mexican Association for Fusion Energy (AMEF) held a joint seminar in Mexico City Feb. 19-20 to unveil a 20-year integrated economic program for Mexico's industrial, energy, and agricultural sectors.

The seminar's 150 participants included representatives of eight government ministries, numerous private-sector firms, educational institutions, and research groups, who engaged in a high-level and heated discussion of the controversial conclusions of the just-completed development program. The program was designed using the LaRouche-Riemann econometric model developed under the direction of the FEF.

The FEF and AMEF speakers emphasized the fact that their study of the Mexican economy, titled "The Industrialization of Mexico: 1980-2000," challenges the most basic assumptions of the Wharton School and other well-known econometric studies of Mexico, namely, the claims that too rapid economic growth leads to social instability ("Iranization") and that aggressive exploitation of petroleum resources is inflationary and disruptive to the economy (so-called petrolization—the Venezuela model).

Growth and Oil

"Mexico can and must grow at rates several points higher even than the current 7 to 8 percent growth, and to do this it must export oil beyond the recently set ceiling of 1.5 million barrels a day," FEF research director Uwe Parpart said, summarizing the study's conclusions.

Parpart and the FEF's Dr. Steven Bardwell, who have directed the development of the econometric model, opened the first day's proceedings with a detailed explanation of the LaRouche-Riemann model and its application to the Mexican economy. Both speakers emphasized that without an enhanced "oil-for-technology" trade policy, Mexico will not be able to import sufficient capital goods and will run up against inflationary bottlenecks in attempting to get its nuclear energy, transport, mechanized agriculture, and heavy industry sectors off the ground.

The speakers' emphasis on the need to raise Mexico's oil exports to a minimum level of 3.5 million barrels a day triggered the most intense debate of the conference. One participant asked somewhat sarcastically whether Parpart was really telling Mexico to sell more of its oil for depreciating dollars.

Parpart answered yes, emphatically, explaining at various points in the discussion that oil revenues are crucial for Mexico's rapid industrial takeoff and that, not oil in the ground, is key to the country's national sovereignty and independence.

The second day of the seminar, three senior staff members of the AMEF, Jorge Bazúa Rueda, Dr. Luis Abreu, Cecilia Soto de Estévez, and Patricio Estévez presented in detail the joint FEF-AMEF program for Mexican development, which will be reported on in full in the next issue of *Fusion*.

Development Targets

The program's highlights are the elimination of Mexico's backward, "poor rain-fed" agricultural sector and the urbanization and education of the 13 million peasants engaged in subsistence-level farming; a preferential direction of investment toward industry, focused on the capital goods sector (machine tools, heavy equipment, and communications); and the construction of major port and internal transportation facilities.

The program sets annual growth rates of 11 percent for the output of all tangible goods and 14 percent for capital goods.

These targets and goals of the FEF-AMEF program were greeted favorably by the audience, but questions were raised about their feasibility. The speakers answered that the only barriers to Mexico's becoming a fully industrialized power in the next 20

Adolfo Carbajal

"Mexico must export oil beyond the recently set ceiling of 1.5 million barrels a day." Here, Uwe Parpart addresses the FEF-AMEF seminar at the Mexican Petroleum Institute.

years are political—the economic feasibility is proven.

Industrial Ports

The basic points of the FEF-AMEF program, in fact, were coherent with a presentation by Dr. Fernando Rozensweig, director of industrial port development for the Office of Special Development Projects of the Presidency, who outlined the present commitment of the Mexican government to construct, by the year 2000, four huge "industrial ports." These integrated facilities would significantly relieve one of the most severe barriers to Mexico's development—the decrepit state of its transport infrastructure.

The development program of Mexico's industry ministry (Sepafin) was presented by engineer Narcisco Lozano. This National Industrial Development Plan (PNDI) has growth rates and a general policy direction similar to the FEF-AMEF program, although its projections go only through the year 1990. Lozano vividly described the adverse pressures that have been directed against a growth rate of 10 percent per year by opponents of Mexico's industrial development, such as planning circles influenced by the Wharton School and Cambridge University.

The conference—and its challenge to the slow-growth models for Mexico's economy—received abundant and favorable coverage in the Mexican press, including the nationally syndicated *El Sol, El Heraldo,* and *Ultimas Noticias.*

The poster announcing "Energy and the Economy: Mexico in the Year 2000," the FEF-AMEF seminar held in Mexico City Feb. 19-20.

"Aggressive exploitation of crude, Uwe Parpart recommends to Pemex; scientifically, we will soon be an industrialized power," read *El Sol*'s front-page headline. The article described the seminar as "combating all ideas and projects opposed to national development, especially Malthusianism in all its forms, such as the so-called environmentalist and 'appropriate technologies' policies of the World Bank and similar organizations, and rejecting the racist idea that we Mexicans cannot reach the highest levels of economic, scientific, and technical development."

Other papers gave prominent coverage to FEF research director Parpart's call for a major nuclear drive as the vital complement to Mexico's oil development.

Wide Attendance

The government ministries in attendance included foreign relations, agriculture, finance, planning, housing and public works, the office of special development projects, and the two principal state energy agencies—Pemex and the federal electricity commission. A host of major government and private think tanks were represented, including two institutes of the Universidad Autónoma National de México, the Monterrey Institute of Technology, the Council on Science and Technology, the Colegio de México, and the Center for Third World Studies.

Representatives also attended from three major banks, Banco Nacional de México, Banco de Obras, and Somex, and several of the largest private sector firms, including ICA and Vitro. Also present were delegations from the regional planning office of the Guanajuato state, the National Confederation of Small Property Owners, and the Mexican Petroleum Institute, which hosted the seminar. The Petroleum Institute is the prestigious research arm of Pemex, the Mexican state oil company.

Young Scientist Conf. Begins Education Revival

The first of a series of FEF conferences on scientific education in the 1980s, "Will scientific illiteracy prevail, or will we educate today's youth to make tomorrow's breakthroughs?" was held in Bethesda, Maryland Feb. 14, drawing more than 70 adults and about 30 young people ages 10 to 18.

The youngsters and their parents listened in rapt attention to presentations on both the challenging, frontier areas of science and the current crisis in U.S. scientific training.

The problem was stated starkly. As one speaker put it, because of near-zero population growth, there may not be enough scientists produced in the coming years to meet the scientific challenges ahead.

The sense that emerged in the lively discussion periods was that the way to turn the present situation around is to recognize that science is not the sole purview of a group of specialists; every adult must make the revival of scientific education his personal responsibility, beginning by educating himself in the questions his children will have to answer.

In one case, the excitement generated by this discussion led a father and son attending the meeting to submit the layman's hypothesis on Saturn's "spokes" that accompanies this article.

Will There Be Scientists?

Dr. Bill Aldridge, executive director of the National Science Teachers Association, opened the conference with a graphic review of the deterioration of science teaching in the United States. Aldridge, a former physics teacher, recounted that when he began teaching in 1957, the year Sputnik was launched, there was a short upsurge in science training in the United States. But by 1967, "the bottom fell out of science education in this country," he reported.

Aldridge predicted that the situation will continue to get worse. Forty

states now have sharply declining school-age populations, and if the same small percentage of students goes into the sciences, there will simply not be enough scientists to man a highly technical society.

Science teachers, who in 1967 drew salaries equivalent to their private industry counterparts, now receive half of what they could earn in industry—hardly an incentive to stay in the teaching profession, Aldridge said.

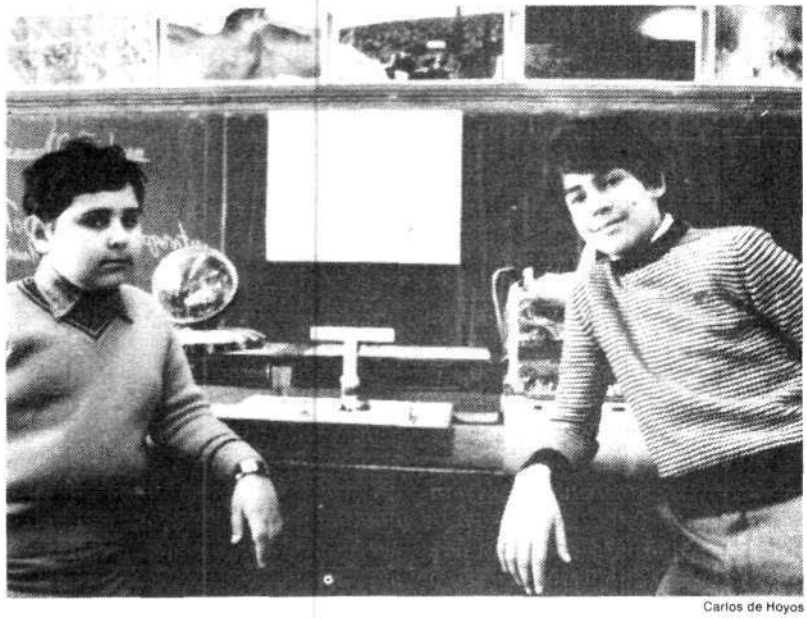
The decline in the number of science teachers and the quality of science education has been aggravated by the underfunding of science education at the federal level. Aldridge reported that the latest projections from the Office of Management and Budget indicate that science education will account for only 7 percent of the National Science Foundation's budget in the coming fiscal year, compared with 33 percent in 1967.

The Two Cultures

Dr. William Ellis, director of mirror programs for the Department of Energy's Office of Fusion Energy, opened his presentation by observing that there are two cultures in the United States today, a scientific, technical culture and a nontechnical one, and that the two rarely mix. Ellis said that the aim of his talk was to make a difficult scientific concept—fusion power—accessible to everyone in the audience. Using a model of a fusion reactor, a table of elements, and other props, Ellis did precisely that, proving that it is possible to bridge the gap between cultures.

Uwe Parpart, the FEF's research director, then described the pivotal role that science and science education have played historically in an industrial republic such as the United States. Parpart began by referring to an address given by Benjamin Franklin in the mid-18th century in Philadelphia to a comparable audience.

"What Franklin emphasized was that without a commitment to science, North America could not fulfill its potential. But with this commitment, North America could become the most powerful region on earth, capable of developing flying machines and technology that would



Carlos de Hoyos

Here, Michael and Yaroslav demonstrate their project at Intermediate School 187.

Young Scientists Win Prize For Tokamak Project

Two seventh-grade students in New York City who based their science project on the tokamak article in the premier issue of *The Young Scientist* magazine, won first prize in the Manhattan borough science fair March 22 for their simulated tokamak model.

The project, which will be written up in the third issue of *The Young Scientist* in the Experiment section, is particularly interesting, because of the method of investigation used. Michael Masterov and Yaroslav Shoikhet set out to find the most efficient way to simulate the various operations of a tokamak reactor. For example, on heating a plasma to the required temperature, they investigated and measured various kinds of heating methods and finally settled on a combination of a tesla sparking device and light focused through crystals. They did the same kind of testing with other simulated operations, from the insulation of the coils to a steam-producing boiler.

Their "tokamak" produces steam—120 watts of power—and is fully automated with a computerized control board to handle 100 operations.

Michael and Yaroslav, who visited the FEF for a meeting with fusion scientists, emphasized that their project is still in the development stage with continuing improvements in the technologies used. "We wanted to do a project based on scientific method, and that's what we got from *The Young Scientist,*" Yaroslav said.

Dr. Steven Bardwell, editor-in-chief of *The Young Scientist,* commented, "This project is particularly exciting because it demonstrates precisely what we intended the magazine's use in the classroom to achieve: getting students involved in scientific experimentation and inquiry and thinking about the problems confronting us on the frontiers of scientific development."

Suzanne Kiebe/NSIPS

Dr. William Ellis, director of mirror programs for the DOE's Office of Fusion Energy, explains how fusion works using a model of the Tokamak Next Step experiment designed by Oak Ridge.

transform the universe. Franklin's only regret was that he had been born too early to realize the fruits of these endeavors.

"We are the first generation to go beyond the Earth's boundaries," Parpart continued. "We are in the generation Franklin longed to be in. Within 3 to 4 million years—a very short period of time in the development of the biosphere—man can colonize not merely the solar system but the entire galaxy."

To illustrate this point, Parpart showed slides of the Voyager mission to Saturn.

Aquarian Subversion

Parpart then brought the audience "back down to Earth" by describing the deterioration of U.S. scientific capabilities over the last 10 years, focusing on the infiltration of the *content* of science and science education by Malthusian ideas—the call for a return to the simple life of preindustrial times, for example. The ideological push toward the "Aquarian Age" has become very real and very frightening, Parpart said.

The Layman's Chance

by Mr. G.P. Layman and Son

Intrigued by the slides of Saturn they viewed at an FEF-Young Scientist Club event in Bethesda, Maryland Feb. 14, Ernest W. Millen and his son Mark Henry Millen of Seaford, Virginia submitted a layman's hypothesis to Fusion. *Excerpts of their article on the conference and the full hypothesis are printed below.*

. . . A dynamic young man, who introduced himself as John Asher, regional director of the Fusion Energy Foundation, opened the meeting and introduced the speakers. . . . He forcefully stated the problem: The deemphasis on science and the decline of interest in the sciences in our schools nationally pose a problem to the progress of future scientific programs.

Each of the speakers contributed powerful evidence corroborating the stated problem: Bill Aldridge, executive director of the National Science Teachers Association, charted and extrapolated the population of scientific pupils and teachers; Dr. William Ellis, Department of Energy, Office of Fusion Energy, ably, and in an interesting way, provided the laymen present with a description of the fusion process; Gregory Vogt, NASA Community and Education Services, described the Space Shuttle; and Uwe Parpart, director of research, Fusion Energy Foundation, inspired attendees with his knowledge of the problem and his conviction. It was the set of vivid NASA graphics taken of Saturn during the Voyager missions, shown and narrated by Mr. Parpart, that inspired a father and son to have lingering interests, which have spawned an exciting and unanticipated result.

What results of a conference on science education could be sufficiently exciting to warrant an article written by a layman father and his son? How about a hypothesis developed by a father and son on the nature of the spoke anomaly in one of the close-up Saturn compositions? Old "pop" has written the article up to here; now the son, 14 years old, has the opportunity to write the jointly developed hypothesis.

The Hypothesis

Hypothesis: The "spoke effect" seen across the inner rings of Saturn is the shadow of the spiraling F ring.

Apparently the spiraling, plaited nature of the F ring gives it sufficient thickness and radial density to cause it to cast a shadow down-Sun on the thinner, but highly planar inner rings.

This hypothesis is based upon the single viewing of a limited number of pictures at a conference. It was formulated by laymen, but the laymen

The final presentation was by Gregory Vogt of NASA's Community and Education Services, who gave an exciting talk on the history of NASA's Space Shuttle program, illustrated with spectacular slides and a model of the Space Shuttle Columbia. Mr. Vogt's discussion of the open-endedness of the space program provoked a great deal of interest, especially in the younger members of the audience.

One of the most remarkable aspects of the conference was the degree of intense discussion among the young people present, touching both on technical topics such as the temperatures required for fusion to take place and on the problems scientifically oriented students run up against in dealing with their peers and teachers.

For example, 13-year-old Ben Finzel, who had delighted the audience with a demonstration of his model of a fusion reactor, told how his work had come in second place in a recent science contest at his school; first prize went to an environmentalist project.

who formulated it are now excited. They want to learn more.

Naturally, the coauthors of the hypothesis are anxious to review more pictures in order to determine if the spoke phenomenon occurs only in the down-Sun Saturn rings, or if the spokes exist concurrently elsewhere in the rings. Action series pictures, if available, could also confirm the hypothesis.

Should NASA scientists confirm the hypothesis and allow the authors the privilege of naming the phenomenon, it is hoped that it could be called the G.P. Layman effect. "G.P." because goodness in people and light are closely allied; and "Layman" as a tribute to scientific organizations like NASA and the Fusion Energy Foundation who share new data and information with laymen, thereby making possible not only better informed people, but also giving laymen who are interested a chance to contribute their ideas.

Forums Challenge Reagan to Save NASA, Implement Fusion Act

FEF members and industry representatives took the reins at a series of West Coast FEF forums Feb. 24-26. The meetings were called as part of a national science alert to put pressure on the Reagan administration to drop the threatened science budget cuts and instead make the revitalization of U.S. basic science research, including the fusion and space programs, a national priority.

The four forums drew close to 250 participants, including many newcomers; especially noteworthy was the strong attendance by university students concerned about the future of science in the country.

Los Angeles. The Los Angeles meeting was attended by 45 people, including longtime FEF supporters, new *Fusion* readers, students from the University of Southern California, and technical experts from the aerospace industry.

A representative from Rockwell International presented a slide show on the Space Shuttle, tracing the history of the NASA program, where it stands today, and where it is heading. His talk focused on the generalized economic benefits of the space program, especially the accompanying breakthroughs in advanced technology.

Martin Simon of the FEF staff showed slides of Voyager's Saturn mission. His emphasis on the theoretical challenge posed by the Saturn results led into a discussion of what the FEF must do to mobilize citizens to support continued scientific development.

Berkeley. The Berkeley forum drew half a dozen students from the university, including the head of the Berkeley chapter of the American Institute of Aerospace and Aeronautics, who gave a presentation on the Space Shuttle program, concluding that the Shuttle's forthcoming launching will be the "next giant step for mankind."

The culmination of the evening was an inspiring presentation by Dr. von Eshelman, professor of electrical engineering at Stanford University, who has worked with NASA since its inception and is currently the team leader for the radio science section of the Voyager mission. Drawing on his own slide collection on Jupiter and Saturn, Eshelman presented a wealth of material, centered on Saturn's moon Titan and findings about its atmosphere that challenge the prevailing theories about the origin of life on earth.

San Jose. In nearby San Jose, 38 people came to hear presentations by Dave Kilber and Martin Hasha on the Saturn mission and the direction U.S. science policy must take. The meeting was opened by Brian Lantz, FEF regional representative, who read greetings from Mayor William Gissler of neighboring Santa Clara.

Seattle. The Seattle forum marked a major step forward in the FEF's activities in the state of Washington, home of the Hanford nuclear facility and a center of the nation's aerospace industry. Seventy people attended, and in addition to the FEF members and *Fusion* subscribers, half of the attendees were students from the University of Washington. (Out of the meeting, an FEF campus club will be established.)

The event opened with the performance of a Bach duet by FEF members. FEF spokesman Mark Calney then gave the major presentation on Johann Kepler's *Harmony of the Spheres,* describing how Kepler arrived at his discoveries of the basic laws of planetary motion.

Kepler Was Right!

Using the slides of Saturn, Calney demonstrated that the highly differentiated and ordered system of Saturn's rings and satellites vindicated the neoplatonic geometrical method of Kepler over Newton's "action at a distance" mysticism.

FEF News

Boeing engineer and FEF volunteer Alan Rathbun then presented slides on fusion-propelled space travel. Rathbun also described for the audience the LaRouche-Riemann model, and explained how instead of "saving" itself a few hundred million dollars—and creating a national disaster—by cutting back the fusion and space programs, the Reagan administration could save more than $20 billion for each percentage point the Federal Reserve lowers interest rates.

East Coast Forums

New Haven. The threat to the economy posed by OMB director Stockman's budget cuts, on the one hand, and Fed Chairman Volcker's continuing high interest rate policy, on the other, was the main topic under discussion at a dinner meeting jointly sponsored by the FEF and *Executive Intelligence Review* in New Haven, Conn. Feb. 26.

EIR economics editor David Goldman contrasted the science of technology, which he said is real economics, with the monetarism of Stockman, Volcker, *et al.* Goldman termed the latter not economics at all, but a conspiracy to embezzle the federal government out of healthy tax revenues and therefore "a matter for the police." The 50 or so attendees participated in a lively after-dinner discussion.

St. Louis. The disastrous impact of Volcker's policy was also the focus of an FEF forum in St. Louis Feb. 24. That forum drew 45 skilled workers, bankers, high school students, and reporters from two local radio stations, indicating that concern over the effects of the Volcker policy is universal.

SCIENCE ALERT

The Fusion Energy Foundation will hold "science alert" meetings nationwide during March and April.

For information about meetings in your area, call or write the FEF headquarters

888 Seventh Avenue,
New York, N.Y. 10019
(212) 265-3749

Saturn Slides Spark Minds Of Italian Youth

For many of the 1,300 Italian high school students who came to hear Dr. Jonathan Tennenbaum's lecture series on the Saturn results in Milan last month, it was the first time they had been exposed to the proscience viewpoint. Tennenbaum, who is the director of the West German Fusion Energy Forum, gave presentations at four different high schools in this northern Italian city on the new scientific frontiers opened up by the Voyager 1 flyby of Saturn.

The American-born mathematician also attacked the Malthusian perspective of the U.S. State Department's *Global 2000 Report,* arguing instead for the rapid development of fusion energy. Tennenbaum explained to his animated audiences that an abundant supply of energy can feed a growing population on Earth and allow the human race to colonize space, thus overcoming the problems of so-called overpopulation and limited resources.

Tennenbaum reported that he and his Italian collaborators were delighted with the students' positive response, because Italy has been inundated more than most countries with antiscience propaganda over the last decade. After Tennenbaum's high school speaking tour, the FEF sponsored a public forum in Milan, "The Atom at the Service of Progress," together with the recently formed student group, the Giovani Nuclearisti Milanesi (Young Milanese for Nuclear Energy), and Agip-Nucleare, the nuclear branch of Italy's state-owned oil company.

FEF Announces New Leadership

Dr. Morris Levitt, who has served as executive director of the Fusion Energy Foundation since its founding in November 1974, submitted his resignation Feb. 27 as executive director and editor-in-chief of the Foundation's publications.

Speaking for the FEF board of directors, Jon Gilbertson, FEF secretary-treasurer, noted that the board very regretfully accepted Levitt's resignation.

The board announced that Paul Gallagher had been appointed as interim executive director for the foundation and that Dr. Steven Bardwell would succeed Morris Levitt as editor-in-chief of *Fusion* magazine and as president of the FEF board. Gallagher had previously served as the business and advertising manager for *Fusion* magazine. Bardwell has been the FEF's director of plasma physics research and associate editor of *Fusion* magazine.

A board meeting and FEF membership meeting is scheduled for March 31 to fill the vacant board position.

Paul Gallagher

Farewell Message From Morris Levitt

Dear *Fusion* readers and FEF members:

On February 27, I submitted to the Board of Directors of the FEF my resignation as executive director of the FEF and editor-in-chief of its publications. This, then, is my farewell message to you.

Looking back, we may all take rightful pride in the accomplishments of the FEF since its founding in 1974. The specific achievements that I would highlight include the quality and integrity of our publications, our impact on science and energy policy, and our own contributions to theoretical science. Above all else, though, the extraordinarily talented and dedicated scientists and other staff members of the FEF, as well as our many representatives and friends throughout the nation, have been successful in rekindling the tradition of Benjamin Franklin and of the scientific institutions that throughout the ages have been at the forefront of creating and disseminating scientific knowledge.

In the case of the FEF, this has centered on our broad-ranging efforts to identify and publicize those breakthrough areas in science and technology that will provide the abundant resources and economic development that the world so urgently needs. We can be rightfully proud of being unabashedly pronuclear, of creating the conditions for an Apollo-style fusion program, and of promoting a North American water development plan and high-technology-based development perspectives for all the major regions of the world.

Our successes—including the passage of the landmark McCormack fusion bill, the invention of a new method of analyzing and projecting the performance of economies, and the rediscovery of the significance of the Kepler-Leibniz-Riemann tradition for contemporary science—are but reflections of our larger commitment to scientific and economic progress for our great nation and the world.

I believe that I have helped to set a sound foundation and a true course for the FEF. But the time has also come for me to take leave of the administrative responsibilities at the FEF and to return to a more direct role in the world of scientific enterprise.

This places a great responsibility on the shoulders of the FEF leadership and staff. The new Reagan administration needs much more input from our scientific, engineering, and entrepreneurial constituencies, to better identify priorities in science, energy, and education policy. In this, the FEF has a vital and, perhaps, unique role to play. I am sure that it will make every effort to be a worthy representative of you, its readers and membership, and to provide the necessary leadership to the scientific community. I will personally be among those of you in the ranks of FEF supporters who are concerned to see that its resources and energies are used to accomplish these ends and even further improve on past performance.

Finally, but most important, I would like to thank all the supporters of the FEF and my own friends both inside and outside the FEF for your help and collaboration over the years. I must particularly thank the staff for how much it has taught me of science and its applications. If I and the FEF have been effective, that in large measure also reflects your own virtues and those of the nation's dedicated scientists, engineers, and technological businessmen.

It has been a great privilege to serve as one of your spokesmen. I am sure that we will continue our collaboration and friendship in many new ways in the future.

Dr. Morris Levitt

Editor's note: Letters to Dr. Levitt may be sent to the FEF for forwarding to him.

Reopening the Atlantis Debate

America B.C.: Ancient Settlers in the New World
Barry Fell
New York: Simon & Schuster, 1978, $6.95
(first published by Quadrangle/The New York Times Book Co., 1976)

Saga America
Barry Fell
New York: Quadrangle/The New York Times Book Co., 1980, $15

Working in conjunction with an extensive group of collaborators in the Epigraphic Society, Harvard Professor of Marine Biology Barry Fell has brought to public light an important body of archaeological work in two recent and interesting books, *America B.C.* and *Saga America*. Fell's work calls for speedy review by professional archaeologists, because if even a significant fraction of it can be fully validated, it will force a total reevaluation of the dominant conceptions of Pre-Columbian America and world history.

Until now, professionals in the field have dismissed the possibility that there may have been extensive contact between Old World civilizations and North America in pre-Columbian times, despite growing evidence to the contrary.

Fell is not strictly speaking an archaeologist. He describes himself as an epigrapher, which is another way of saying a cryptanalyst or codebreaker. His field is primarily the deciphering of inscriptions, as well as other forms of linguistic and literary remains. Fell attempts to demonstrate in both books that a large number of inscriptions found in the New World must necessarily be of Celtic, Punic, Greek, Minoan, Egyptian, Libyan, or other Old World origin.

Fell studied ancient Celtic and received a doctorate from the University of Edinburgh, the center that promoted the Nordic Thule myth in the early 20th century—which later became the basis of Nazi ideology. Fell himself at times veers off in the direction of adulating the primitive cults he is writing about.

As a second caveat to readers, it should be pointed out that Fell tends to stress material that fits in with his own cultic bias—namely, Celtic (solar cult) and Punic (modern-day Libyan) remains—and downplay other—for example, Phoenician—evidence. Fell, in fact, holds an honorary professorship from the University of Tripoli in Libya, and presumably on the basis of Fell's work emphasizing the Punic presence in ancient America, Libyan dictator Qaddafi announced earlier this year that he was the rightful political representative of the American Indians.

Although one must therefore be wary of the interpretations he places on his findings, the raw evidence that Fell has assembled is so impressive and potentially so significant that his work is worthy of the utmost attention by more objective professional archaeologists.

The Ogam Inscriptions

Fell presents evidence of not just one or two stones, but of hundreds of inscriptions, some that were discovered by his group and others that were found years back by professional archaeologists and have since resided undeciphered in museums. Perhaps the largest single group of inscriptions Fell discusses is the Ogam inscriptions of Celtic origin, which from the evidence were extensive in America B.C.

Ogam is a form of ancient Celtic writing that consisted of letters defined by one, two, three, four, or five short lines drawn above, below, or through a central stem line. This gave 15 letters; some curved and crossed lines were added to yield an alphabet of approximately 20 letters.

Large numbers of Ogam inscriptions have been found in the Old World Celtic areas of England, Ireland, France, Spain, and Portugal. It became possible to decipher many of these when the ancient Irish manuscript the *Book of Ballymote* was discovered in the late 1700s, providing the key for some 16 different Ogam alphabets.

Fell shows that a large number of New World inscriptions previously regarded as either indecipherable American Indian "stick writing" or random "plough marks" are in fact Celtic Ogam. Some of the New World

The Creation of the Sun

11.	a.	Vanyingi	tars	ai.	Wu	nata	kahi	Hiya-nyi	tamai,
	b.	Bunyan	turs	auj.	Hu	nataj	qahir	Iḫya-nyi	ṭamih,
	c.	He raised	the sun	on high.	He	created	the mighty	Giver-of-Life	aloft,
12.	a.	Ya	ahai!	Punan	ait	ko-o! (*bis*)			
	b.	Ya	aya!	Bunyan	ata	kaya!			
	c.	What	a marvel!	Raised up	to bestow	warmth!			
13.	a.	Si-iya	ldi	takio,	wopa	himu	kahowu.		
	b.	Swiya	ladi	taqs,	wabl	hamma	quhula.		
	c.	He regulated	the sharpness	of the weather,	giving rain	in heat	and drought.		
14.	a.	Tait	cun	yuku,	sapava	Mununaa!	(*da capo* from 13)		
	b.	Tiyat	kaun	yakana,	sabaka	Muniya.			
	c.	The design	of the world	continuing,	shaped	by Destiny.			

Quadrangle/The NYT Book Co.

An extract from the Sacred Creation Chant of the Pima Indians, a chief piece of evidence cited by Barry Fell as proof of extensive contact between Old World civilizations and North America in Pre-Columbian times. The first line is an English transliteration taken down by Bureau of Ethnology agent Frank Russell in 1902. The second line is Arabic, and the third is the English translation of what turns out to be the Phoenician creation story.

descriptions use the same alphabets as the Irish and Spanish ones; others use Ogam varieties listed in the *Book of Ballymote,* for which no Old World examples have been found.

Fell has also deciphered a good number of inscriptions of Punic origin found in the New World, of Carthaginian, Libyan, and Iberian Punic derivatives of the basic Phoenician alphabet. Especially interesting are the bilingual inscriptions, the most common combination being Iberian Punic and Celtic Ogam, corresponding to a historical interface between Carthage and the Celts, well known from classical sources. One may well hypothesize with Fell that the collapse of the bilingual transatlantic culture that these inscriptions represent may have been caused by the overrunning of the home areas of these peoples in Carthage, Spain, Gaul, and Britain by Rome in the period from 200 B.C. to 50 A.D.

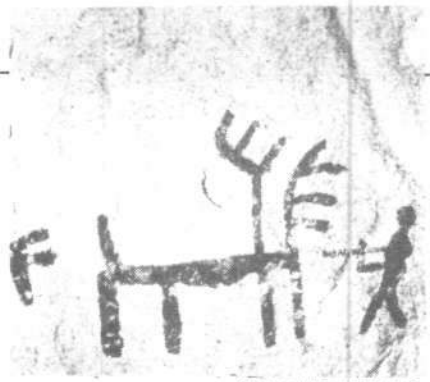
The 'Root Cellar' Thesis

Fell supplies additional evidence for his Celtic contact thesis by showing that the "root cellar" stone structures found in New England, on which many of the Ogam inscriptions he cites were found, all have a precise astronomical orientation, most commonly with the door facing sunrise on Dec. 21. This, of course, is the day of the winter solstice, an important holiday in most ancient pagan religions, including the Celtic-Druidic Sun cult. Combined with the Ogam inscriptions, this astronomical orientation makes the previous attribution of the "root cellars" to early colonists rather untenable; Fell argues convincingly that they are temples.

As further evidence of ancient Celtic presence in New England, Fell deciphers a multitude of placenames, such as the well-known Merrimack River, that have both Old World and New World meanings. In Algonquinian, the name means "deep fishing." However, it also sounds very much like the Gaelic *mor-riomach,* "of great depth."

The Pima Chant

One of the most noteworthy pieces of evidence, because it is independently verifiable, is the Pima Indian



Quadrangle/The NYT Book Co.

This rock painting of hunter and stag found in Cogul, Spain also reads as an example of Ogam, a form of ancient Celtic writing, yielding "With the youth [is] a stag. The hunter bends his bow." Many Ogam inscriptions have been found in America.

chant shown in the figure. The first line in the transcription of the chant is an English transliteration of the Pima chant taken down by Bureau of Ethnology agent Frank Russell while he was stationed among the Pima in the American southwest in 1902. The chant was published by him along with a garbled translation in the *Twenty-Sixth Annual Report* of the bureau in 1908. The chant was incomprehensible to the Pima, who learned it only by rote.

Fell maintains that the chant is ancient Arabic slightly garbled over time. The second line is the Arabic and the third line the English translation of what turns out to be the Phoenician creation story.

In looking up Russell's report I found that Fell's rendition of it is identical with the original, and an Arabic speaker certified the accuracy of the Arabic in the second line and its English translation. It would appear that the chant is striking proof of past contact between Phoenicians and the Pima, one of the more advanced Pueblo Indian tribes.

Some critics of Fell's work have suggested that the Pima chant could have been mutated into any number of languages; however, this possibility has yet to be demonstrated.

In his later book, *Saga America,* which is somewhat less well-documented than *America B.C.,* Fell translates a number of additional Pima chants using identical methods; some turn out to be other myths, and some are Aesop's fables! All of the chants are drawn from Russell's report, and Fell assured me that the accuracy of his Arabic translations has been certified by several leading Arabic scholars.

The Atlantis Hypothesis

What Fell neglects, amid this wealth of empirical evidence, is a competent discussion of the important implications of the material he has uncovered.

The essential point implied in demonstrating the validity of the "Atlantis hypothesis"—the existence of a relatively advanced, ancient, maritime-based transatlantic culture—is that *civilization is the natural condition of man.* Contrary to the Dark Age ideologues from Rousseau to today's environmentalists, the condition of the American Indians at the time of contact with the Europeans was not their "natural state" but the remnants of a destroyed civilization. (Perhaps Fell's admiration for primitive cults keeps him from drawing this conclusion.)

What is clear from evidence such as that presented by Fell is that a maritime-littoral civilization spanning the Atlantic existed, and that it collapsed into a Dark Age. The civilization must have failed at some point to master the scientific and technological prerequisites for continued civilization, and fallen victim to geological and meteorological catastrophes and conquest and domination by backward, hinterlands cultures.

An Old Controversy

The political implications of the Atlantis debate were very much in view during the heated controversy that took place over this question in the United States during the early part of the 19th century. Humanists like Alexander von Humbolt and the Whig statesman Caleb Atwater argued for the existence of a higher culture predating the American Indians. The debate at the time was focused on the massive ruins of an old stone fort found by early settlers in Spruce Hill, Ohio and the discovery within the still standing fort of several hundred tons of iron slag. Atwater theorized that the ruins were Greek or Roman.

Others thought that they might be remains of Norse or Atlantis civilization or the Lost Tribes of Israel.

Then in 1848 the proslavery financier Albert Gallatin financed a "definitive study" published by the Smithsonian Institute purporting to prove that the slag was "meteoric iron," which had accidentally fallen inside the fort; no presumption of an advanced metalworking culture was necessary.

Given Gallatin's influence at the Smithsonian, this theory effectively closed down debate until the 1950s, when an amateur archaeologist, Arlington Mallerry, conducted excavations at the Spruce Hill Fort. Mallerry discovered some 14 furnaces for casting iron, some of Celtic, some of later, apparently Norse, origin. He also had the slag tested by experts, and their unanimous opinion was that the material was furnace slag and nothing else. Mallerry's work, published in *The Rediscovery of Lost America* in 1951, was ignored by professional archaeologists!

Barry Fell's work reopens the debate. If archaeology is to proceed in North America, it is incumbent upon the archaeological profession to deal with the findings of Fell and Mallerry, and either refute them or confirm them and proceed to reconceptualize North American prehistory as the key to recognizing a much greater level of accomplishment by man in the millennia before Christ.

—Robert Zubrin

Fighting for Progress

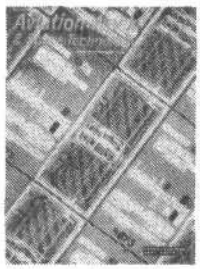
Progress and Human Value
Edited and with an introduction by Peter Schuller
Reynoldsburg, Oh.: Advocate Publishing Group, 1979, $12.95 casebound, $8.65 softcover

The selection principle for this anthology of readings edited by Peter Schuller is to restore "the fight for progress" to the concept of humanism, which has been misappropriated by zero-growth advocates and counterculturalists. The first section of *Progress and Human Value* explores a rigorous approach to economic wealth and human development. It includes writings by Benjamin Franklin; by Henry Carey, the 19th-century economist and industrialist who was an advisor to Abraham Lincoln; by Michael Goldman, Schuller's colleague at Miami University of Ohio and a philosopher of science; and by the economist Lyndon H. LaRouche, Jr., on "The Theory of the European Monetary Fund."

The second section examines fascist tendencies, which represent the culmination of the fight *against* progress over the past 200 years, beginning with Henry Carey's critique of Parson Malthus (one of the few in American history). Excerpts from Hitler's *Mein Kampf* on population and resources and from Martin Heidegger on the Nazi philosophy of education are accompanied by Costas Axios's study of "The Schachtian Economy of the Third Reich" and Edward Spannaus's study of "The Destruction of the Cognitive Powers of Labor" under Hitler, and Schuller's essay "The Essence of Fascism." The continuity from Malthus to Schacht to post-World War II advocates of "conservation" is suggested through selections from Ralph Nader and Jimmy Carter.

This is a valuable source book, particularly because many of the selections, including Pope Paul VI's landmark 1967 encyclical "On Promoting the Development of Peoples," which equates peace with economic development and Christianity with moral elevation through material progress, and the essays by Henry Carey, are not readily available elsewhere. All the more pity that it is unpleasingly designed and marred by typographical errors, a problem that mirrors the preference of the mainstream publishing industry for volumes on the Malthusian track.

—Susan Johnson



NEW DOD REPORT PROPOSES SPACE-BASED BEAM WEAPONS

A forthcoming Department of Defense report on space-based beam-weapon battle stations urges that the United States make an effort to demonstrate the operation of an Earth-orbiting laser-beam battle station within this decade.

A 5-megawatt-power laser with a 4-meter-diameter mirror could be placed in orbit within nine years, according to a review of the report in *Aviation Week & Space Technology* Feb. 16.

Although previous *Aviation Week* articles on beam weapons have emphasized the weapons' applications to destroying Intercontinental Ballistic Missiles, this latest report points out that the first practical use of such laser weapons in space would be for the interdiction of high-flying aircraft and offensive antisatellite operations, together with defense of U.S. space satellites. More advanced beam weapons could be used at a later time to fulfill the more difficult anti-ICBM role.

This DOD report opens up new perspectives on the beam-weapon controversy. First, this limited, initial application of beam weapons against aircraft and small antimissile missiles could be demonstrated quickly and could prove to be quite practical and economical.

Second, viewed from this new standpoint, the suspected Soviet development of land-based beam weapons could be directed primarily against space-based battle stations, rather than ICBMs, as previously thought.

Could this mean that Soviet planners are thinking one step ahead in the race to develop more advanced weapon systems?

REPORT DEMONSTRATION OF LIVERMORE X-RAY LASER

Fusion scientists at Lawrence Livermore National Laboratory in California scored a major scientific and technological breakthrough recently when they experimentally demonstrated an X-ray laser system, according to Clarence Robinson, writing in *Aviation Week & Space Technology* Feb. 23. The new laser, which is more compact and cheaper than conventional lasers, has the ideal energy wavelength for destroying Intercontinental Ballistic Missiles.

The Livermore X-ray laser uses a small nuclear bomb to produce a carefully tailored pulse of soft X-rays that are then deposited onto as many as 50 metal rods. The rods are rapidly transformed into a plasma whose physical characteristics lead to the amplification and focusing of a very concentrated pulse of X-rays. Each rod would be pointed at a separate ICBM target.

Aviation Week reports that enough of these X-ray laser systems could be deployed in orbit on one Space Shuttle trip to knock out the entire Soviet strategic missile force, in the event that it was fired at the United States.

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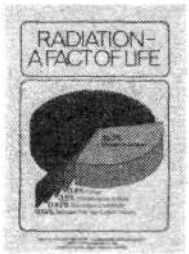

SOME FACTS ON RADIATION

We recommend to readers "Radiation—A Fact of Life," a booklet written by the International Atomic Energy Agency and published by the American Nuclear Society. In a clear, straightforward manner, the booklet presents answers to some common questions about radiation: what is it, what are some of the different kinds, where does it come from, and what does it do? Although the booklet is too short to deal with more complex questions, it does effectively dispel some of the fears and misconceptions surrounding this emotional topic.

For instance, did you know that a glass of milk contains 300 picocuries of radioactivity, compared to the less than 0.3 picocurie per glass contributed to a river by a nuclear power plant? (Both amounts, however, are of the smallest consequence.)

Or that radiation from the natural environment contributes more than two-thirds of the total radiation dose that we each receive? The other large contributor to annual human radiation exposure—more than 30 percent—is radiation for medical purposes. Less than one five-hundredth, or 0.15 percent, of human exposure results from releases by the nuclear industry.

This booklet is well illustrated, with graphics that depict the sources, strengths, and the relative contributions of radiation. For a copy of the booklet, write to the American Nuclear Society, 555 N. Kensington Avenue, LaGrange Park, Ill. 60525.

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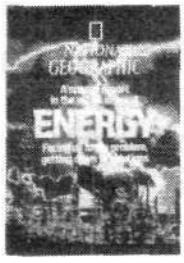


NATIONAL GEOGRAPHIC ON ENERGY: CONSERVATION GONE APE

In departure from its traditional subject matter—primitive cultures and wildlife—and its proper, yellow-bordered format, *National Geographic* devoted its February issue to "Energy, a special report in the public interest."

The text opens with a scenario that makes David Erdman's *Crash of '79* look like a museum piece: "It is the summer of 1983. Violent uprisings have shaken Saudi Arabia, and the House of Saud has fallen." Anti-Western Muslims of the Wahhabi sect have cut the oil flow to the West. The United States, bound by the International Energy Agency's 1975 sharing agreement, is being forced to share its oil with Europe and Japan. The whole world is paying for not having cut back its oil consumption sooner.

This—the need for radical conservation measures—is the overbearing message of the *National Geographic*'s extravagantly produced special issue. Fusion energy gets a favorable mention—along with the caveat that it is "so complex that some feel it will never be inexpensive enough to use."

The only hope is to cut energy consumption and return to more primitive life-styles, according to *National Geographic*. This message is conveyed primarily through the photographs.

Instead of the usual pictures of bare-breasted African tribeswomen, this issue features foldout "thermographs"—infrared photographs that show heat escaping from uninsulated houses and buildings. This is followed by a muckraking photo essay on "America's auto mania," which gives the impression that the average American attends drive-in church and is laid to rest in drive-in funeral parlors.

Counterposed to these images of overconsumption are examples of "living better on less" through conservation: a sail-aided oil tanker; solar-powered planes; an Integrated Urban House in Berkeley, Calif., which is outfitted with solar heating, a wind machine, and composting toilets; and a cave-like foam home made from insulating, polyurethane-coated plastic sheets.

The final section is a study of life among the Wyoming coal miners, which depicts blackened, smiling miners and is photographed with the same detached facination as the magazine's usual photographic studies of autochthonous tribes or nearly extinct insect species.

In all, the February *National Geographic*'s promotion of American cave homes and compost toilets is of a piece with the magazine's long-standing interest in undisturbed primitive cultures.

NEWTON'S REPUTATION POSES GRAVE PROBLEM

Science historian I. Bernard Cohen takes somewhat unusual pains in the March 1981 issue of *Scientific American* to establish Isaac Newton's scientific bona fides. As Cohen confides, however, Newton not only seized upon the prior discovery of Robert Hooke without attribution, but did so only after considerable prodding by Hooke. Hooke discovered both the inverse-square law of gravitation and the vector decomposition of orbital motion into its centripetal and tangential components.

Cohen also documents that Newton's so-called discovery of universal gravitation could not have occurred earlier than December 1684, as Newton claimed. Cohen writes: "In 1717 Newton wanted to ensure his own priority in discovering the inverse square law of gravitation, and so he invented a scenario in which he made the famous moon test not while writing the *Principia* but two decades earlier in the 1660s."

Despite his own documentation of Newton's frauds, science historian Cohen begins his article with the statement: "The high point of the Scientific Revolution was Isaac Newton's discovery of the law of universal gravitation." As anyone who knows of Albert Einstein's work is aware, however, it is precisely by going back to the standpoint of Johannes Kepler's actual discovery of the laws of gravitation, as exemplified in planetary orbit, that modern science has been able to advance beyond the ideological confusion sowed by Newton's linearized notion of gravitation. It was Kepler who studied the universe as a whole; while Newton, in the name of a universal theory, reduced gravitation to an inexplicable relationship between bodies as such.

Perhaps next Cohen will establish the even more scandalous plagiarization by Newton of the discovery of the calculus by Gottfried Wilhelm Leibniz.

* * *

REINDUSTRIALIZATION FUTILE SAYS SCIENTIFIC AMERICAN ARTICLE

"The proposed reindustrialization of an economy dominated by services is an exercise in futility," authors Eli Ginzberg and George J. Vojta conclude in the lead article in the March 1981 *Scientific American*. Their advice is that "Americans must unshackle themselves from the notion, dating back to Adam Smith, that goods alone constitute wealth whereas services are nonproductive and ephemeral."

The article, titled "The Service Sector of the U.S. Economy," is an unabashed defense of the shift in the American economy away from high-powered goods-producing industries toward the services—everything from accounting and legal services to more dry cleaning.

Although the article is purportedly the outgrowth of a long-term study of the restructuring of the U.S. economy jointly conducted by Columbia University's business school, where Ginzberg teaches, and Citibank, where Vojta is executive vice president for strategic planning, it reads, in fact, like a point-by-point answer to *Fusion*'s coverage of the economic analysis underlying the LaRouche-Riemann econometric model. The model's starting point is the distinction between productive, goods-producing industries and the nonproductive sectors of the economy, where nonproductive includes both useful and necessary endeavors like scientific research, health care, and education and nonuseful ones like gambling and much bureaucratic paper pushing.

The Ginzberg-Vojta piece, on the other hand, maintains that the productive versus nonproductive distinction is irrelevant; that services have replaced goods as "the cutting edge of economic growth"; that "human capital . . . has become the critical input that determines the rate of growth of the economy and the well-being of the population"; that the increasing internationalization of the U.S. economy (the shipping of manufacturing plants abroad to sources of cheaper labor) and the diversification of industrial firms is a promising trend; and that "What is needed is not reindustrialization but revitalization of the U.S. economy."

Since the article is written to an audience of scientifically oriented professionals, the authors make a big deal about the growing economic role of "human capital," which they define as the "skill, dexterity and knowledge" of the population; they maintain that the growth of the service sector correlates with an "improvement in the educational preparation of the labor force."

This claim flies in the face of numerous recent studies such as the Wirszup report on the serious erosion of skill levels and scientific capabilities of the U.S. labor force, as well as the practical experience of employers in every field from machine tool production to data processing. The shift to a service economy has, in fact, been characterized by the substitution of labor—and low-skilled labor at that—for capital and energy in the economy.

In a recent interview, Ginzberg, who is best known for his manpower studies, commented that raising U.S. productivity is not a question of more capital investment but simply one of upping the "labor utilization rate"—the proportion of the population in the labor force, which is now about 50 percent. In other words, his solution is putting everyone to work in any jobs possible.

Unfortunately *Scientific American* is increasingly becoming a forum for different varieties of zero-growth economic quackery. The irony of the magazine's current support for the service sector model is that basic scientific research has always gone hand in hand with in-depth industrial development. Thus by promoting the service economy, the editors of *Scientific American* are helping to retard scientific development.

Fusion Budget

Continued from page 15

energy production capacity by the end of this century," he began.

After reviewing the needs of the nation's nuclear program, McCormack reminded the committee that the law "commits this country to an Apollo-like program" for fusion. The difference between the administration request for fusion and the level mandated in the law, he stated, is "the difference between moving forward or not with critical projects already underway and starting critically needed projects, such as the FED."

"To abandon this commitment now in order to save $75 million would be an act of extraordinary folly, virtually without parallel. It would constitute the abandonment of one of the truly significant initiatives undertaken by the government in many years and would be a betrayal of the faith that so many people in this country and around the world have placed in the Congress."

Some Results

The pressure exerted on the DOE by Congress, the fusion community, industry, and the Fusion Energy Foundation began to show returns March 18 when Pewitt once again testified before the Bouquard House subcommittee.

Back-tracking on his statements that the administration would not commit itself to the projected $1 billion FED in order not to have to pay large "mortgages" in the budget over the next four years, Pewitt said that after the program is reviewed this summer, the DOE may well decide to commit funds for the FED construction within the timetable of the law. This would require money for construction beginning in fiscal year 1983.

The next step in the budget process is the mark-up of the fusion budget. Meanwhile, postcards, letters, and telegrams to President Reagan, senators, and congressmen should continue to push for full funding of the fusion budget and implementation of the 1980 legislation.

Downgrading the U.S. Space Program

Similar to the fusion budget situation, where the Reagan budget request was approximately 10 percent less than that requested under the previous administration, the OMB has recommended a 10 percent cut in the fiscal year 1982 NASA budget. This entails a cut of $603.5 million.

The cuts in the NASA program would cancel the most important international cooperation program, the Solar Polar Mission, and would eliminate or defer all fiscal year 1981 and fiscal year 1982 new program initiatives in space science, aeronautics, and applications.

The Venus Orbiting Imaging Radar proposed for launch in 1986 is being delayed until 1988. The same is true for the launch of the Gamma Ray Observatory. The Spacelab flight schedule will be "revised," a change that has antagonized the nation's European allies who are building Spacelab.

The programs that are proposed for cancellation include many of the applications of NASA science and technology programs that are critical to the nation's economic health. These include geological applications programs for mineral exploration, the program for materials processing in space, AgRISTARS—the agricultural applications of remote sensing program, the National Oceanic Satellite System, and the Technology Transfer program.

Although most of the authorizing and appropriations hearings on the NASA budget have not been held as of this writing, it is quite likely that these cuts will be restored.

In testimony before the Space Science and Applications subcommittee in the House March 12, the director general of the European Space Agency, E. Quistgaard, stated plainly that the cancellation of the U.S. craft for the Solar Polar Misson would cancel the entire project.

"Over the past 10 years Europe has spent over $1.2 billion in cooperative projects with NASA," Quistgaard said. Delays in the program have cost the European Space Agency an additional $20 million he stated, but the cancellation of the U.S. participation will "have profound consequences" on long-term joint research activity.

"The nation's science and technology position is precarious, to say the least."

Sen. Harrison Schmitt

Under questioning from committee members, Quistgaard admitted the United States was seen as an "unreliable partner" in space cooperation after this budget cancellation.

Senator Schmitt can be expected to lead the fight to restore the proposed NASA cuts.

In a special press briefing Feb. 23, Schmitt said, "The nation's science and technology position is precarious, to say the least. . . . The present budget-cutting exercise by the Reagan administration is being carried out in the absence of major science and technology advisors. . . .

"In the course of economic recovery, we must make sure that the nation's capability to sustain economic recovery is not jeopardized. Only a strong and expanding science and technology base can sustain this recovery."

Echoing a similar concern, Rep. Bill Nelson, a Florida Democrat, stated that the House Budget Committee wants to minimize cuts that "are counterproductive." The key to economic recovery, he stated is "high-technology investment which stimulates increases in productivity." In that light, Nelson was hopeful that Congress would decide to enhance NASA's capability rather than putting it under the budget axe.

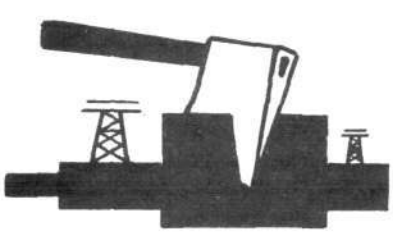
Excising Science Education from The NSF

The response from the nation's educators and scientists to the proposed elimination of the National Science Foundation's Science Education Directorate was swift and angry. In testimony before the Subcommittee on Science, Research, and Technology of the House Committee on Science and Technology, several representatives from the teaching profession expressed their concern that the NSF science education budget was cut 90 percent—from $111.9 million to $9.5 million—leaving only money to continue ongoing graduate fellowships.

Dr. Donald W. McCurdy, the president of the National Science Teachers Association (NSTA) told the subcommittee that the Reagan budget proposal "distorted the NSF mission." According to law, McCurdy said, the foundation is directed to support *both* basic scientific research *and* "science education programs at all levels."

The crisis in science and engineering education already exists, McCurdy stressed. "The shortage of qualified mathematics and science teachers in secondary schools has reached crisis proportions."

The NSTA recommended that the directorate be restored to a funding level of $86 million, compared to the $9.5 million proposed by the OMB. Included in the NSTA testimony to the committee was the Viewpoint column from the April issue of *Fusion* magazine written by NSTA executive director Dr. Bill Aldridge.



FEF Policy Statement

Continued from page 5

This is precisely the distinction missed by the OMB.

It should be stressed that even before these proposed cuts, the legacy of the Carter administration science policy left the nation in a perilous state. Senator Harrison Schmitt, a New Mexico Republican and former astronaut-scientist, put it this way in a press conference Feb. 23:

"The nation's science and technology position is precarious to say the least. On the one hand, the economy has deteriorated to the point where adequate new public and private investment in science and technology are either economically or politically impossible. On the other hand, major challenges exist that require a rapid rejuvenation of our science and technology base: challenges in productivity, space, aeronautics, defense, strategic energy and materials, health, environment, agriculture, education, and basic science itself."

The Economic Consequences

The most immediately obvious consequences of the OMB budget cuts are economic. In the short term, the proposed budget reductions would destroy the nation's immediate ability to implement existing advanced technologies in the energy and automation fields. Specifically, this means that a fusion engineering device will not be built now, although technologically possible, because there will not be the funds to do it. In the long term, the cuts would destroy the nation's chances to recover from the present economic crisis.

Stockman's proposed cuts in the advanced energy budget epitomize this ironic situation. On the one hand, Stockman and his cothinkers point out that energy problems must be solved today. Only nuclear energy can do this, they argue. Therefore, why should money—now so precious—be invested in an area like fusion that will not pay off in energy for another 20 years?

There are three types of reasoning behind this argument. First, there is a significant fraction of the supporters of this view who are truly and sincerely shortsighted. Blinded by an austerity-induced myopia, they truly think that investment in nuclear energy today is more important than—and competitive with—fusion energy tomorrow. What would have happened in the postwar period if civilian nuclear power were not developed because the coal and oil industries lobbied against it?

The consequences of such myopia were recently summarized by economist Lyndon H. LaRouche, Jr., chairman of the advisory board of the National Democratic Policy Committee: "Cutting research and development (in fusion) is easy to justify from a cost-benefit standpoint. It is also a policy that ensures that a firm or national economy will still be producing buggy whips when people are driving automobiles."[4]

As discussed specifically here in terms of the military consequences of cuts in basic science—an area where Robert McNamara's theories of cost-efficiency and cost-benefit analysis continue to wreak destruction—it is precisely these myopic systems-analysis proponents who are responsible for the destruction of large parts of the nation's military capability.

'Supply-Side' Mythology

The second justification advanced for the cuts in long-term energy research is perhaps more important in the current political arena. Under the now-fashionable rubric of "supply-side" economics, the government is advised to stay out of long-term, advanced energy research like fusion because it is neither the responsibility of government nor something that government can afford.

At the outset, it should be emphasized that the important economic distinction is not "supply-side" versus "demand side" but productive versus nonproductive—a distinction we have discussed in detail.[2]

The supply-siders—such as Jack Kemp, Jude Wanniski, and Art Laffer—argue further that cutting research out of the budget makes it possible for the government to create more tax cuts. These tax cuts, they

argue, will then so greatly encourage private investment that private industry will then be able to take up fusion research. (This is similar to Milton Friedman's "free enterprise" reasoning against government support for science.[5])

This supply-side argument, in fact, is simply a new name for a policy of no investment. The significance of this fact was proudly described by the *Morgan Guaranty Financial Newsletter* in the February issue. The newsletter candidly pointed out the basis for supply-side economics:

"The new supply-side philosophy is different in its emphasis. Instead of focusing on the leverage between the size of the nation's capital stock and the nation's supply of goods and services, the new supply-side thesis stresses the role of work effort as a key conditioner of the volume of total production. Sharply rising tax burdens, it is argued, have discouraged effort; lower those burdens via the Kemp-Roth three-year tax-cut plan (thereby allowing people to retain a greater portion of what their efforts yield) and work effort would be greatly stimulated. The consequences would be a surge in the total supply of goods and services that could ultimately dampen upward price pressure."

In other words, capital investment in production, new technologies, and automation are thrown out the window in favor of a philosophy that puts the burden of economic growth on individual "work effort"!

The Postindustrial Argument

Stockman himself is a supporter of the third line of argument for the budget cuts in basic science research and education: Such cuts are the prerequisites of the postindustrial society. This policy calls for the funding of investment in the so-called sunrise industries like computers and solar energy, and a rapid disinvestment in the sunset industries like steel, auto, and other heavy industry. The lie here is that the present economy cannot even sustain sunrise industries if the industrial core of the economy—heavy industry—is deliberately cut out.[6]

Stockman, a supporter of this postindustrial perspective, has followed the reasoning behind the *Global 2000 Report* for the destruction of scientific research, the deemphasis of science education, and the postponement of advanced energy research like fusion.

Economic Growth Requires Science

The economic necessity of investment in basic science research, advanced energy systems, and science education is straightforward: An economy can grow only if it has access to new resources, more highly skilled manpower, and adequate energy. All of these require new technologies ("useful arts"); their continued progress requires scientific research.

The empirical evidence for this is overwhelming: The period of highest growth rates in the U.S. economy, of sustained productivity growth, and of even minimally adequate capital investment all occurred during the period between 1960 and 1967. Why? Because of the NASA Apollo program.

The United States today has fewer scientists and engineers engaged in research and development than in 1965. (The Soviet Union, by comparison, has more than twice as many as it did in 1965.) The United States produced more steel in 1965 than it does today; the United States produced more machine tools in 1965 than it does today; and the United States produced more energy in 1969 than it does today.

The relative economic health of the 1960s was almost totally the result of the invigorating effect of the NASA space research program.[7] The marshaling of scientific and technical manpower for the moon shot created and educated hundreds of thousands of new scientists and engineers; it forced the development of new automation technologies; and it resulted in the discovery of new materials, new diagnostics, and new industrial processes. This was the leaven for the whole economy.

Many detailed econometric studies have shown that this effect of "science-intensive" government spending is absolutely lawful. According to a study by Chase Econometrics, every dollar spent by NASA resulted in 14 dollars of economic activity.[8]

This economic activity is deflationary, according to that same study: If the same dollar amount were spent on less science-intensive areas, not only would it generate less additional activity, but also it would cause inflation.

A study by Econ Inc., an econometrics consulting firm in Princeton, N.J., shows the same impact from an aggressive fusion research program.[9]

And the detailed studies conducted by the Fusion Energy Foundation using the LaRouche-Riemann econometric model show conclusively that an investment program in fusion along the lines of the 1980 fusion legislation would completely reverse the present downward economic spiral by raising productivity, encouraging investment, and training new manpower.[10]

The Military Consequences

For all the economic fantasies of the supply-side economists or the neo-Malthusians of the Global 2000 persuasion, there is an objective measure of the success or failure of a nation's basic science policy—what happens to that country's ability to defend itself militarily.

Since 1960, the United States has pursued a military expenditure policy that has consistently downgraded the importance of scientific research and advanced technological development—the result of the same cost-benefit mentality that motivates Stockman's budget cuts.

Over the past 10 years alone, the Soviet Union has spent approximately $50 billion more on military research and development than the United States. The gap continues to grow not so much because of cuts in the military budget, but because the civilian economy has now become so technology-poor, so deficient in skilled manpower, and so obsolete in critical industrial areas.

The facts are frightening:

"The U.S. all-volunteer army has been a military disaster. Today's weapons are too complex for today's soldiers. . . . Between 10 and 30 percent of U.S. troops in Europe are on heroin or cocaine, with a much larger per-

centage of habitual users of hashish and marijuana; 25 percent are classed by the Army as problem drinkers. The average recruit reads at a fifth grade level, and 60 percent of recruits are rated below average in the Army's mental aptitude tests."[11]

The impact of scientific research on military strength has another, more long-range side in the development of new weapons systems. Since in engineering terms an effective military capability relies on firepower, as Clausewitz noted, the science most relevant to war is always that science dealing with high energy or power densities.

Certainly today this science is, uniquely, fusion. Fusion energy is not only the power source for the hydrogen bomb; in addition, it is the most relevant area for the technologies of high-power lasers and intense particle beams.

In both lasers and beams, the country that has invested in a broad-based program of fusion research for civilian application will have the scientific manpower and industrial experience to successfully develop the much-feared beam weapon.

That the Soviet Union has done so is the widespread assessment of the scientific and intelligence community. And it is a matter of public record that the United States continues to avoid committing large resources to this research, that it continues to hamper currently funded research with absurd criteria of cost-effectiveness, and that the chief obstacle to accelerated research is the lack of a supportive civilian research program in laser fusion development.

The consequences of not developing this weapon are devastating in national security terms. To quote from a report prepared by the Defense Department in February 1981: An orbiting laser is "an awesome force capable of checkmating a massive ICBM attack. A hundred laser battle stations in space . . . could cope with the simultaneous launch of 1,000 ICBM's."

The Soviet Union is known to be within years of deploying this weapon or its particle beam relative.

In 1967, at the height of the NASA Apollo program, 33 percent of the budget of the National Science Foundation was spent on science education. The 1980 NSF budget *before* the Stockman cuts included 8 percent for science education. Stockman proposes to cut that amount by 90 percent, leaving only the multiyear graduate fellowships that the NSF is under contract to continue!

The most profound impact of this budget proposal is not economic or even military; it is social. The effect on the minds and morale of the present generation of students will be devastating. Recent studies by both governmental and private groups show in sickening detail the decline in both the number and quality of U.S. scientific graduates, the decline in enrollment in science programs of all types, and the decline in the scientific literacy levels of the general population.[12] These reports concur that the United States has become a nation of "scientific illiterates."

Restoring U.S. Education

A restoration of American education requires much more, however, than adquately funding education programs; it demands a national priority, a national purpose, a national goal of scientific progress.

During the 1960s the NASA Apollo program captured the imagination of a generation of American children with the dream of becoming an astronaut—a scientist who explores new worlds. That vision sparked the scientific spirit in children; it defined a goal, a motivation for rigorous academic work and its translation into reality.

Without this national goal, without a vision of a nation that is growing and progressing, a pervasive demoralization has set into this country. The cultural susceptibility toward drug usage, toward hedonism, toward banality can be traced in large part to the lack of national self-confidence or optimism.

The only source of this optimism is an aggressive scientific life.

More than anything else, this vision comes with the space program. Think of the message received by a child when his government proposes a budget that would decimate not the entire NASA program, but specifically its Office of Space Research and the space science programs.

If we allow these budget cuts to go through, there will be no vision and no scientific frontier for the generation of the 1980s; and there will be no scientific breakthroughs, because we will not be training the next generation of scientists who would make tomorrow's breakthroughs.

The majority of Americans believe in science and progress and will fight for the American System and against the notion of a postindustrial, zero-growth society. The Fusion Energy Foundation *science alert* intends to mobilize this majority to defeat Stockman's budget cuts.

Notes

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3. *Executive Intelligence Review*, March 17, 1981, p. 36.
4. Lyndon H. LaRouche, Jr., "Administration Energy Budget Policy Has the Wrong Bias," National Democratic Policy Committee White Paper, Feb. 7, 1981.
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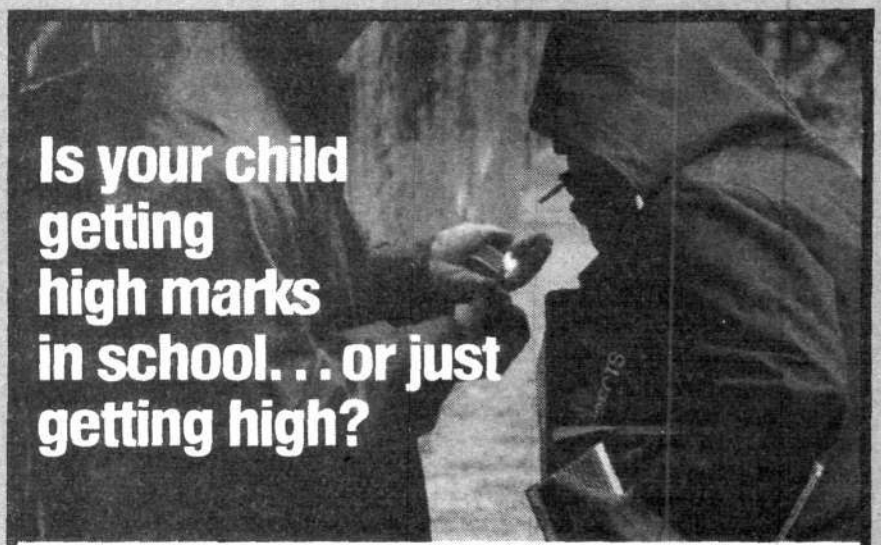

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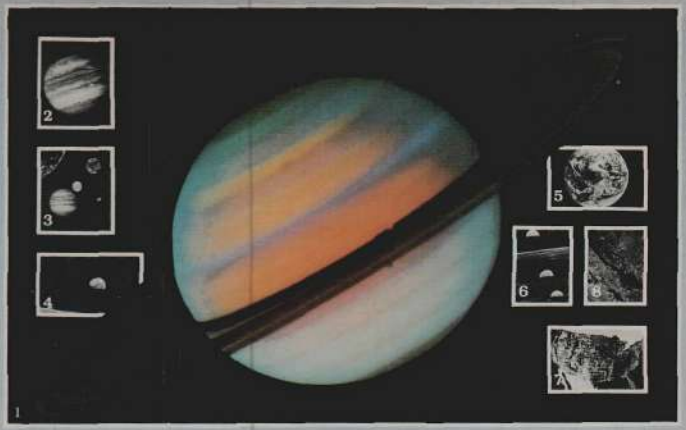

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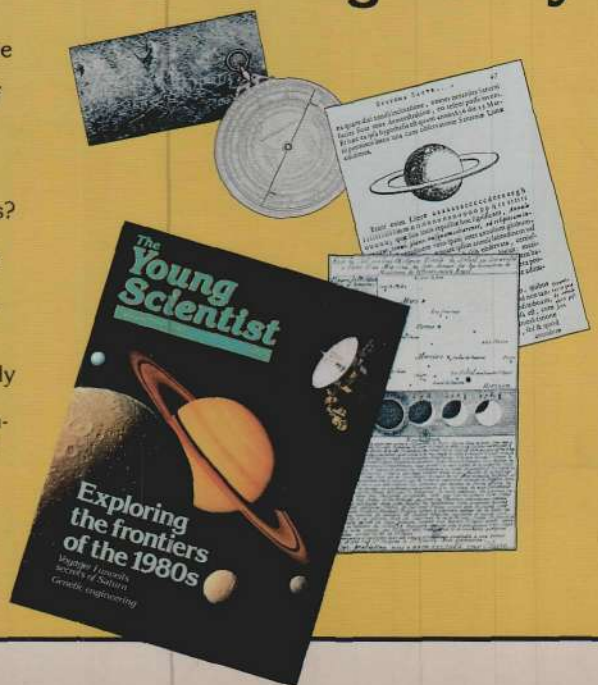

In This Issue

Adolfo Carbajal

Dr. Steven Bardwell addressing the FEF-AMEF seminar at the Mexican Petroleum Institute.

'MEXICO 2000': ECONOMICS FOR GROWTH

The FEF and the Mexican Association for Fusion Energy unveiled a 20-year development model for Mexico's economy at a headline-making seminar in Mexico City Feb. 19-20. The program breaks with the "go slow," conventional wisdom about Mexican development and shows that the oil-for-technology approach is the means for making Mexico a fully industrialized nation by the year 2000. The July issue of *Fusion* will present the progam in detail, including a U.S. "shopping list" for the $100 billion in capital goods that Mexico will need for industrialization.

GLOBAL 2000: LICENSE TO KILL?

To officials in the U.S. State Department's Office of Population Affairs, the bloody civil war in El Salvador—which has killed 13,000 people and destroyed the country's economy—is a way of achieving world population stabilization. This is the real message of *Global 2000*, the report on resources and population prepared for the Carter administration by the State Department and the White House Council on Environmental Quality. So far, the Reagan administration has shown no sign of repudiating *Global 2000*.

C. Chauvel/Sygma

The fruits of civil war in El Salvador: "To reduce population quickly, you have to pull all the males into the fighting and kill significant numbers of fertile, child-bearing age females"—Thomas Ferguson, Latin American case officer, State Department, Office of Population Affairs.

Men of Progress by Christian Schussele, oil on canvas, 1862. This gallery of American inventors shows Charles Goodyear seated left of the table, Samuel Morse at right; leaning against the left of the pillar is Joseph Henry, at right is John Ericsson; seated at far right is Elias Howe; overlooking the group is a portrait of Ben Franklin.

SCIENCE BUDGET CUTS AND MEN OF PROGRESS

After four years of President Carter's antiscience measures, the proposed Reagan budget cuts would finish the job—crippling the very science capability that can provide economic and population growth. The cuts in the fusion budget, for example, make it impossible to begin the engineering phase mandated in the 1980 fusion legislation. How would "men of progress" solve the budget crisis in the American tradition? This issue's feature on "The Physical Laws of Economic Development" and the FEF science policy statement provide the answers.

The Cover: Front cover illustration by Virginia Baier; cover design by Christopher Sloan.