
FUSION
AT THE FRONTIERS OF SCIENCE AND ENERGY
February 1981
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Saturn Results Overturn Newtonian Mechanics
See page 45
Launching America's Newest Industry– Fusion
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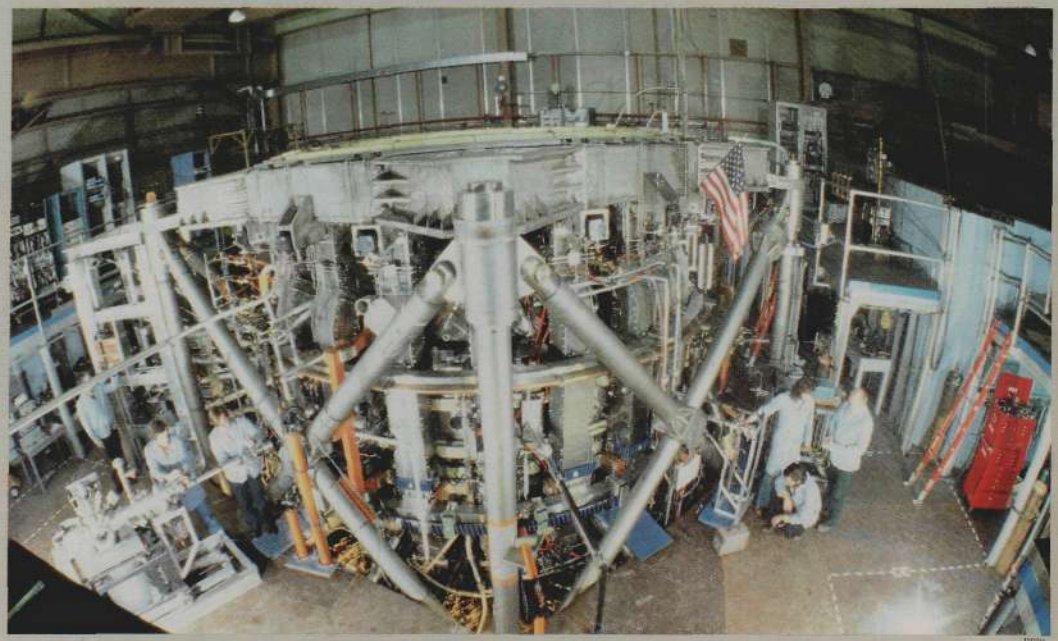
We stand up for you and America.



PPPL

Join the **Fusion Energy Foundation**

Fourteen thousand Americans last year invested from $75 to $1,000 each in the future of America's scientific and industrial leadership by joining the **Fusion Energy Foundation,** the nation's largest scientific membership organization.

With this kind of clout, we waged a vigorous educational campaign nationwide and on Capitol Hill, culminating in what Congressman Mike McCormack called "the most important energy project undertaken anywhere by anyone"—the Magnetic Fusion Energy Engineering Act of 1980. As the first national organization to support an Apollo-style fusion program for America, we and our 14,000 members are proud to take credit for creating the environment in which Congress and the president have mandated fusion as the energy source of America's future.

Now we're aiming for 50,000 new members who believe in progress and growth. Our goals for 1981 are just as important as 1980's fusion legislation:

(1) Eliminate the obstruction of progress by the Environmental Protection Agency.

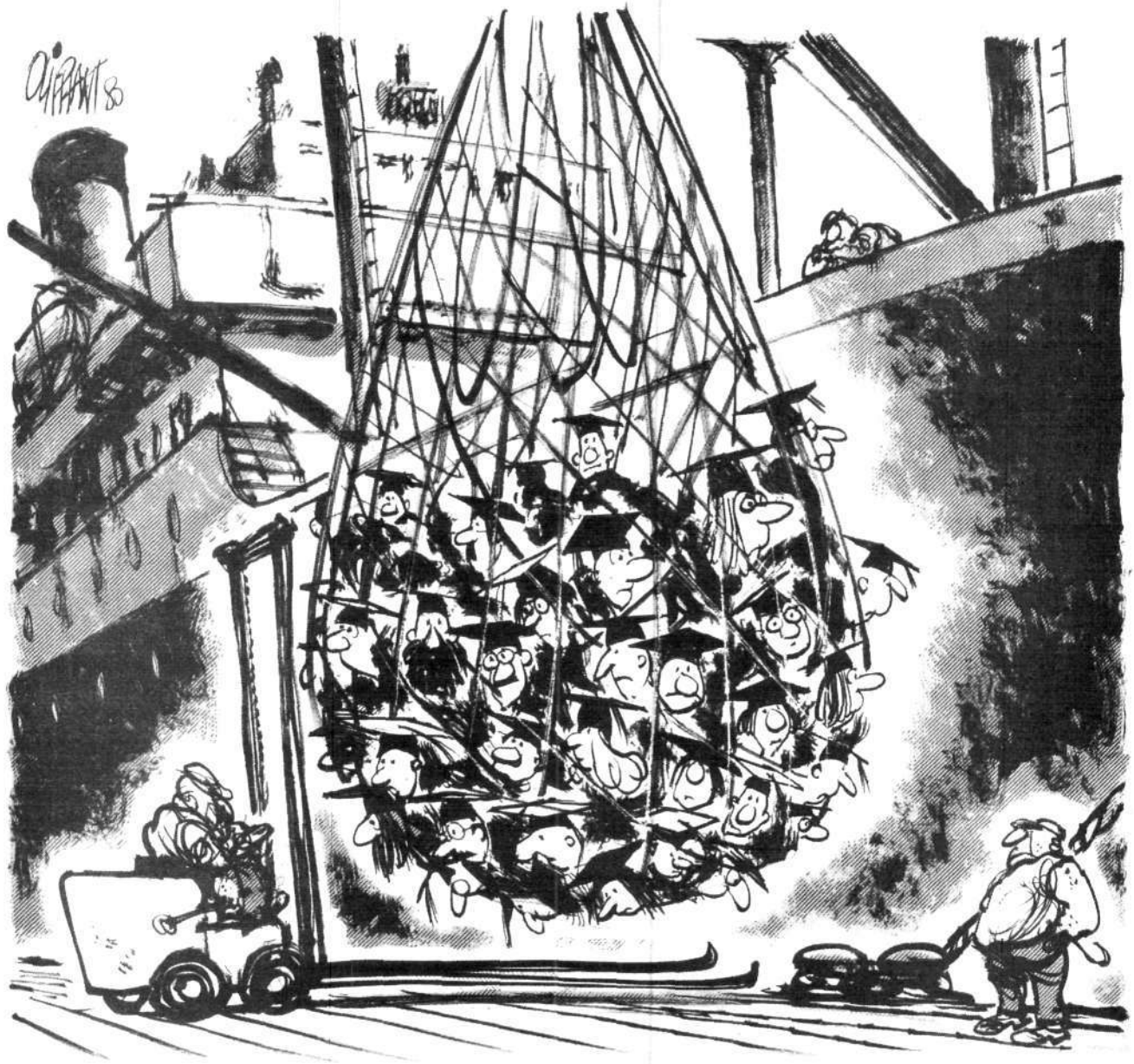
(2) Launch an unprecedented program of scientific education for our children.

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

With your active support, we can make 1981 the year that environmentalists cease determining U.S. policy. We can eliminate the artificial impediments to nuclear energy and put an end to the Malthusian politics of austerity and scarcity.

Join the **Fusion Energy Foundation** now. We work for you all year long.

Fill out the membership card opposite this page.



WHAT WILL WE HAVE TO IMPORT NEXT, COLLEGE GRADUATES?

Ever since World War I, most of the rest of the world has come to the United States for the latest technology and for the newest in business management.

Now we're in real danger that the pendulum is swinging the other way. Our technological lead is being cut. We're importing know-how in many fields instead of exporting it.

Unfortunately this situation will get progressively worse. Unless we all make absolutely sure that our colleges and universities continue to be first-class.

For our colleges and universities supply most of the basic research upon which technological progress is built. Not to mention the trained minds that are best able to direct its uses.

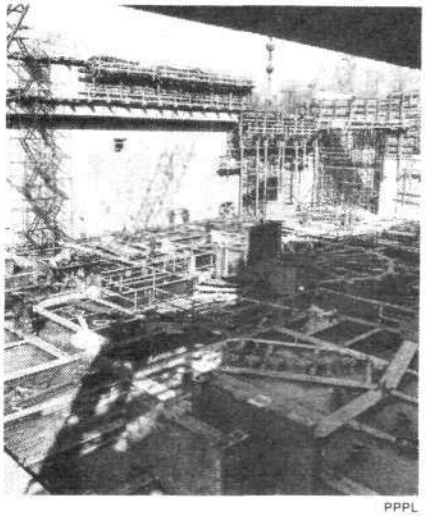
But America's colleges are being hurt by inflation. Rising costs are eating away at their operations to a dangerous degree.

So, please make sure that your company is giving as much as it can, as much as it should, to the colleges of its choice. This year. Today.

If we keep the intellectual "balance of trade" in our favor, the industrial balance is bound to follow.

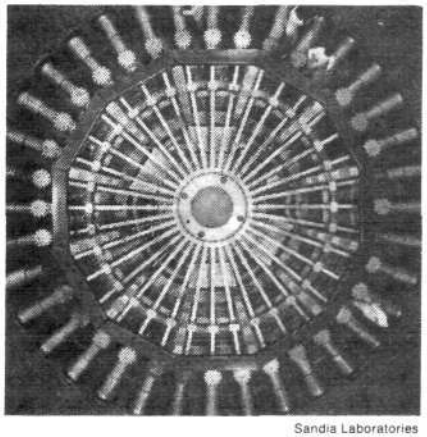
Send for our free booklet, "How to Develop an Effective Program of Corporate Support for Higher Education." Write CFAE, 680 Fifth Ave., New York, N.Y. 10019.

HELP PRESERVE AMERICAN KNOW-HOW.
GIVE TO THE COLLEGE OF YOUR CHOICE.



PPPL

Who will supervise the national effort to build a Fusion Engineering Device? Ebasco's Leonard Reichle discusses industry's crucial role. Shown here is the site of Princeton Plasma Physics Laboratory's Tokamak Fusion Test Reactor, scheduled to be in operation by 1982. Ebasco is the subcontractor for the TFTR engineering, design, and installation. *See page 22.*



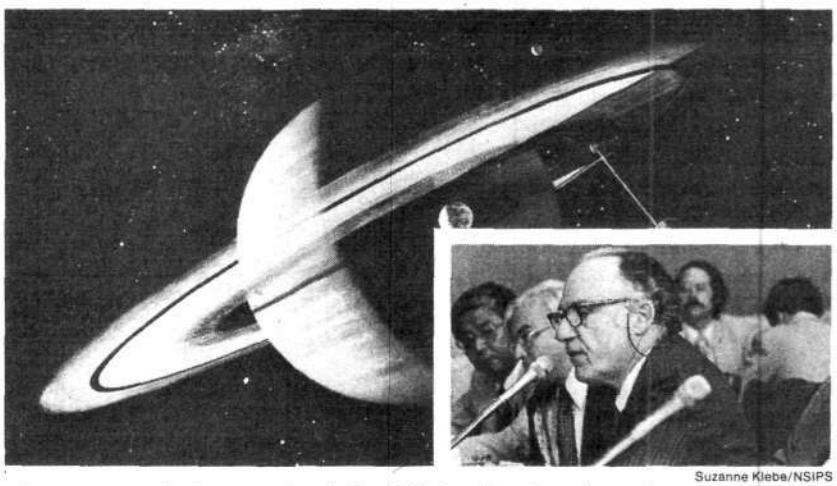
Sandia Laboratories

Fusion's Charles B. Stevens recently toured the national fusion laboratories. In Part II of his report to readers, he describes the PBFA-I accelerator at Sandia Laboratories. Here is an overhead view of the PBFA-I showing the 36 transmission lines converging on a diode area. *See page 12.*

Features

News

Departments



NASA

Suzanne Klebe/NSIPS

The FEF agenda for 1981 includes full funding for the U.S. space program and the fusion effort. Here, a view of Saturn and PPPL's Dr. Melvin Gottlieb.

From the Editor's Desk

The awesome views of Saturn transmitted by Voyager I (see page 45) are a happy reminder of what man has accomplished—and the challenge that lies ahead. As we lay out in this issue's editorial and a new column for FEF members, 1981 must be a year in which we restore the educational excellence of the NASA years, remove the environmentalist restrictions choking industry and energy development, and ensure that the fusion law is fully implemented.

I'm proud to report that our new weapon in the fight to put science back into American schools—*The Young Scientist* magazine—has received an initial enthusiastic response. We'd like to hear from more of you and your children.

And on the fusion front, just how far the United States has come is the theme of a special event Feb. 6, "Fusion: 50 Years of Progress," to honor Dr. Melvin Gottlieb upon his retirement as director of the Princeton Plasma Physics Laboratory. For details, see page 11.

Marjorie Mazel Hecht

Marjorie Mazel Hecht
Managing Editor

FUSION

AT THE FRONTIERS OF SCIENCE AND ENERGY

February 1981 **Vol. 4, No. 4**

FUSION is published monthly by the Fusion Energy Foundation, Suite 2404, 888 Seventh Ave., New York, N.Y. 10019, Tel. (212) 265-3749. Dedicated to providing accurate and comprehensive information on advanced energy technologies and policies, FUSION is committed to restoring American scientific and technological leadership. FUSION coverage of the frontiers of science focuses on the self-developing qualities of the physical universe in such areas as plasma physics—the basis for fusion power—as well as biology and microphysics, and includes groundbreaking studies of the historical development of science and technology.

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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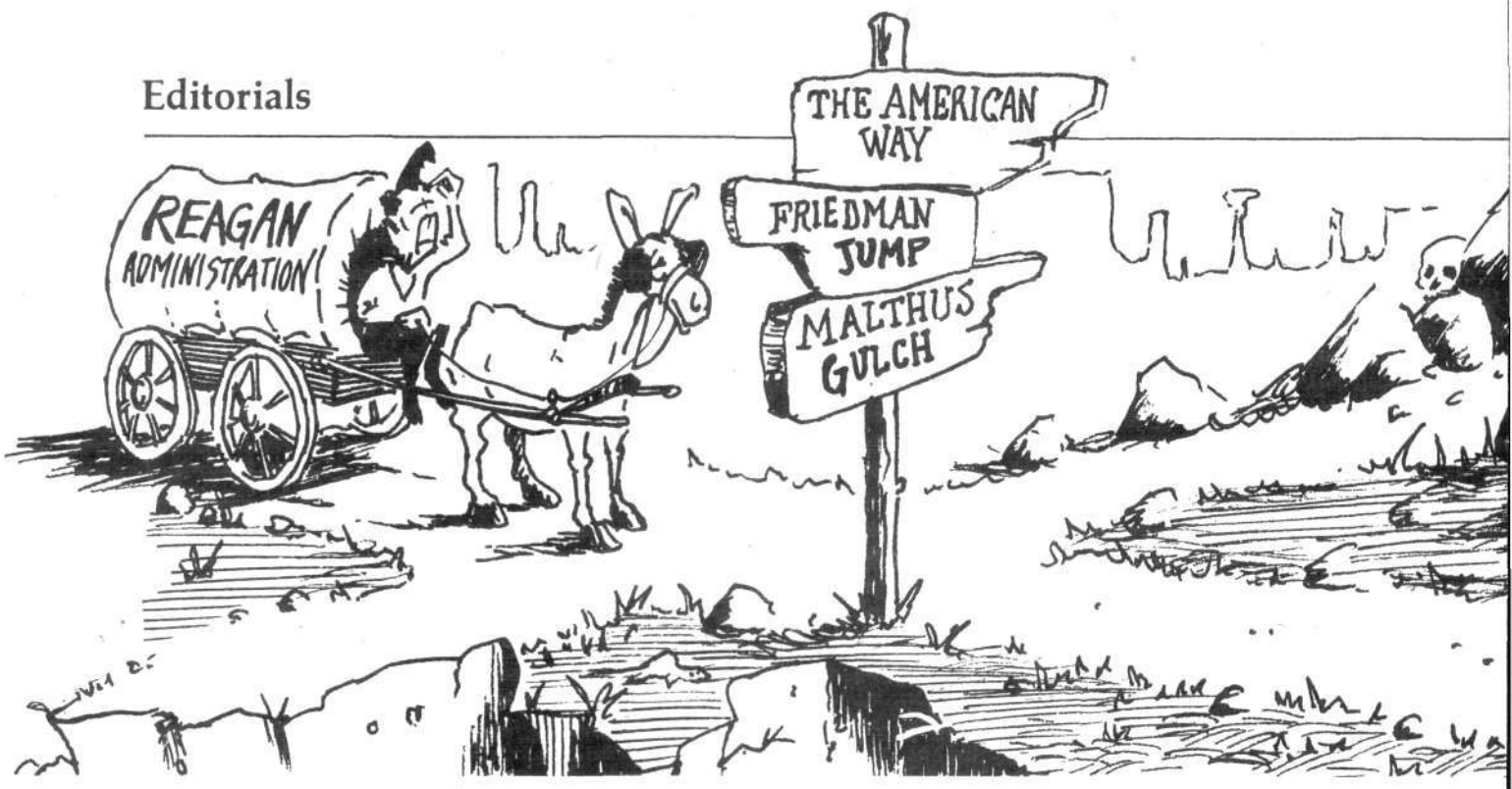


Restore the American System

The most important result of the Nov. 4 presidential election is that the American population has given President-elect Reagan a decisive mandate to take whatever steps are necessary to restore America's battered economy and world standing to a position of prosperity and leadership.

Some of the important policy areas and specific recommendations for action to achieve this objective are outlined in this month's Viewpoint column. Underlying the required policies in science, economics, education, and military and civilian R&D is the larger issue of restoring the American System. By that we mean the body of theoretical and practical knowledge that founding fathers Franklin, Washington, and Hamilton made the basis of the American Constitution. This then was elaborated by American System economists Matthew and Henry Carey in the 19th century as the basis for the vast industrialization policy of the Lincoln administration that made America the world's leading industrial nation.

Now is the time to restore the American System—the system of promoting maximum individual freedom to create and employ scientific advances as the driving force of economic and cultural progress. Now is also the time to get straight the proper role of the government. Its proper constitutional role is to pursue the monetary and credit policies, along with direct investments in strategic scientific research and large-scale infrastructure, to provide the optimal climate for individual creativity and initiative.

The FEF Role

The Fusion Energy Foundation will function in this critical period ahead as the largest, most aggressive spokesman in the nation for scientific and technological progress. If you want to get these things done, we are your voice and "clout":

- Get rid of zero-growth environmentalist restrictions on science and industry and replace them with proper tax and credit incentives for research and productive investment.
- Unleash the nation's full nuclear fission capabilities for domestic use and

profitable export, including the breeder reactor, fuel reprocessing, and waste storage, and fully implement the McCormack fusion bill.

- Implement a North American water plan to provide all the nation's water needs in agriculture, industry, transportation, and municipal use for the coming decades.
- Provide upgraded resources for all areas of basic research, from space science and accelerator physics to biology and agriculture, and at the same time rebuild the scientific excellence of our educational system at all levels.

Within the FEF itself, we intend to continue our own groundbreaking research in the mathematical economics of the American System: the LaRouche-Riemann economic model. Likewise, we will continue to bring you the most advanced coverage of the frontiers of science and technology available anywhere.

We have a wonderful opportunity now to make America the shining example to the world again. Now is the time to restore the American System—for good.

Mike McCormack's Future

The defeat of Rep. Mike McCormack is one of the few unfortunate aspects of the Nov. 4 election; however, we are sure he will continue to play a major role in determining future U.S. science and energy policy.

There are few, if any, members of Congress who have McCormack's grasp of the broadest issues of economics, politics, and science plus his technical expertise. During the darkest days of the Carter administration, McCormack represented the epitome of responsible citizenry as he assumed a leadership role abandoned by most other moderates. In specific areas of science and technology, we have Congressman McCormack to thank for support of advanced accelerator research, valuable work on the nuclear safety and waste storage bills, and, of course, the enduring achievement of the historic McCormack fusion bill.

As we enter the critical transitional period ahead, we hope that McCormack will assume a position equal to his capabilities. That includes not only the areas of government policy noted here, but also a leadership role in rebuilding the Democratic Party around a sound program of industrial growth and scientific progress.

The Lightning Rod

My Dear Mr. President-elect:

Congratulations! I know you're pretty busy these days, because all the newspapers are full of long lists of names of all the people who are giving you advice. Most of them seem to have a lot of experience giving advice to presidents, too. Now unfortunately, I wasn't able to do much for Mr. Nixon or Mr. Ford (come to think of it, the same could be said about some of these fellows), and of course I was never a president myself. But I have seen a lot of presidents come and go, and I do know a thing or two about the business; in fact, you might say I helped to write the job description back in 1789.

So I thought I'd weigh in with some advice of my own, because if there's one thing that all the newspaper fellows seem to agree on, it's that you are just wonderful when it comes to taking advice. (By the way, I wouldn't worry too much about keeping up that reputation if I were you. As soon as some of the fellows on those long, long lists find out that they have not gotten exactly the job in your outfit they had in mind, you are going to find your advice-taking capability has suffered quite a bit in the eyes of their favorite newspaper reporters.)

Anyway, since you are probably getting a lot of advice as to what you should worry about as president, I thought I would start off by giving you some good news about things you don't have to worry about.

Don't worry about the snail darter.

The little fellow's going to be all right. In fact, they just found a whole lot more of him about 60 miles away from that big dam site that his friends wanted to shut down because they were terrified that tiny little fish couldn't survive anyplace else but where the people of the United States wanted to put that dam. Mr. President-elect, I think this is a particularly important thing for you not to worry about, because your predecessor spent a lot of time worrying about such things, and people got pretty upset with him about it after a while.

Don't worry about conservation in the prison system.

You may not know this, but the Department of Energy you are about to inherit has a program for teaching energy conservation to the inmates in U.S. correctional institutions. Given the demonstrated lack of altruistic spirit among this particular sector of the population, dividends would seem to be negligible. You should spend practically no time on this one. About one phone call should do it.

Don't worry about "nuclear non-proliferation."

By the end of his administration, even your predecessor had turned this over to his daughter Amy. Don't classify basic scientific knowledge because some whiz kid claims he can build an A-bomb in his basement.

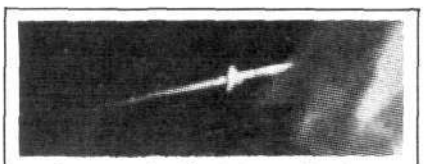
Help us build more nuclear plants; let's get the breeder reactor program going again; take President Eisenhower's Atoms-for-Peace approach out of the history books, dust it off, and let's put peaceful nuclear energy to work to raise living standards throughout the whole world.

Mr. President-elect, there is one thing I know you can't help worrying about, and that is the state of our economy. I remember we had quite a problem with that when President Washington was taking over, but fortunately, we got some pretty good advice from a young fellow by the name of Alexander Hamilton. You might take a look at how he reorganized the continental debt and got our farms and industry going again; it's all in his *Report on the Public Credit* and *Report on Manufactures*. It's a shame Mr. Hamilton isn't available to be your treasury secretary, as I'm sure he would do a superb job, but I would recommend highly anyone who understands the principles he laid down.

As for myself, I've said just about all I canright now; anyway, I'm not as young as I used to be and commuting to Washington from Philadelphia would overtax my powers. But I thought you might put my name on one of those advisory lists, down near the bottom someplace, and after everybody else had their say on an issue, if you still weren't entirely sure what you wanted to do, you could look down at my name on that list and see if any idea came to mind. I remain, with the greatest respect, Mr. President-elect,

Yr. obt. svt.,

Benj. Franklin



Coming in the March issue of *Fusion*

Colonizing Space with Fusion-Propulsion Rockets

by Dr. Friedwardt Winterberg

Letters

No Defense for Monetarists

To the Editor:

An advocate of the use of nuclear energy, I recently subscribed to *Fusion*. As a teacher of economics, I was appalled at David Goldman's article, "Why Monetarism Destroys High Technology" [*Fusion*, Sept. 1980, p. 15].

Either (a) the article is a hoax, (b) a long series of typographical errors, or (c) Mr. Goldman is totally ignorant of monetarism, Milton Friedman, or economics in general. . . .

Please get a competent rebuttal of Mr. Goldman's article into print so that those readers who don't know anything of economics recognize that Goldman doesn't either.

Donald H. Buck, Ph. D.
Department of Economics
San Joaquin Delta College
Stockton, Calif.

To the Editor:

David Goldman, in his denunciation of Milton Friedman's monetary policies and their application in Chile, uses a quote by William F. Buckley, thus implying that Mr. Buckley would agree with Goldman's thesis. However, the following passage from Mr. Buckley's syndicated column indicates otherwise: "When the military coup overthrew Allende in September, 1973, inflation was running just under 1,000 percent. Now it is running at 28 percent. That's progress. It would be equivalent, in America, of reducing our inflation of 10 percent to inflation of 0.28 percent, which is where it would be if we took the advice of Milton Friedman."

John Wittman
North Bergen, New Jersey

The Editor Replies

We would gladly print a competent defense of Milton Friedman's economic theories, but we have yet to see one.

The cornerstone of Friedman's economics is his proposal to keep money supply growth within a specified band, a tactic that is supposed to minimize inflation and promote capital formation. The experience of the U.S. economy since Oct. 6, 1979, when the Federal Reserve adopted Friedmanite principles in setting monetary policy, shows that it needn't do either. The Fed's austere credit and monetary policies have crippled industrial output and damaged the long-term bond market and capital investment, while doing nothing to alleviate double-digit inflation.

This failure should not have come as any surprise. Friedmanite economics proceeds from the incorrect assumption that monetary categories are all-determining in an economy, whereas it is real economic inputs like the level of capital investment and living standards that in fact determine growth rates and inflation. The corrolary flaw of monetarism is that it

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Extent and nature of circulation, Oct. 1980

	Average no. copies each issue during preceding 12 months	Actual no. copies of single issue published nearest to filing date
Total copies printed	108,750	179,000
Sales through dealers, street vendors, counter sales	48,220	54,200
Mail subscriptions	42,250	83,000
Total paid circulation	90,470	137,200
Free distribution	2,018	2,300
Copies not distributed	2,137	5,000
Returns from news agents	14,125	34,500
TOTAL	108,750	179,000

does not distinguish between the creation of credit for productive or nonproductive purposes—for example, the construction of nuclear power plants or of gambling casinos. One has a deflationary impact; the other is decidedly inflationary.

What then of the often cited success stories of Friedman's economic policies? The quotation from William Buckley supplied by Mr. Wittman indicates that the real content of Friedman's antiinflationary policies is austerity—levels of austerity that can only be enforced under a military dictatorship like that which exists in Chile. In Goldman's original article, far from implying that he and Buckley were in agreement on Friedman's economics, Goldman commented ironically that Buckley "was right" in frankly pointing out that Friedman's economic policies cannot work in a democracy: "Friedman's theories suffer from the inherent disqualification that they cannot get sufficient exercise in democratic situations. . . ."

Moreover, Mr. Buckley has not told the whole story of the "economic miracle" worked by Milton Friedman in Chile. First, he is simply lying about Chile's inflation rate. According to official government statistics, Chilean inflation was running at a 350 percent annual rate on the eve of Allende's ouster. One of the first acts of the Pinochet military junta was to lift price controls, and within two months Chile's inflation rate had more than doubled. Inflation continued at this rate for two more years. It subsequently subsided to the 28 percent rate cited by Buckley, but the Chilean economy collapsed along with it.

Second, the austerity policies drafted by Friedman for the Chilean junta precipitated a bloodletting of Chile's industrialists—ostensibly the beneficiaries of the policies, as well as of the general population. For example, of the 2,000 textile firms that were operating in 1974, 400 were out of business as of mid-1978; and 1980 is already a record year for bankruptcies in the Chilean economy.

Industrial production has never regained the levels achieved under the Allende government. Chile's foreign debt, on the other hand, has tripled since 1974, giving Chile the second highest per capita debt in the world after Israel, another economy that retained Milton Friedman as advisor.

Finally, let me quote what former British Prime Minister Edward Heath had to say about Friedman in a BBC radio debate on Nov. 8. Heath blamed Friedman's economic policies, as implemented by Britain's current Prime Minister Margaret Thatcher, for "the catastrophic things" happening in the British economy—17 percent interest rates, a doubling of inflation, and 2 million unemployed. According to the *Financial Times,* Heath also accused Friedman of "wishing to abolish America's industrial base in the same way that was happening in the UK."

Lydia Schulman
Energy News Editor

Back to the Dark Ages

To the Editor:

If you have read the book *Entropy,* by Jeremy Rifkin with Ted Howard, you share my concern about taking the 1 billion people that will be left back into the 14th century.

Forget the book report. You need to devote an issue to the scientific aspects of entropy!

J. Stuart Franklin
Hendersonville, N.C.

The Editor Replies

We plan to!

A Real Alternative

To the Editor:

I looked over your publication *Fusion* pretty carefully, and I must say that I am impressed. During the sixties and seventies my generation began to talk about "alternative thinking," and, since there was a lot wrong with the world, I watched to see what kind of "alternative" ideas would turn up. I was astonished to see the best minds of my generation lose themselves in astrology, talking plants, the Bermuda triangle, leftist social philosophy, EST, gurus, etc. ad nauseum.

It is refreshing to see, at last, a real alternative.

Keith B. Fowler
Seabrook, Texas

Ruckelshaus's Political Decision

To the Editor:

I just want to express my admiration and appreciation to Dr. Pollak! His articles in the latest issue of *Fusion* [Nov. 1980] were tremendous! I was especially interested in "The Great Pesticide Hoax," which was extremely well written. I hope he will be writing similar articles about other vital issues that have been the subject of distortion by the "neo-Luddites" and pseudoenvironmentalists in this country and abroad. . . .

In the first paragraph, you indicated that Ruckelshaus told a friend in 1972, "There is no scientific basis for banning this chemical—this is a political decision." I wouldn't be too surprised if he actually did say that to a friend, however it sounds enough like a statement he made in a letter to Alan Grant [of the American Farm Bureau] in 1979 to make me wonder if that was actually the source of the quote you attributed to him.

In a letter to the American Farm Bureau where he refuses to support a Dispute Resolution Conference to examine the issues surrounding the use of the pesticide 2,4,5-T, Ruckelshaus (ex-EPA head and then Senior Vice President of the Weyerhauser Company), stated:

"In the first place, the basic assumption of the [Dispute Resolution Conference background] paper is that the question of continued use of 2,4,5-T is a scientific one. Decisions by the government involving the use of toxic substances are political. . . . The ultimate judgment remains political. . . . The power to make this judgment has been delegated to the Administrator of EPA. If your Dispute Resolution Conference does not explicitly recognize this delegation, properly characterize the nature of the decision as political, and restrict the scientific inquiry to areas proper for science's role, it will resolve nothing. . . ."

Dr. J. Gordon Edwards
Professor of Entomology
San Jose State University
San Jose, Calif.

Viewpoint

The Reagan Landslide: A Mandate for Economic Growth

by Lyndon H. LaRouche, Jr.

The economic and foreign policies of the Carter administration have been repudiated by the landslide victory of President-elect Ronald Reagan. To understand President-elect Reagan's victory most effectively, we must stand for a moment above the formal lines of division between the two major parties. We of the traditional currents within the Democratic Party, together with the traditional currents of the Republican Party, represent in total the strongest single political force in the United States.

We, the traditional, or Whig, Democrats, are based on a harmony of interests among farmers, labor, scientists, and related professionals, and entrepreneurially minded business forces. That harmony of interests is also based on the consciously and implicitly traditional forces of the so-called minorities, those currents struggling for full assimilation of minority groups into the realization of their potential for contributing to our nation's life and policy-making.

If the Whig, or traditional, Republicans will understand us clearly on this issue of harmony of interests, a bipartisan cooperation on policy and legislation can be developed rapidly between the Whig currents of the two parties. And once such a bipartisan force is established, every other political current of either party must reckon with it.

The implicit promise of the Reagan landslide and the defeat of the McGovernite liberals includes a commitment to the following items of immediate action:

- The slide into a new depression must be stopped. In particular, the "Volcker measures" must be repudiated and repealed.
- We require a selective credit policy that provides ample credit at reasonable borrowing costs for production and commerce. Let credit be otherwise relatively restricted, except for short-term consumer credit and first mortgages on new construction, and let borrowing costs rise on inflationary categories of investments.
- We require immediate tax reforms. There must be selective tax relief in rates of tax credits for depreciation, amortization, and depletion of investments in capital goods of agriculture, industry, and commerce. There must be investment tax credits, in addition to increases in these categories of depreciation, amortization, and depletion allowances.

Tax credits to owners of paid-in-equity and savings deposits used for productive-investment loans must be introduced to give tax incentives to savers for investment in industrial and agricultural capital. What should be taxed are investments that are nonproductive, such as real estate speculation or gambling casinos.

This path of tax incentives will force income from real estate and other sources into investment and savings in industry, agriculture, and technological improvements of administration and commerce. This will channel private capital and savings into putting the unemployed back to work productively.

- We must solve the energy crisis. We must give tax incentives, in the form of depletion-allowance increases for development of petroleum and natural gas resources. We must clear away the tangle of harassing legislation and related court decisions from rapid development of high-technology fossil-fuel and nuclear energy production. We must junk the use of the wasteful synfuel technology copied directly from the Nazi Auschwitz concentration camp, and use the high-temperature gas-cooled reactor to convert coal into methane and water into hydrogen.

We should immediately accept the proposal of Mexico's President Lopez Portillo for increased petroleum production and offer in exchange our capital goods. That by itself will put many of our citizens back to work while helping to overcome energy problems.

100% Parity

- We must restore 100 percent parity for agriculture. We must establish tariff agreements establishing a world parity price for agricultural products, thus promoting the high-technology investment in agriculture worldwide needed to maintain an adequate food supply and to control food prices through the benefits of rising productivity of technologically progressive agriculture in all categories.
- By reorganizing international monetary arrangements to promote the expansion of world trade, we must enable the State Department, Agriculture Department, and Export-Import Bank to generate exports of U.S. agricultural products—especially grains, beef, and dairy products.
- The United States must support and cooperate with the European Monetary System. Such cooperation is indispensable to stop world inflation and to reorganize international debt and credit for promotion of substantial increases in total volumes of world trade.

Those are minimal measures required to turn away from the present slide toward a depression, and into the direction of rapid economic recovery and full employment.

Lyndon H. LaRouche, Jr., a founding member of the Fusion Energy Foundation, was a 1980 Democratic presidential candidate. He is the chairman of the advisory committee of the National Democratic Policy Committee, and this viewpoint is adapted from a statement issued by the NDPC Nov. 5.

News Briefs

McClure: Goodbye to zero growth and Friedmanism.

McCLURE: ZERO-GROWTH, FRIEDMAN ARE OUT

Senator James McClure (R-Idaho) stated Nov. 14 that Ronald Reagan's landslide electoral victory signifies "the end of zero-growth economics." Noting that it is very important that President-elect Reagan realize the meaning of his victory, McClure said: "I really think it's over for Milton Friedman, the economist who has advocated harsh austerity policies. If Republicans don't realize their mandate was not for austerity, but for economic growth, then we're sunk."

McClure is slated to chair the Senate Committee on Energy and Natural Resources.

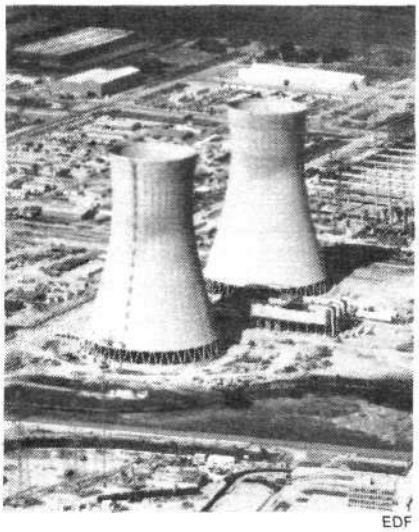
LaROUCHE-RIEMANN MODEL: VOLCKER POLICY SPELLS DISASTER

The LaRouche-Riemann model, a computerized forecasting tool developed jointly by the Fusion Energy Foundation and *Executive Intelligence Review* magazine, has predicted that real industrial output will fall very steeply during the first quarter of 1981 if Federal Reserve Chairman Paul Volcker continues to increase interest rates in the period prior to Ronald Reagan's inauguration. The model predicted that a 60 percent annual rate of short-term debt increase would be required for industrial corporations to maintain existing output, which is not possible given the Volcker interest rate increases. This conclusion was based on a computer simulation conducted Oct. 24.

The LaRouche-Riemann model, the only one to have correctly predicted the inflationary consequences of Volcker's policies during 1979-1980, treats the economy as a physical system, measuring financial indicators as a scientist would measure temperature, pressure, and volume in a diesel engine. Summing up the results, economist David Goldman said: "If Reagan doesn't put a stop to Volcker now, there could be no industrial economy left come inauguration day."

IEA DIRECTOR CALLS FOR FIVEFOLD RISE IN NUCLEAR ENERGY

Ulf Lantzke, director of the International Energy Agency, called for a fivefold increase in nuclear energy output over the next two decades, speaking at an IEA executive meeting Nov. 16 in Washington, D.C. Lantzke stated that to get such a program going would entail "a spectacular turnaround from the present situation." He noted that nuclear power was making a comeback in parts of Europe because of the "economic penalties of doing without nuclear power" in recent years. Lantzke said that to equip the 500 percent rise, the 21 member countries of the IEA would each have to get 16 new orders annually for nuclear plants. These orders would best be shared out equally among North America, Japan, and Europe, he said.



EDF

France has 20 nuclear plants operating with another 27 under construction. Here, the Tricastin plant.

FRANCE SELLS NUCLEAR PLANTS TO KOREA, CHINA

The French nuclear firm Framatome recently signed a contract with Korea to sell two nuclear reactors plus a 10-year fuel supply at highly favorable credit terms. Framatome also signed an agreement in principle with the People's Republic of China for a two-reactor sale in the near future. The reactor systems going to Korea, the nation's ninth and tenth nuclear plants, are both 900 megawatts-electric capacity. The contractor for previous Korean nuclear reactor and fuel purchases was Westinghouse Electric Corp.

The Korean contract for the reactor systems is valued at $443 million; and the agreement for France to supply both natural and enriched uranium for a 10-year period beginning in 1986 is valued at $483 million. The construction of the two plants, to be undertaken by Korean firms, is expected to cost $2.2 billion. Credit will be provided by a consortium of French banks at 7.6 percent interest with a 7-year grace period and 15 years to repay.

By 1988, Korea will have 9 nuclear reactors producing 7.6 gigawatts, 30 percent of total Korean electricity; by 1991, the figures will rise to 12 plants

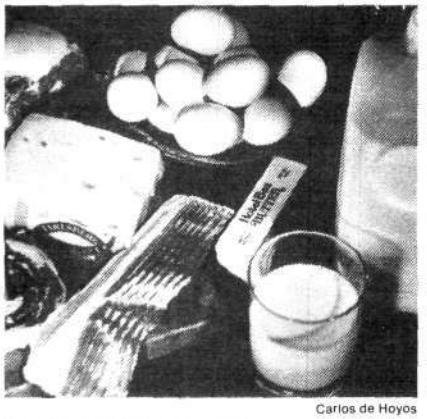
producing 10.1 gigawatts, 36 percent of total electricity; and by the turn of the century, 40 nuclear power installations will provide more than 50 percent of the nation's electricity resources.

THIRD WORLD MORTALITY RATES INCREASING

Mortality rates in many Third World countries are no longer decreasing, and in some countries they are showing signs of increasing, according to the World Health Organization's sixth report on the state of the world's health. WHO claims that it is difficult to understand this disturbing trend "except in terms of flagging determination on the part of the governments concerned and special circumstances (for example, acute poverty) that make further improvement in health especially difficult." More than 50 percent of Third World deaths occur among children.

NEW STUDY DISPROVES CHOLESTEROL LINK TO HEART DISEASE

A study released Nov. 12 further refutes the contention that cholesterol-rich diets are the cause of heart disease. Sponsored by the National Heart, Lung, and Blood Institute, the study looked at the relationship of a variety of factors to heart disease for 10,000 people in the United States and Canada. Several factors were found to be associated with altered levels of the blood constituent HDL or high-density lipoprotein, and higher levels of HDL appear to lower the risk of heart disease. Most significant, the study indicated that people with high amounts of total cholesterol and high amounts of HDL still showed a decreased likelihood of heart disease. The findings also indicated that physical activity and very moderate levels of alcohol consumption tended to increase the HDL levels and therefore "protect" against heart disease. On the other hand, obesity and smoking, two factors known to increase the risk of heart attacks, tended to be associated with lowered HDL levels.



Carlos de Hoyos

Cholesterol: Just another myth to cut U.S. living standards?

BARDWELL TELLS EUROPEANS ABOUT U.S. FUSION ACT

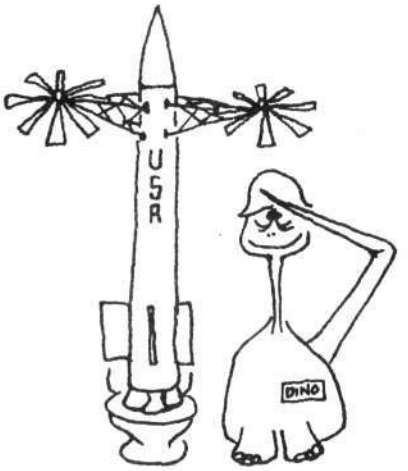
Dr. Steven Bardwell, Fusion Energy Foundation director of plasma physics, explained America's Magnetic Fusion Energy Engineering Act of 1980 to physicists, professors, students, and representatives of the press in a half-dozen European cities in late October. Touring under the sponsorship of the West German Fusion Energy Forum, Bardwell gave well-attended forums in Munich, Stuttgart, and Karlsruhe as well as Vienna, Austria. The European press has given scant coverage to the U.S. fusion bill.

FEF Dinner to Honor Gottlieb

Feb. 6 at New York's Biltmore Hotel is the date of a special event, "Fusion: 50 Years of Progress," to honor Dr. Melvin Gottlieb upon his retirement as director of the Princeton Plasma Physics Laboratory. Tickets are $50 per person ($80 per couple for FEF members). To make reservations now for this fusion milestone, send your check (payable to the Fusion Energy Foundation) to Vera Kronk, dinner coordinator, at the FEF New York office. Or phone (212) 265-3749.

LOUSEWORT LAURELS TO U.S. AIR FORCE

This month's lousewort award goes to the U.S. Air Force for its proposal to use solar, wind, biomass, and geothermal energy for its planned MX missile complex. As reported in the Nov. 17 *Aviation Week* magazine, the Renewable Energy Systems Project is jointly sponsored by the departments of Defense and Energy. The plan is to provide electricity for two main operating bases with 30,000 civilian and military personnel plus a system of 4,600 shelters at a research and development cost of $202 million. The artist's drawing of one planned MX site shows a solar thermal dish, solar thermal troughs, photovoltaic cells, and a windmill. Dispersed renewable energy sources would contribute to solving "sabotage problems," *Aviation Week* noted.



National Fusion Labs: A Firsthand Report

PART II

Part I of Charles B. Stevens's report on his Sept. 1980 tour of the national fusion laboratories appeared in the Dec. 1980 issue of Fusion.

* * *

In the first part of this report I described the work of the Lawrence Livermore National Laboratory in California. This lab is conducting research on two of the mainline approaches to harnessing fusion energy: the Shiva laser, which is the leading facility in the world exploring inertial confinement fusion, and the tandem mirror, which is the mainline alternative to the tokamak in magnetic confinement approaches to harnessing fusion.

I also visited Los Alamos Scientific National Laboratory and Sandia National Laboratory in New Mexico, both of which are developing alternative approaches to the mainline fusion experiments.

This is not to say that the fusion research at these labs is any less important or exciting than at Livermore. Work at these two fusion labs is designed both to back up the mainline research and to develop new technologies and basic approaches to fusion development. Because of the exploratory nature of the research at these labs, their work is concerned with more advanced, frontier areas of fusion physics and engineering. Therefore, their work is carried out with a much greater margin of freedom.

Sandia National Laboratory

Sandia National Laboratory is located on the Kirtland Air Force Base in Albuquerque and is operated by Western Electric under contract from the U.S. Department of Energy. Although Sandia carries out major energy research programs, such as the light-ion-beam inertial fusion effort, its 7,600 engineers, scientists, and skilled technicians are primarily concerned with defense-related projects. These involve everything from the design of nuclear weapons to the development of advanced laser and particle beam weapons for defense against ballistic missiles.

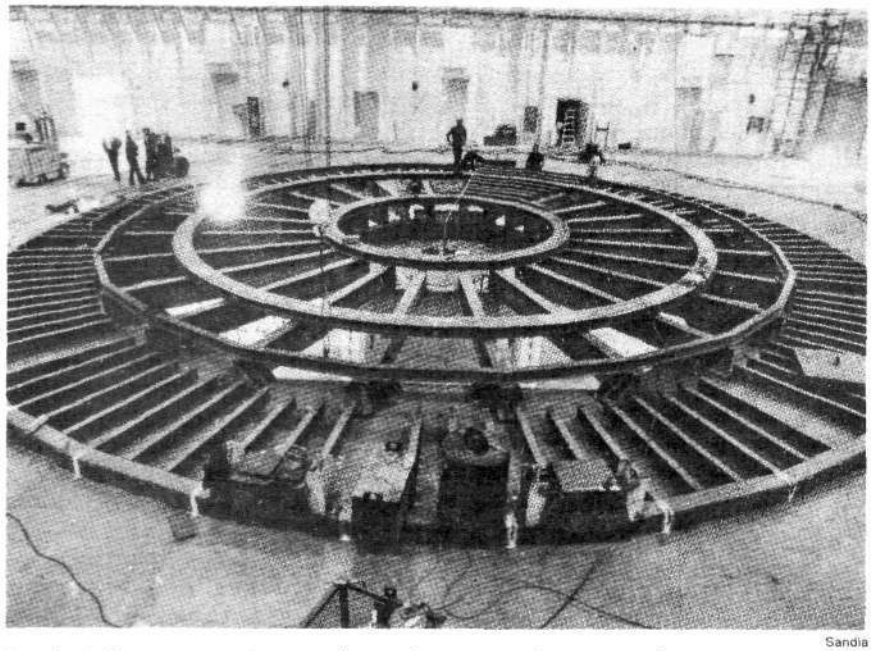
Kirtland Air Force Base is itself the site of the nuclear weapons school for the U.S. Armed Forces and the U.S. Air Force's advanced weapons lab.

More than 120 members of the Sandia staff work in the Particle Beam Fusion (PBF) program, which is both complementary to and an outgrowth of Sandia and Kirtland's weapons-related research.

Dr. Gerald Yonas, the PBF program director, is one of the most respected scientists in the world fusion community. In the early 1970s, Yonas was among the first to understand the great potential of applications of electrical pulsed-power technology for harnessing fusion energy. This technology can be used to generate intense beams of charged particles, either electrons or ions, which can then compress and ignite small quantities of fusion fuel, much as laser beams are used as drivers at Livermore Lab.

The difference is that particle beam accelerators are based on the already developed electric power industry, and these devices are inherently more energy-efficient in terms of the ratio of beam energy output to electrical energy input. The PBF technology, therefore, is much more capable of being scaled up to practical power reactor configurations, and it is much cheaper to develop, even in the research phase.

In fact, Yonas and his Sandia team have won the admiration of the world scientific community for keeping up with the mainline laser programs at



Sandia

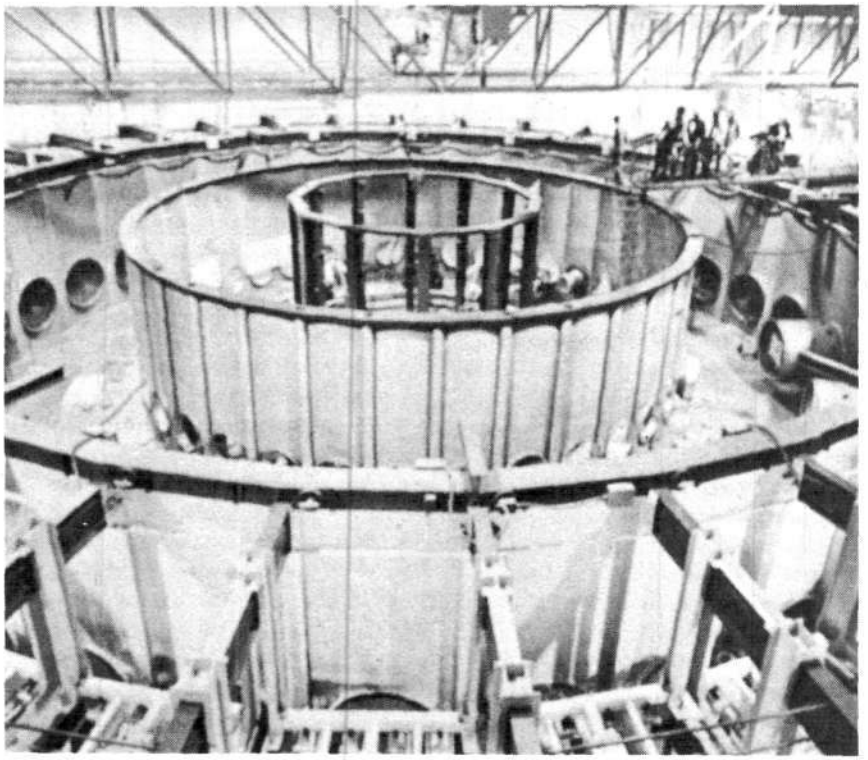
Sandia Laboratories' electron beam fusion accelerator under construction in 1979. The facility is now completed and beam experiments are underway.

Los Alamos and Livermore in terms of beam power generated, a key parameter determining the capability for igniting fusion. And the Sandia group has done this on a very modest budget.

PBFA

The Sandia fusion team has just completed construction of the Particle Beam Fusion Accelerator I (PBFA-I). This facility consists of 36 accelerator modules, which generate a 20-trillion-watt pulse of ion beams—840,000 joules of several-million-volt ions in a 40-nanosecond pulse.

PBFA-I is scheduled to achieve significant thermonuclear burn of fusion fuel by 1983. At that time, PBFA-I will be upgraded to PBFA-II, which will consist of 72 modules producing a 100-trillion-watt pulse of light ions. PBFA-II is projected to achieve net energy gain by 1986. Sandia scientists will simultaneously be developing the repetitive electrical-firing technology needed for a power reactor that must shoot several fusion fuel pellets per second in order to reach economical levels of energy output.



Sandia

PFBA-I in a later stage of construction. The tank containing the accelerator was designed with sufficient room to contain an upgraded accelerator.

Upon arriving at the new PBFA facility, the first thing that one notices out by the parking lot is one of the older electron-beam accelerators. This accelerator has been retired after almost a decade of use and now stands as a monument to the tremendous progress that has been achieved. Just six years ago, a Canadian fusion review reported that the successful construction and operation of high-power, pulsed electrical accelerators was a "black art." Sandia researchers not only have increased the practical performance of pulsed-power systems by many orders of magnitude over that time, but also they have begun to solve the scientific mysteries involved in these devices, working together with their colleagues in a number of other pulsed-power labs throughout the world.

The first stage in the operation of the PBFA consists of taking a large pulse of electrical current from the public utility lines. Then, in each of the 36 modules of the PBFA, the electrical pulse is stepped up to 100,000 volts and converted to a DC current. This pulse, which is only at a power level equal to several kilowatts, is then used to slowly charge a Marx generator. The Marx generator contains capacitors submerged in oil. Each capacitor is charged to 100,000 volts. Thirty-two such capacitors are eventually discharged in a series within one-millionth of a second.

The electrical pulse is now up to 3 million volts and a power level of 100 billion watts. This output current is then passed to an intermediate storage capacitor. This storage capacitor, and later stages of the system, consisting of pulse-shaping lines, are immersed in a large pool of water. The 36 modules are now in a large circular "swimming pool." The water acts as a dielectric, which prevents the electric pulse from escaping or prematurely firing along the pulse line.

A triggered gas switch discharges this final capacitor stage and represents the point at which all 36 modules are synchronized. The pulse has now been compressed to one-quarter of a millionth of a second and a power level in each module line of 0.25 trillion watts. The current then is passed through the pulse-forming section, which further compresses the current, so that nearly a 1-trillion-watt power level is reached. The current is then put into a vacuum transmission line, which transmits the pulse to the particle beam source 6 meters from the pulse generator.

Several alternative electrode ion sources are currently being developed by Sandia researchers. One of the major research goals of the PBFA program is still to determine the best configuration for generating and focusing powerful beams of ions driven by the electrical current pulse. At a later point it will be important to develop the means for transmitting these intense ion beams through plasma columns to a fusion target. In a working fusion reactor it will be necessary to separate the beam-generating circuit from the actual fusion target so that firing can be carried out repetitively.

—*Charles B. Stevens*

Radiofrequency Heating May Move PLT to Next Plasma Regime

The PLT tokamak at the Princeton Plasma Physics Laboratory in New Jersey is preparing to explore the next plateau in fusion research with the addition of powerful radiofrequency (RF) electromagnetic wave heating apparatus. When the newly installed 3 to 4 megawatts of RF heating is combined with the PLT's already successful neutral beam heaters, Princeton scientists may be able to bring the entire PLT plasma up to extremely high fusion temperatures.

Neutral beam heaters with a capacity of several megawatts have already brought the central core of the PLT donut-shaped plasma up to about 80 million degrees Celsius. As Princeton researchers have previously reported, there are indications that the high-temperature plasma core appears to be passing into a new physical regime, which in classical plasma theory is termed fully collisionless.

A New Regime

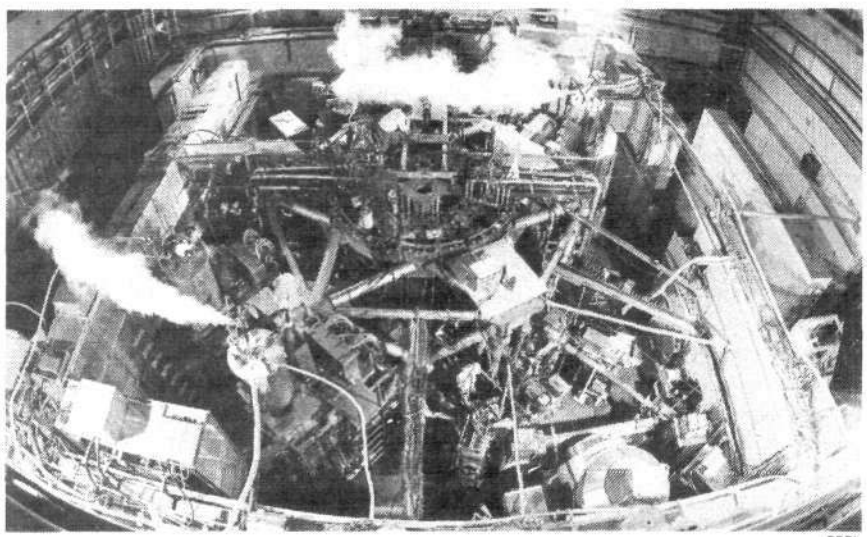
With the added heating power made possible by the RF units, Princeton scientists may succeed in bringing almost the entire PLT plasma into this new regime. If this is achieved, these fusion scientists will be able to determine whether the plasma does indeed act according to classical plasma theory.

Current measurements of the high-temperature PLT plasma core indicate that the classical collisionless state does occur. In particular, researchers have observed that as the plasma reaches the range of 70 to 80 million degrees, the diffusion of energy out of the plasma no longer increases with increasing temperature.

In fact, classical plasma theory predicts that diffusion of energy out of the plasma will decrease with increasing temperature. This means that the plasma energy confinement increases with increasing temperature. If this proves true in the upcoming PLT experiments, it will be a most significant breakthrough.

Here's why. First, the fusion plasma energy output and gain (gain is the ratio of fusion energy output to the plasma heating input) both increase with increasing plasma energy confinement time. The already experimentally achieved energy confinement in tokamak fusion plasmas is sufficient for going to breakeven experiments and power reactors. If in addition the plasma acts classically and actually improves energy confinement with increasing temperature, it will greatly improve the scientific and technical basis for tokamak power reactors. It will also open up new possibilities for using higher temperature advanced fusion fuels.

Although nothing can be definitely predicted now, the early RF heating experiments indicate that RF heating is as efficient as neutral beam heating with up to 50 percent of energy absorbed by the plasma. As to the upper boundaries of what can be achieved, it should be noted that if energy confinement increases with increasing temperature, the plasma will be around longer to absorb more and more of the input RF and neutral-beam heating power.



PPPL

Princeton's PLT made world headlines in 1978 when the tokamak achieved record temperatures. Now radiofrequency heating is expected to send PLT temperatures into a new physical regime.

Researchers Explore Laser-Fusion Hybrid

Scientists and engineers from Lawrence Livermore National Laboratory, TRW, Westinghouse, and Bechtel have combined efforts to begin design of a new type of hybrid fission-fusion reactor using laser fusion. The new design combines the most relaxed scientific and technical constraints with the maximum economic utilization of the fusion energy generated. Specifically, the group has combined the design called Hylife with the breeding of nuclear fuel for conventional fission reactors.

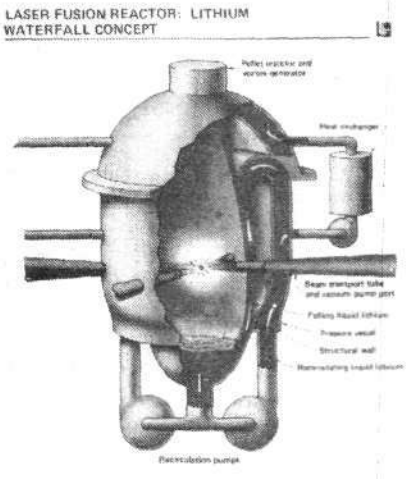
Hylife was developed by Lawrence Livermore National Laboratory as the most technically feasible type of reactor configuration. In Hylife, a jet waterfall of liquid lithium metal surrounds the laser-produced fusion microexplosion. In this way, the first wall of the reactor chamber is protected by a "curtain" of lithium that greatly slows the high-energy fusion-generated neutrons (and explosive debris), and absorbs most of the neutrons' energy.

The new idea is to use this reactor configuration for breeding nuclear fission fuel. At first glance, the Hylife configuration does not appear to be

the optimum breeder. Because Hylife downgrades fusion neutrons to lower energies in order to lessen the damage of reactor materials, it would seem that the generation of fission reactions would be suppressed. As it turns out, this feature of Hylife is actually beneficial when all considerations of reactor design, economics, and rate of fission fuel production are taken into account.

When the fusion-generated neutrons pass through the curtain of liquid lithium jets to strike the wall of the reactor chamber, they have lost most of their energy in collisions with lithium atoms. As these relatively low-energy neutrons penetrate the wall of the chamber, they tend to be absorbed by the heavy nuclei of atoms of uranium-238 or thorium placed in the breeding blanket. Very few fission reactions would take place, for uranium-238 and thorium are converted to plutonium or uranium-233, respectively, when they absorb neutrons. These new atoms are fissile and make excellent fuel for fission reactors.

Furthermore, since the fission process is suppressed in the breeding blanket of such a Hylife hybrid, the overall design and safety of the reactor is made much simpler. One Hylife hybrid could support up to 15 conventional light water nuclear fission reactors.



LLNL

The initial lithium waterfall laser fusion concept: A curtain of liquid lithium metal surrounds the reactor chamber.

ANS Meeting Marks Year of Fusion Progress

The American Nuclear Society's Fourth Topical Meeting on the Technology of Controlled Nuclear Fusion Oct. 14-17 convincingly marked the broad advances of fusion technology over the past year. More than 200 papers presented at the King of Prussia, Pa. meeting described the details of progress in the full range of fusion technology: existing experimental equipment, near-term major experiments, and new designs of fusion electric power plants.

In addition, there were several presentations on new concepts and ideas, such as using the Hylife lithium waterfall laser fusion reactor for breeding fissile fuel and using impact fusion for disposing of nuclear fission radioactive wastes.

The conference was keynoted by Dr. Edward A. Frieman, director of the DOE Office of Energy Research and a former fusion physicist at the Princeton Plasma Physics Laboratory, who reviewed the prospects for the U.S. fusion program under the Magnetic Fusion Energy Engineering Act of 1980. Stressing the importance of the McCormack fusion bill in terms of its committing the nation to build a commercial magnetic fusion electric power plant by the year 2000, Frieman noted that progress in fusion technology development would have to be accelerated.

Frieman announced that the DOE is beginning a high-level review of the U.S. inertial fusion program, to be carried out by the Buchsbaum committee, the same group that reviewed the magnetic confinement program in 1980 (see *Fusion*, Oct. 1980, p. 48). The review was proposed by Energy Secretary Charles Duncan in a letter to the Office of Management and Budget, Frieman said.

A full rundown of the inertial confinement program was presented to the conference the next day by Dr. Gregory Canavan, the director of the DOE Office of Inertial Fusion.

Several papers were presented on reactor designs. Of particular note are the continuing work on the Argonne National Laboratory design for the Starfire tokamak reactor, the Lawrence Livermore Hylife laser fusion reactor (see article this section), a new design for the tandem mirror done by the University of Wisconsin fusion engineering group, and a new proposal for impact fusion by Brookhaven Laboratory.

Dr. Gerald Kulcinski, who headed up the Wisconsin tandem mirror design (Witamir-1), discussed this project as the most practical fusion reactor from an engineering standpoint, as well as economic practicality. Its projected costs for electric power prices are competitive with other advanced energy sources such as the fission fast breeder.

Dr. H. Makowitz presented the Brookhaven National Laboratory's design for Hyperfuse, an impact inertial fusion reactor. This reactor is designed so that it permanently disposes of the most biologically hazardous radioactive wastes from nuclear fission reactors by transmutation while simultaneously producing economical electric power.

The secret to Hyperfuse's dual function is that the waste materials are placed within the fusion inertial target. In this way the fission wastes are compressed to higher densities along with the fusion fuel, and they are immediately exposed to the fusion-generated neutrons. This results in a much more efficient nuclear transmutation of the waste materials.

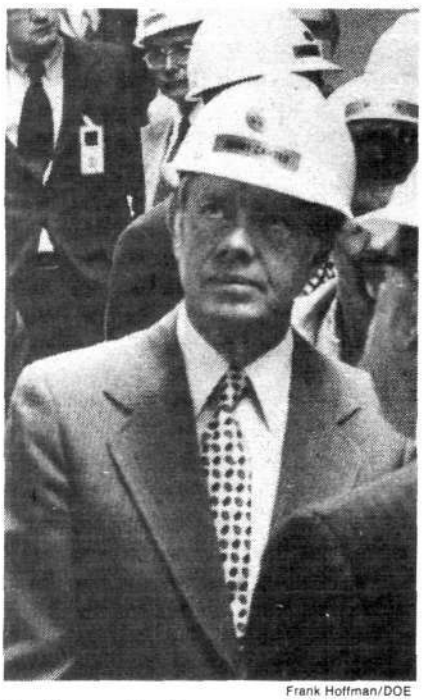
Dr. Mike Monsler of Lawrence Livermore Laboratory presented a new concept for inertial fusion reactors in which the reactor's first wall would be constructed with a honeycomb structure containing material made with a microscopic "steel wool" (currently used in jet engines). In the laser fusion reactor, liquid lithium would flow through the steel wool, thus avoiding the need to recreate a lithium jet waterfall to protect the first wall each time a fusion microexplosion was set off. The "steel wool" would maintain the hydrodynamic structure of the flowing lithium.

Election Analysis:

Things Are Looking Up For Fission, Fusion

The stunning national victory of the Republican Party in the Nov. 4 elections has created the possibility for sweeping changes in the nation's energy and science policies. For the first time since 1954, there will be a conservative majority in the Senate and an administration in the White House with a commitment to the development of nuclear energy and an overall revival of U.S. scientific excellence.

"Special interest" pressure groups influencing White House policy will shift from the Council on Environmental Quality and the antinuclear environmentalist groups to production- and growth-oriented industry, labor, and farm representatives. It is also possible that the key position of science advisor to the president will once more be a liaison to the scientific community instead of a conduit for announcing shutdowns in research and development.



Frank Hoffman/DOE

Hardhat and soft energy: The Carter administration's support for so-called soft energy alternatives is slated to be dumped by President-elect Reagan. Here Carter visits the Oak Ridge National Laboratory.

As the editorial in this issue makes clear, the Fusion Energy Foundation—which has been in an adversary position to the Carter administration in terms of science, energy, and economic policy—intends to be a major voice representing the mandate of the election to reverse the past four years of economic destruction. Furthermore, it is expected that the scientific, technical and industry representatives, both Republican and Democrat, who have been collaborating with the foundation will be in a position to help turn the nation around.

Science Advice to the President

President Eisenhower was the first executive to appoint a science advisor in peace time. Since then, that position has been often abused, giving a scientific veneer to the worst anti-science policies.

President-elect Reagan has appointed a science advisory panel of 15 nationally prominent scientists and engineers to advise him on national science policy. The two cochairmen, Drs. Simon Ramo of TRW and Arthur Bueche of General Electric, represent two of the largest corporate research and development organizations in the country. Together they help sustain and make advancements in the civilian nuclear industry and the national space program.

Other panel members include Dr. Edward Teller, responsible for the scientific advances over the past 50 years that have taken us into the nuclear and fusion eras; Dr. Harold Agnew, the president of General Atomic Company, which is in the forefront of both fusion and advanced fission development; Dr. Frederick Seitz, prominent in the NASA work of the 1960s and professor at Rockefeller University; Dr. Ed David, the head of R&D for Exxon; and Dr. William Baker, the retired head of Bell Telephone Labs.

The panel's first statements, formulated Nov. 8-9, affirmed that science is vital for the preservation of military power and industrial competitiveness.

In particular, the panel brought to the fore the major fight that will determine whether or not there is a U.S. economic recovery by revitalizing both science and industry: They attacked the proposal by Reagan advisor Milton Friedman that the government end its support for university research. "It is naive to contemplate reconstructing U.S. society to make possible the removal of government involvement in science and technology," panel cochairman Ramo stated.

Dr. William A. Nierenberg of Scripps Institute of Oceanography, one of the panel members, stressed his concern that the government intervene to reverse what he described as the "growing scientific illiteracy" of Americans. The panel will make recommendations on policy direction, key appointments, and specific research areas. Washington sources also report that a member of the panel itself will be chosen as Reagan's science advisor and director of the Office of Science and Technology Policy in the White House.

Congressional Changes

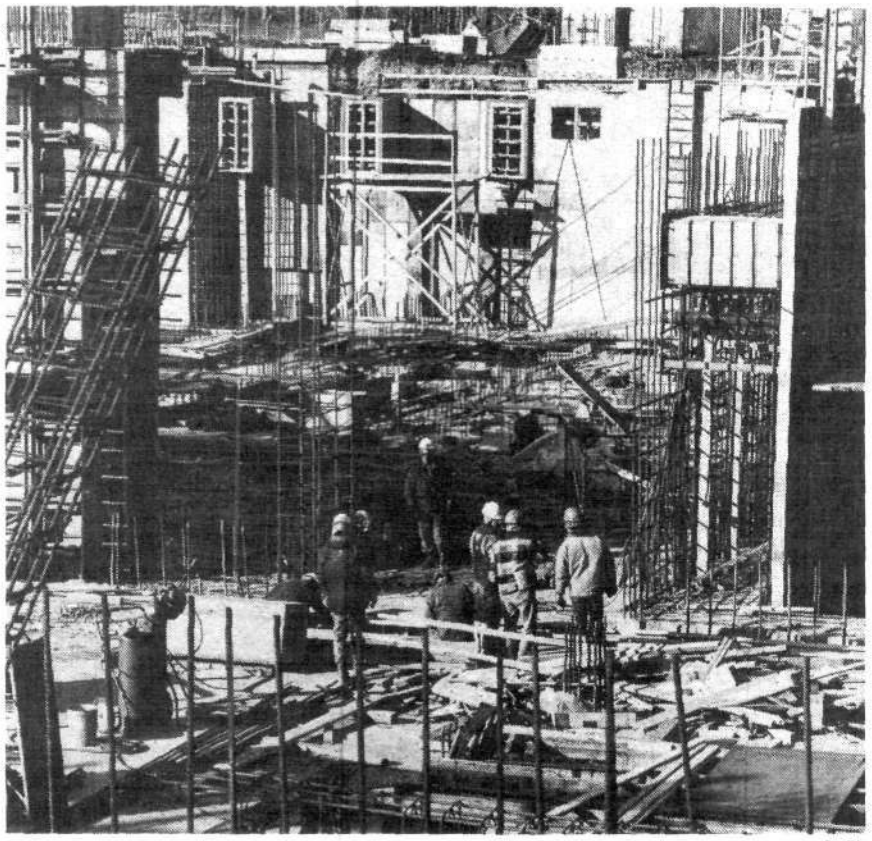
Along with the Republican sweep for the presidency, key liberal and antinuclear representatives were voted out of Congress. Also defeated were four of the six antinuclear referenda on ballots in six states. This mandate to go ahead with the nation's safest and most economical solution to the energy problem will be reflected in key committees, especially in the Senate.

The Republican majority will propel Senator James McClure (R-Idaho) into the chairmanship of the vital Senate Committee on Energy and Natural Resources. McClure will replace Henry Jackson who functioned as the major Senate sponsor for the Carter administration's unpopular conservation, solar, and synthetic fuels boondoggles.

Senator McClure led the fight against the 1978 Nuclear Nonproliferation Act, which the Carter administration has used as an excuse to deny developing countries needed civilian nuclear technology. Senator McClure also led the fight in the Senate this fall for the United States to meet its obligations and send nuclear fuel to India.

On the campaign trail in Tennessee, President-elect Reagan stated his intention to reverse the previous administration's policy of stopping the Clinch River Breeder project. In addition to McClure, Reagan will have two important allies in that fight. One is Congresswoman Marilyn Bouquard (D-Tenn.) in the House, who may replace defeated Congressman Mike McCormack (D-Wash.) as the chairman of the Energy Research and Production subcommittee of the House Committee on Science and Technology.

The second is Senator Howard Baker (R-Tenn.) who will become the Senate majority leader in the next congressional session. The bipartisan Tennessee delegation will now have support from the White House in resuming the process of obtaining a construction license from the Nuclear Regulatory Commission to build the Clinch River Breeder, hopefully completed by 1988.



PPPL

Fusion advocates are keeping up the pressure on the new administration to ensure that the program is funded adequately to meet the goals of the new fusion act. Here, Princeton's TFTR under construction in 1980.

A Nuclear Renaissance

Using its opportunity to appoint new leadership to the Nuclear Regulatory Commission, the Tennessee Valley Authority, the Environmental Protection Agency, and other key posts, the Reagan administration can work with the Republican majority in the Senate and the conservative representatives in the House to get the nation's stalled nuclear programs back on the track.

As well, Reagan has stated his commitment to reverse the four-year reign of the environmentalists in straitjacketing the nation's coal and other industries by revising the Clean Air and Clean Water Acts and other key legislation that comes up for review this year.

One of the tests of the new administration's understanding of the relationship between investment in basic scientific research, the development of technology, and the growth of the economy will come in the fight to implement the provisions of the Apollo-style fusion program authorized in the Magnetic Fusion Energy Engineering Act of 1980, signed into law Oct. 7 by President Carter.

The Department of Energy, under the pressure of the fusion legislation and the department's internal review of the fusion program over the past year, submitted a fiscal year 1982 budget to the Office of Management and Budget that included a $100 million increase for magnetic fusion. Now the new Congress will have to decide on appropriating that additional funding.

Fusion Issue Key

Fusion scientists are concerned that the budget-cutting advocates, especially the Friedmanites, who advise the new president on economic policy, may decide that this is too much of an increase, in terms of attempts to balance the budget next year. It took nearly two years for Congressman McCormack, the fusion community, and the FEF to reverse Carter's attempts to strangle the fusion program during his first two years in office, and fusion advocates don't want to have to repeat the process with Reagan.

Washington sources also report that the Carter OMB may not approve the $100 million increase and may cut it in half—for no reason except spitefulness. This would leave it up to the Reagan administration to double the suggested Carter increase.

This battle will be all the harder with the defeat of Congressman McCormack in the Republican landslide; for McCormack, "Mr. Fusion," is known as the major champion of the fusion program. Nuclear and fusion supporters will have to keep up the pressure on the new Senate leadership and the White House to ensure that the nuclear program goes ahead and that fusion is funded to meet the goals of the new fusion act.

Will There Be a DOE?

Since it was established in 1977, the Department of Energy has come under increasing criticism. Federal investigators checking on the department's operations have filed 70 negative reports on its performance. Democrats and Republicans alike have characterized its burgeoning bureaucracy of more than 20,000 government workers as incompetent and unable to produce results.

Out of the 20,000 DOE employees, an estimated 3,000 are technical or scientific people working on developing new energy technologies. The rest are involved in regulation, clerical work, and the monitoring of the energy industry. The principal purpose of its predecessor agency, the Energy Research and Development Administration, was to support and guide the research and development of advanced energy technologies.

But under the guidance of its first secretary, James Schlesinger, the DOE turned to the control of production and pricing of energy instead. The appointment last year of a former administrator from the Defense Department to head the DOE reinforced this pattern.

Now, with the new Reagan administration, the key question is what should replace the DOE?

Back to Basics

My suggestion is that we get back to basics. As for areas to trim:

- There is no need for the federal government to dispense hundreds of millions of dollars to industry or consumers to cajole them to buy conservation and solar devices that should be put on the competitive market system.
- The Strategic Petroleum Reserve is an instrument of foreign policy and domestic economic policy—not energy policy.
- The regulatory agencies dealing with energy, such as the Nuclear Regulatory Commission and Economic Regulatory Agency, should be pared down. They should function to provide national standards for industry in the energy field and not as a constraint on growth for economic policy reasons.

The nation has an urgent need to develop advanced nuclear, breeder, fusion, and conversion technologies as quickly as possible. The Carter administration has frustrated every attempt to push these new technologies into the commercial demonstration stage. Now is the time to move ahead.

The role of the federal government is to provide adequate funding and to bring the most prominent scientists and engineers in the nation to Washington to supervise and lead these programs.

Administratively this can probably best be done by an agency rather than a cabinet-level department, much on the model of ERDA. If it is styled after NASA, the federal government's only agency primarily devoted to research and development, and if it is run by people with unquestioned technical expertise, a federal agency for energy development could meet the goals ERDA had set before the DOE came into being.

It would be a pleasure to change the name of this monthly column and to begin to report on the positive accomplishments of a new energy program for research and development.

—Marsha Freeman

Diaz Serrano in Asia

Mexico Establishes Oil-for-Technology Deals

Jorge Diaz Serrano, director-general of Pemex, the Mexican state oil company, toured Japan, South Korea, and China from Oct. 11 to 24 with the aim of winning cooperation in Mexico's industrialization efforts and setting up joint ventures worldwide.

By far the most successful leg of Serrano's journey was his visit to South Korea. There, as in Japan, Serrano proposed the setting up of joint refinery and petrochemical facilities whose products would be distributed throughout Asia, on the model of the relationship Mexico already has with Spain. Although the proposal was summarily rejected in Tokyo, the president of the Korean Chamber of Commerce and Industry, Chang Cho Chung, agreed to the arrangement, stipulating that the details would have to be worked out on a government-to-government basis.

Industrial Partnership

"We are not interested simply in commodity trade. We want to have big construction projects in Mexico and to transfer industrial technology," Chang said.

Plant and equipment export ventures have been a major aspect of South Korea's economic strategy for some years now and are already plentiful in the Middle East.

In light of South Korea's cooperative attitude, the Mexican delegation pledged that Mexico will begin delivering oil to South Korea in early 1982. The agreement between Mexico and South Korea demonstrated a principle that Serrano's Japanese hosts failed to appreciate: Mexico will only sell its oil as a means of financing its industrial development, and the oil will be sold only to those countries that agree to cooperate with Mexico's ambitions to become an industrialized nation.

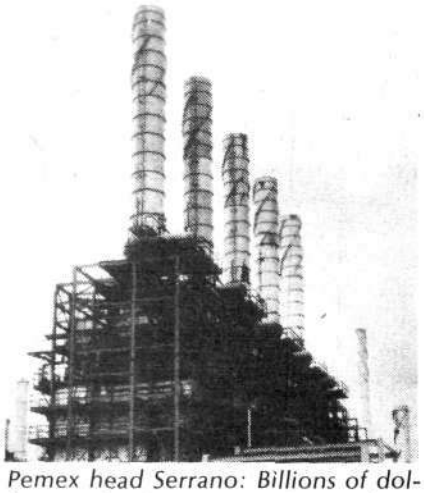
Nothing could contrast more sharply with the success of the Korean-Mexican talks than the fruitlessness of the discussions Serrano held in Japan. Serrano and Mexican Special Projects Coordinator Moctezuma Cid proposed Japanese participation in billions of dollars worth of projects, including four superports that will cost $1.4 billion between 1980 and 1982 and a massive, $20-billion steelmaking facility that will be constructed over the next 10 years.

Cid had particular expectations of winning Japanese cooperation on the steel project, because of the favorable attitude expressed by Japanese industrialists during the April 1980 tour of Industry Minister Jose Andres de Oteyza. One of the main purposes of the second tour was to examine Japan's relative strengths in blast furnace and direct reduction steelmaking technologies. Mexico would prefer to invest heavily in direct reduction since it uses as a reductant natural gas, which is plentiful in Mexico.

Japan Rebuffs Mexican Offers

Shuo Izawa of Japan's Long-Term Credit Bank told the Mexican delegation that Mexico "cannot expect to industrialize overnight." He added that it was premature of the Mexicans to react harshly to the rebuff, since the cooperation talks between the two nations have been going on for "only two years." Izawa also demanded that Mexico revamp its "Mexicanization" law, which prohibits foreigners from owning more than 49 percent of any production venture in Mexico.

Although he rejected the Mexican initiatives for joint projects, Prime Minister Zenko Suzuki nonetheless pressured Mexico to step up its oil shipments to Japan from the current 100,000 barrels per day level to 300,000 bpd. The Mexicans not only refused to do this, but they repudiated leaks to the press from Suzuki implying that Mexico had acceded to his demand.



Pemex head Serrano: Billions of dollars worth of projects in the works.

Japanese businessmen attributed Suzuki's behavior to a fear of offending U.S. President Jimmy Carter. One Japanese banker in New York told *Fusion*: "Washington regards Mexico as part of its sphere. Japan cannot seek a great deal of Mexico's oil or aid its industrialization program without first consulting with the United States."

The banker added: "Japan's 10-year perspective is to shift heavily from oil to nuclear power and coal, but we must depend heavily on the United States for both. We cannot risk losing U.S. help by seeking too much Mexican oil against the wishes of the U.S. government."

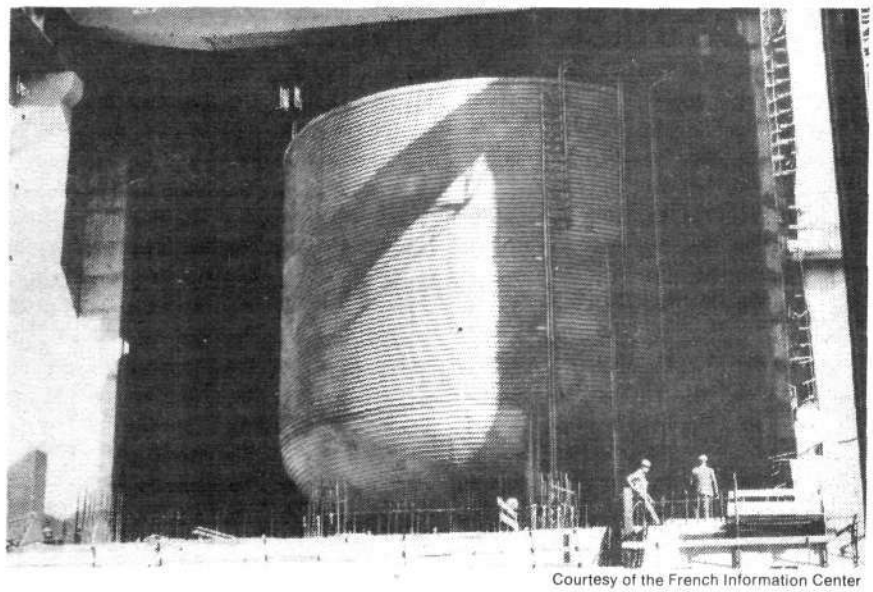
—Richard Katz

France's 5-Year Plan:

High Technology With Low Growth?

The promising thing about France's new five-year economic plan for the period 1981 through 1985 is that it stresses government-fostered scientific and technological research and the development of technologically advanced industries. Before the plan was made public last September, President Giscard d'Estaing issued a statement calling for another "priority" to be added to its objectives: "Bring French scientific research to the level of that in the most advanced nations."

The aim of the plan, France's eighth, is to raise French research and development expenditures from a current 1.8 percent of gross domestic product to 2.15 percent in 1985. The plan places special emphasis on efforts to develop France's fast breeder nuclear technology, to help reduce the proportion of oil in total energy consumption, and to modernize agriculture and France's antiquated food processing industry.



Courtesy of the French Information Center

France leads the way in nuclear and breeder technology, but its basic industries are being gutted. Here, the assembly of the Phenix breeder reactor at the Marcoule Nuclear Center.

Government investment over the five-year period will total some 100 billion francs (about $23 billion) for the development of advanced technologies ranging from the nuclear and aerospace industries to microelectronics, telecommunications, computers, and office systems. It will be up to individual companies to take the initiative in investing in modernization; however, the state will provide investment in sectors and projects it considers to be the most important.

The overall setting for these proposals is the government's blunt predictions that France is in for an extended period of austerity. The new five-year plan opens with the sentence: "For the first time in a generation, most French people think the coming years will be harder than the last ones. They are right."

The plan foresees an annual growth rate averaging between 2 and 3 percent over the next five years. This compares with a 3.4 percent growth of real (inflation-adjusted) Gross National Product over 1979, a period during which inflation accelerated because of the jump in world oil and raw material prices, the decontrol of domestic industrial prices, and increases in public service rates.

One of the most serious indicators of longer-term problems in the French economy is the fact that there was zero growth in real capital investment in the private sector during 1979, despite improved profitability because of the lifting of government price controls. Most investment was carried out by France's large public sector, and the lion's share of this was done by Electricité de France, the state utility, in connection with the country's nuclear program.

As for France's basic industries—steel, shipbuilding, and auto—government policy is to rationalize these sectors as "sunset" industries. The French steel industry is in the process of cutting back production levels by another 20 percent in conformity with production quotas set by the Davignon steel plan of the European Commission in October.

The question this raises is can France really expect to have a high-technology renaissance while its basic industrial base is being dismantled?

Soviets, Swedes Chart Expanded Trade And Energy Projects

Yurii Brezhnev, son of the Soviet president and Soviet deputy foreign trade minister, told the Swedish newspaper *Dagens Nyheter* Sept. 10 that he hoped bilateral trade between the two nations would double over the coming decade. The expansion, said Brezhnev, should be concentrated in industrial trade, particularly in the area of energy. The Soviet Union could buy drilling equipment from

Continued on page 60

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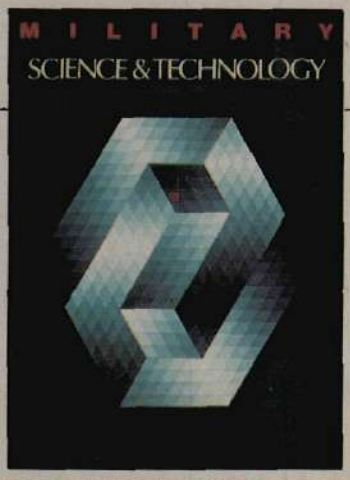

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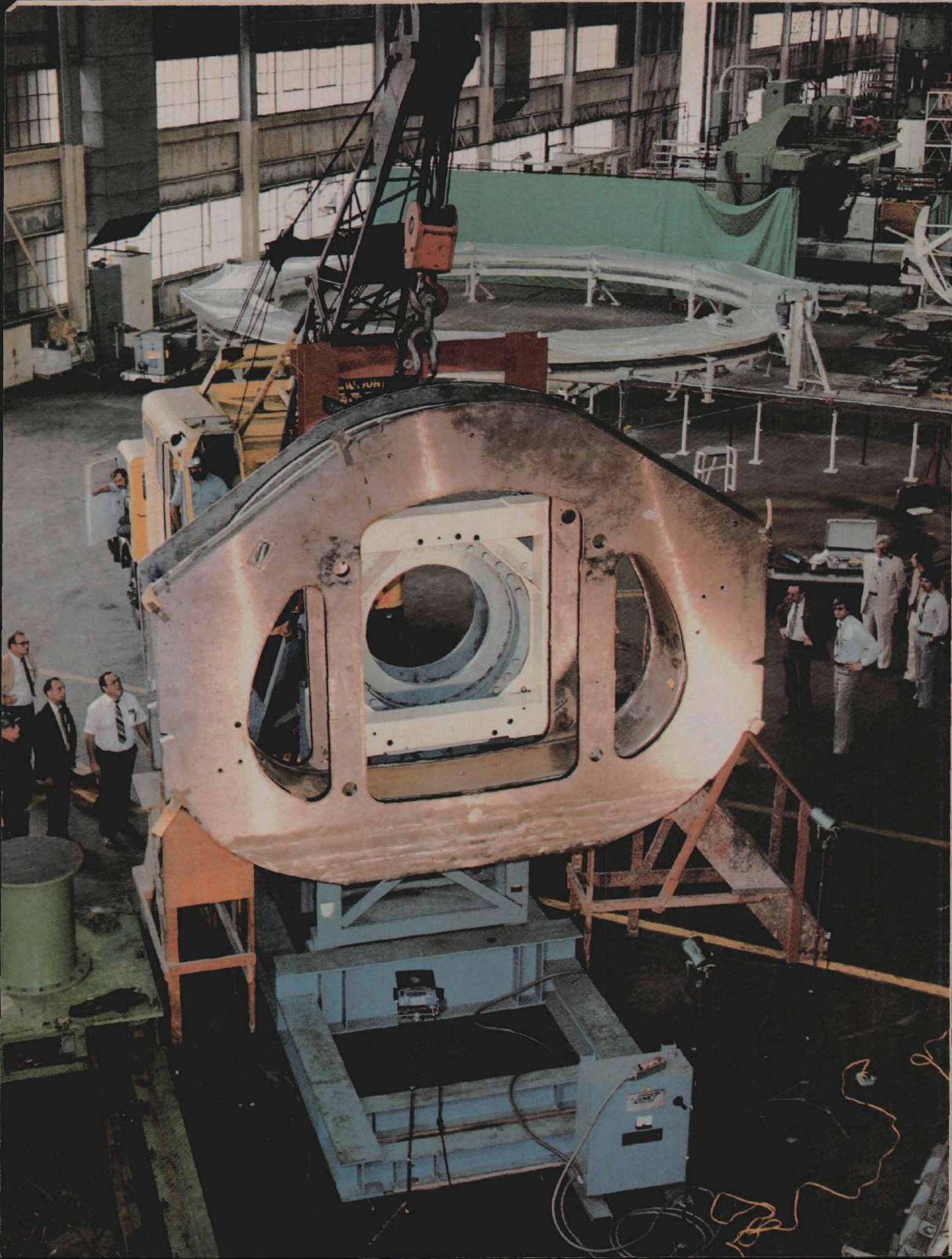


The Magnetic Fusion Energy Engineering Act of 1980 commits the nation to establishing a new Center for Fusion Engineering (CFE) to build a Fusion Engineering Device (FED) by 1990. Here are concrete recommendations for managing and operating a CFE.

How Industry Can Lead The Fusion Engineering Effort

by Leonard F.C. Reichle

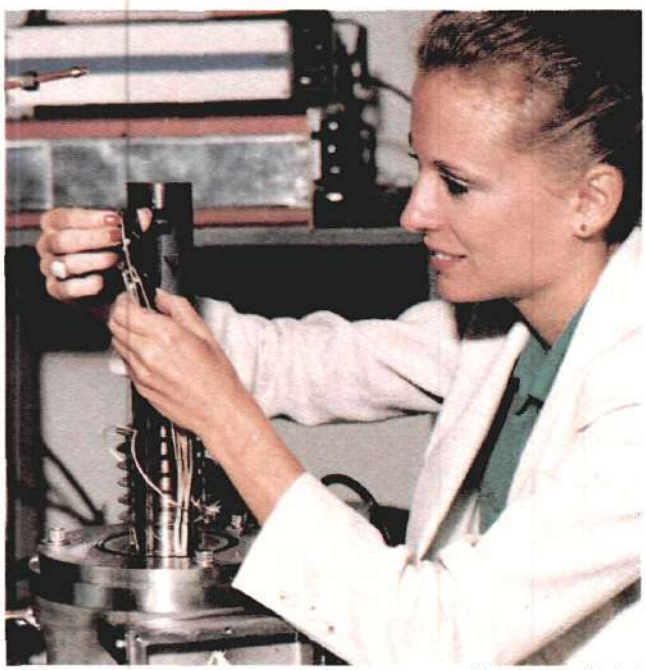
GOVERNMENT, INDUSTRY, the national laboratories, and universities are all considering how to organize, staff, and operate a Center for Fusion Engineering (CFE) to achieve commercial fusion electric power. The progress of magnetic confinement fusion and its promise for the future more than justify the establishment of a CFE.

We are now beyond the stage of research and small experimental devices and are in the stage of engineering and building large, billion-dollar demonstration plants, heading toward the commercial application of fusion energy. It is therefore in the national interest to establish a Center for Fusion Engineering at the earliest practicable date and define the objective of this CFE as primarily the achievement of commercial fusion electric power that is safe, reliable, environmentally compatible, and economically competitive.

The mission of the CFE should be defined as specifying CFE site requirements and managing the site; and selecting a contractor to manage and technically direct engineering design, procurement of materials and equipment, installation and assembly of a Fusion Engineering Device (FED), and to design and construct supporting buildings and facilities.

In addition, the CFE mission should include operating the FED and other devices located at the CFE; maintaining liaison with the fusion community; planning and directing a program of fusion engineering and analysis; and planning and directing a program for development of fusion engineering technology.

A contractor for the CFE should be selected who will bring to the CFE strong corporate responsibility and support, on-site strength, advice, and assistance from the fusion community and from the electric utilities who will



Westinghouse Hanford

Opposite: One of six large coils being fabricated by General Dynamics, General Electric, Westinghouse, Siemans, Hitachi, and Brown-Boveri under a cooperative agreement with the International Energy Agency on superconducting magnets for fusion. Above: Fusion materials testing at Westinghouse Hanford: Engineer Debra Mervyn is checking a fatigue test machine before running a test on a metal specimen. The electrical wiring attached to the specimen allows fatigue crack growth to be monitored remotely.

DOE

ORNL

The ISX tokamak at the Oak Ridge National Laboratory showing the neutral beam heating apparatus. ORNL made the neutral beam equipment for the PLT tokamak at Princeton Plasma Physics Laboratory, which achieved record temperatures in August 1978.

be the end-product users of fusion reactors, and broad industrial participation. It appears that the most desirable kind of organization to organize, staff, and operate the CFE would be a large engineer-constructor with advanced-technology capability as the prime contractor with one or more large manufacturers with advanced-technology capabilities as subcontractors to the engineer-constructor.

The operating methods of the CFE should be broadly prescribed. That is, single-line and clear delegations of authority and responsibility should be established from the Department of Energy (DOE) to the CFE. The operating methods should also be prescribed to direct that CFE programs be accomplished to the maximum extent through contracts with industry and that the CFE will guide and monitor industrial contractors both technically and financially to ensure strict accountability for performance.

With these conclusions in mind, I recommend that the U.S. Department of Energy take the following steps: First, the DOE should issue a request for proposals for a CFE contractor to large engineer-constructors with advanced-technology and construction capability, to large manufacturers with an advanced-technology capability, and to nonprofit institutions, national laboratories, and universities with advanced-technology capability for organizing, staffing, and operating the CFE.

Second, the DOE should select a CFE contractor on the basis of the best proposal, judged in terms of preannounced evaluation criteria. Third, the DOE should enter into a contract for operation of the CFE promptly and fund the contractor to carry out the mission of the CFE as I have outlined above, which is aimed at reaching the objectives of the CFE.

The progress and technical achievements of the magnetic confinement fusion program show that we have reached the engineering stage. A look at some of these achievements makes the case. First, the following fusion devices are now in operation or construction:

Tokamaks. The world program for the development of magnetic confinement fusion energy has made outstanding progress. During the past five years, several tokamak machines have been in operation in the United States, including the Massachusetts Institute of Technology's Alcator-A, Princeton Plasma Physics Laboratory's Princeton Large Torus (PLT), Oak Ridge National Laboratory's Impurities Studies Experiment (ISX), and, most recently, General Atomic's Doublet III, Princeton's Poloidal Divertor Experiment (PDX), and MIT's Alcator-C. In addition, the Tokamak Fusion Test Reactor (TFTR) of the Princeton Plasma Physics Laboratory is expected to be in operation in 1982.

Internationally, tokamaks in operation or under construction include the Soviet Union's T-4, Britain's Diverter & Injection Test Experiment (DITE), France's Tokamak Fusion Reactor (TFR), West Germany's DIVA and TEXTOR, the European Community's Joint European Torus (JET), and Japan's JT-60.

Mirror Machines. The Tandem Mirror Experiment (TMX) of Lawrence Livermore National Laboratory (LLNL) has been in operation for two years. The LLNL Mirror Fusion Test Facility (MFTF) is coming on line, and MFTF-B is being actively proposed.

Bumpy Torus Machines. Elmo Bumpy Torus (EBT-S) is in operation at Oak Ridge. Four industrial design teams prepared EBT design studies in phase I of the EBT project for the DOE's Oak Ridge Operations Office. McDonnell

Douglas Corporation was recently selected to design and build an Elmo Bumpy Torus Proof-of-Principle experiment (EBT-P). EBT experiments have also been conducted in Japan.

Technical Achievements

The progress of the magnetic confinement fusion research program is also demonstrated in the area of fusion technology. During the past few years, progress has been made toward solving many of the technical problems involved in a magnetic confinement fusion reactor. Several of the tokamaks mentioned above have achieved significant technological accomplishments in the basic area of heating and confinement:

- The Alcator-A has achieved an $n\tau$ of 3×10^{13} sec/cm^3, demonstrating the validity of empirical "Alcator scaling" for electron energy-confinement time over a wide range of parameters and showing that ions remain nearly classically confined. This $n\tau$, the product of plasma density (n) and confinement time within the magnetic fields of the tokamak (τ), is an important measure of success in sustaining contained fusion reactions. To attain a burning plasma, $n\tau$ must equal approximately 10^{14} sec/cm^3, a minimum value called the Lawson criterion.
- Efficient plasma heating has been demonstrated on several tokamaks using neutral beam heaters. It also appears that two methods of radiofrequency (RF) heating are feasible: ICRH, or ion cyclotron resonance heating of plasma ions and ECRH, or electron cyclotron resonance heating of plasma electrons. All three methods put heat directly into the fusion plasma.
- Ion heating to 7 keV has been demonstrated with no degradation of performance at required collisionality levels.
- Stable confinement at betas of 3 percent has been demonstrated. Beta is the ratio of plasma pressure to the strength of the magnetic pressure containing the plasma and indicates the efficiency of the magnetic confinement. A commercial reactor probably would require betas of 6 to 10 percent.
- Nonaccumulation of impurities in the center of high-density plasmas has been demonstrated. Impurities are atoms heavier than the atoms of the plasma whose presence in the fusion fuel volume can remove energy through radiation, thus making it difficult to sustain the fusion reaction.
- Predictability of plasma disruptions from plasma current profiles has been demonstrated.
- Pellet fueling has been demonstrated on the ISX tokamak.

It is obvious from these accomplishments that we are beyond the basic research and small experimental-device stage and have entered the engineering stage of large, billion-dollar demonstration plants. We now need to begin to engineer large superconducting-magnet systems, tritium breeding systems, blankets for heat transfer, remote handling systems, auxiliary heating systems, impurity control and ash removal systems, energy storage systems, and reactor control systems.

The promise of a fusion electric-power-generating plant is perhaps the most attractive among all the energy options in terms of world energy supply since it could use the inexhaustible fuel resource from our oceans, the naturally occurring hydrogen isotope deuterium, and breed the artificial hydrogen isotope tritium for use as a fuel. From the point of view of fusion's primary end-product user, the electric utility industry, fusion is most attractive since it has the potential of being a commercially viable electric power producer.

Figure 1 illustrates the breakeven economics of fusion electric power for the first 10 years of plant operation in the period 1992 through 2002, if we could get a fusion power plant on line in that period. It shows that, assuming a capacity factor of 65 percent, a fixed charge rate of 18.5 percent for light water reactors (LWRs) and fusion, and a fixed charge rate of 18.1 percent for coal-fired plants, the estimated fuel cost is 78 mill/kW-hr (mills per kilowatt-hour, 1 mill equals 1/10 cent) for fossil-fired plants burning Eastern coal and 63 mill/kW-hr for those burning Western coal.

The estimated fuel cost is 25 mill/kW-hr for light water reactors. By comparison, the estimated fuel cost for a fusion plant would be only about 0.06 mill/kW-hr, assuming in-plant breeding of tritium fuel. This extremely low fuel cost dramatizes the great potential of a fusion electric plant.

Of all the plants shown in Figure 1, the LWR is the plant with the lowest levelized busbar power cost (that is, cost at delivery to the power grid) of 112 mill/kW-hr. This shows that a fusion electric plant would still break even with a LWR even if its fixed charges were as high as 104 mill/kW-hr, as compared with the nuclear fission plant's 79 mill/kW-hr. In oher words, while the LWR's capital investment cost would be $2,557 per kilowatt-hour, the fusion plant could afford to spend as much as $3,374 per kilowatt-hour and still break even with the LWR.

The CFE Objective and Mission

Given these cost considerations, even though the next fusion machine will be an engineering device and not yet a fusion power producer, the CFE objective should be primarily *to achieve, at the earliest practicable date, commercial fusion electric power that is safe, reliable, environmentally compatible, and economically competitive.*

Setting this as the objective will focus attention on the primary end-use product, a commercial fusion electric plant, that we hope will evolve from fusion's development and demonstration plants of the near future. It will properly orient the attitudes and efforts of government, industry, national laboratories, and universities toward this goal. It will help define the roles of primary developer, supplier, and user. This should be done, however, in a manner that does not detract from other national programs directed toward the achievement of the highest potential of fusion.

The objective of the CFE clearly should not be to perform basic research. It should not be to perform for its own sake applied research to develop technology for general application. Naturally, some general R&D should be planned and carried out to fulfill the needs of a specific object, such as the FED. This kind of generic R&D is consistent with the concept of a CFE, a Center for Fusion *Engineering.*

To reach the objective of the CFE, commercial fusion electric power, the mission of the CFE should include the following tasks, under programmatic direction and contract administration of the DOE:

The CFE should specify the site requirements for a FED and manage the site. It should select a contractor to manage and technically direct the engineering, design, procurement, installation, and assembly of the FED. The contractor should also design and manage construction of supporting buildings and facilities.

The CFE mission should include monitoring the performance of the FED contractor both technically and financially and operate the FED and other devices and facilities located at the CFE. In addition, working relationships with national laboratories, universities, and industry regarding fusion engineering should be maintained. Finally, the CFE should plan and direct a program of fusion engineering and analysis; plan and direct a program for the development of fusion engineering technology; and supervise safety, environmental, and quality-assurance aspects of the CFE program.

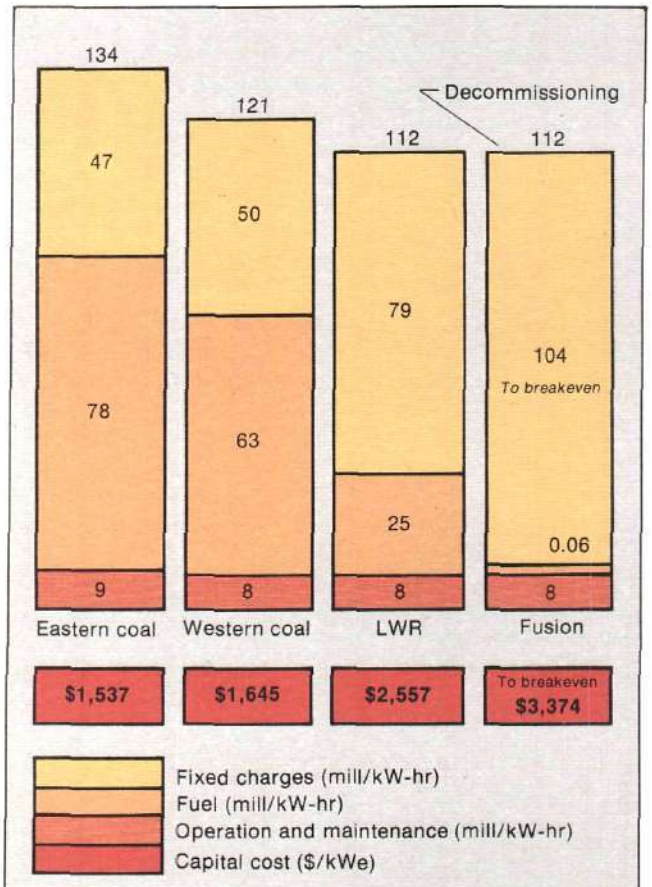


Figure 1
BREAKEVEN ECONOMICS OF FUSION ELECTRIC POWER

This comparison of fossil-fueled coal-burning plants and nuclear fission light water reactor (LWR) plants with a fusion power plant in the first 10 years of plant operation (1992-2002) shows that fusion can be economically competitive. Assuming capacity factors of 65 percent and a fixed charge rate of 18.5 percent for LWRs, and fusion plants and of 18.1 percent for coal-fired plants, the estimated fuel costs are lowest for the fusion plant at 0.06 mill/kW-hr electric, compared to 78 and 63 mill/kW-hr for plants burning Eastern and Western coal, respectively, and 25 mill/kW-hr for LWRs. The levelized busbar power cost at the top of each bar is the overall cost at delivery to the electric power grid. A fusion plant could break even with the lowest levelized busbar power cost—112 mill/kW-hr for the LWR—even if its fixed charges were 104 mill/kW-hr.

Criteria for the CFE Contractor

There are several kinds of organizations that appear to be qualified to operate a CFE: large engineer-constructors with advanced-technology capability; large manufacturers with advanced-technology capability; nonprofit institutions with advanced-technology capability, either already established or created ad hoc for the CFE; national laboratories; universities with an advanced-technology capability; and consortiums of industrial companies, national laboratories, and universities.

Each of these has unique strengths and relative weaknesses. Although all could perform the role of organizing, staffing, and operating the CFE, the key question is which type of organization or combination of organizations is likely to perform the role best? Arriving at a dispassionate answer is not easy.

I suggest that the organization, staffing, and operation of the CFE can best be performed by the organization having the highest probability of being responsive to these overall criteria; that is, being best able to provide corporate responsibility and involvement, corporate management and engineering support, a sound CFE organization plan, a strong and experienced CFE director, a strong and experienced CFE management staff, a strong and experienced CFE engineering staff, fusion community advice and assistance, end-product user advice and assistance, and broadly based industrial participation.

I shall review what is involved in each of these considerations.

Corporate Responsibility and Involvement. The parent of the CFE organization should be responsible and involved in the CFE operation. Responsibility may reside in a university board of directors and involvement may be carried out primarily through an executive officer of the university, as is the case with the board of trustees and president of the University of California for operation of the Los Alamos National Scientific Laboratory. Or such responsibility may reside in one of industry's corporate boards of directors and involvement may be carried out primarily through an executive officer of the corporation, as is the case with Ebasco's board of directors and its executive vice president for advanced technology & special projects with respect to the industrial subcontract for the Tokamak Fusion Test Reactor (TFTR). The parent body of the CFE should be a responsible organization with a continuity of purpose, technical capability, financial soundness, and demonstrated reliability. It should have

real interest in the mission of the CFE and be willing to pledge a meaningful involvement on a constant basis in the affairs of the CFE. It should be accountable for the actions of the CFE and willing to speak up on behalf of the CFE.

In general, greatest support is likely to be derived from the home organization having a natural long-term interest in the commercialization of fusion electric power. Some *organizations will have this kind of interest; others will* not. For example, Ebasco and its parent company, ENSERCH, have a strong and active interest in the development of commercial fusion power for use by electric utilities. Other engineer-constructors such as Stone & Webster, Bechtel, Burns & Roe, and others, and large manufacturers such as GE, Westinghouse, Combustion Engineering, and Babcock and Wilcox also have a long commercial relationship with the electric utility industry and are likely to be vitally interested in the further development of fusion.

Ebasco, because of its commitment to the development of fusion, gives the TFTR project very special attention. The Ebasco TFTR project manager reports directly to the executive vice president for advanced technology & special projects, who reports to the president and chief executive officer of the company and is a member of the Ebasco Board of Directors. Through this direct line of corporate responsibility, the status of the TFTR project is highlighted at the president's weekly staff meetings and at meetings of the board of directors. The chairman, president, and CEO of ENSERCH, Ebasco's parent company, is a member of the Ebasco Board and attends these meetings where TFTR problems and need for further support are reviewed. The supporting action is responsive.

In general, although a definitive evaluation can be made only on the basis of the commitments of specific organizations, large engineer-constructors with an advanced-technology capability and large manufacturers with an advanced-technology capability can be expected to rate highest from the point of view of home office responsibility and involvement. Nonprofit organizations, national laboratories, and universities are likely to rate lower.

Corporate Management and Engineering Support. The parent of the CFE organization should have the ability and be willing to provide at the CFE site a full complement of management and engineering staff. It should have a reservoir of highly qualified and experienced management and engineering staff available to assist CFE personnel on a consulting basis and to provide staff expansion at the CFE, ad hoc assignments to solve specific problems, and staff replacements. Also, it should be willing to commit such staff as they are required by the CFE to achieve its mission.

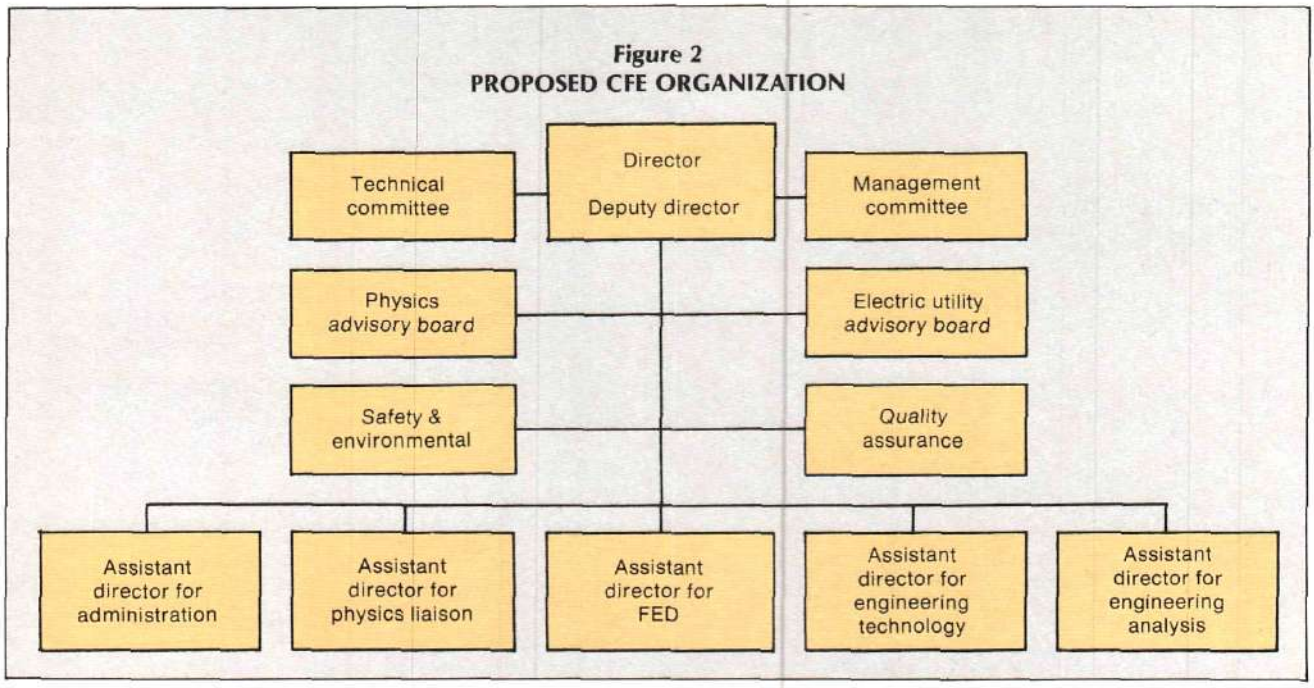
A Sound CFE Organization Plan. A sound CFE organization plan should be developed in advance. I propose an organization structure such as that outlined in Figure 2. Here are my suggested responsibilities of the CFE:

(1) *Manage Interim FED Team.* The CFE should take over management of the interim FED design team.

(2) *Direct the FED.* The CFE should direct the efforts of the FED, including the following tasks: perform site duties, including development of site selection criteria; preparation of a plan for site development and for supporting facilities; direct experimental, test, development, and modification programs; and perform results evaluation.

In addition, the CFE should establish an R&D program to help define the scope and cost of the FED; select two competing industrial teams to perform concept formulation and preliminary design; evaluate competing industrial designs for the FED; award a contract to the organization having the best design and management/engineering capability for carrying it out; and direct the contractor to perform detailed engineering design of the device, perform detailed engineering design of the buildings and facilities, procure materials, equipment, and components,

Figure 2
PROPOSED CFE ORGANIZATION



manage construction of the FED buildings and facilities, or construct them by force account, install and assemble the FED, develop procedures, and carry out startup and operations.

Finally, the CFE should operate the FED device, including performing advance planning, writing of operating procedures, developing and training an operating organization located at the CFE site, and evaluating results.

(3) *Establish a Physics Advisory Board.* The CFE should keep abreast of developments in physics at universities, national laboratories, and industry that affect fusion engineering. It should also establish a physics advisory board comprised of organizations such as Princeton Plasma Physics Laboratory, Oak Ridge National Laboratory, Los Alamos Scientific National Laboratory, Lawrence Livermore National Laboratory, Massachusetts Institute of Technology, General Atomic Corporation, and INTOR or other organizations overseas to advise and assist in the solution of fusion engineering problems.

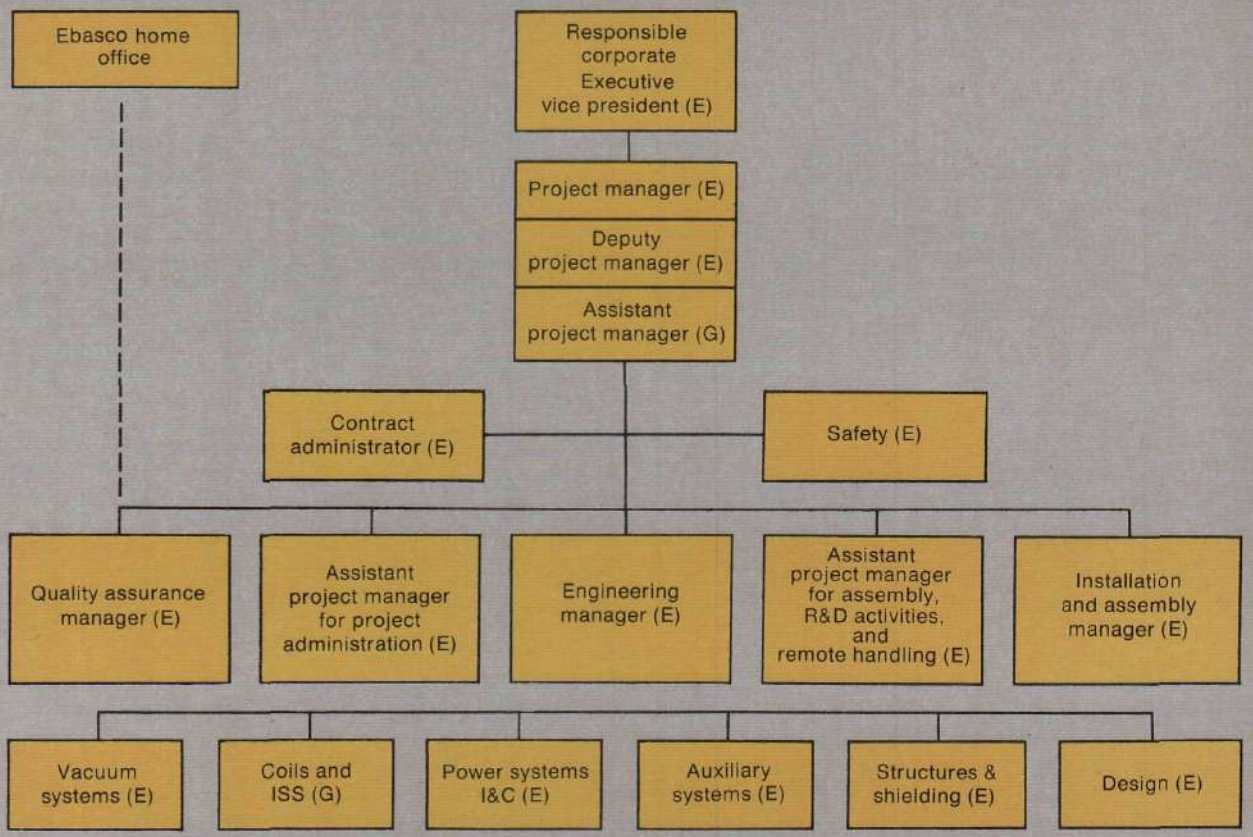
(4) *Establish an Electric Utility Advisory Board.* The CFE should keep abreast of user's requirements for a fusion-electric plant and establish an electric utility advisory board to advise the CFE on electric utility requirements for a fusion-electric plant and to keep the electric utility industry advised of technical progress and commercial potential.

(5) *Plan and Direct a Program for Development of Engineering Technology.* This technology should include such items as large high-field superconducting magnets; tritium processing and handling systems; materials for the first wall and blanket; blankets for heat transfer, tritium breeding, and shielding; remote handling and maintenance methods; auxiliary heating systems; fueling, impurity control, and ash removal; energy storage, transfer, and switching systems; and reactor control systems.

(6) *Plan and Direct a Program for Engineering Analysis.* The CFE should maintain up-to-date knowledge of the engineering and operating experience of the PLT, PDX, TFTR, Alcator-A, TMX, MFTF-B, Doublet III, EBT, Tritium Systems Test Assembly Project, Large Coil Project, neutral beam and radiofrequency development programs, the Fusion Materials Irradiation Test Facility, JET, JT-60, T-4, and others.

Also, the CFE's program for engineering analysis should evaluate fusion engineering and operating experience and make recommendations to the DOE's Office of Fusion

FIGURE 3
TFTR-EBASCO ORGANIZATION



This chart of the overall organization for the TFTR project indicates the lines of authority. Ebasco is the industrial subcontractor for engineering, design, procurement, and installation of the Tokamak Fusion Test Reactor and its auxiliaries. (E = Ebasco; G = Grumman.)

Energy regarding the engineering aspects of present and advanced systems.

Principal methods, procedures, and relationships with other organizations should be described. The organization plan for the CFE should include a plan for how the CFE relates to other organizations and how the FED project would be carried out by the CFE. Let me relate the significance of this by reference to the TFTR program.

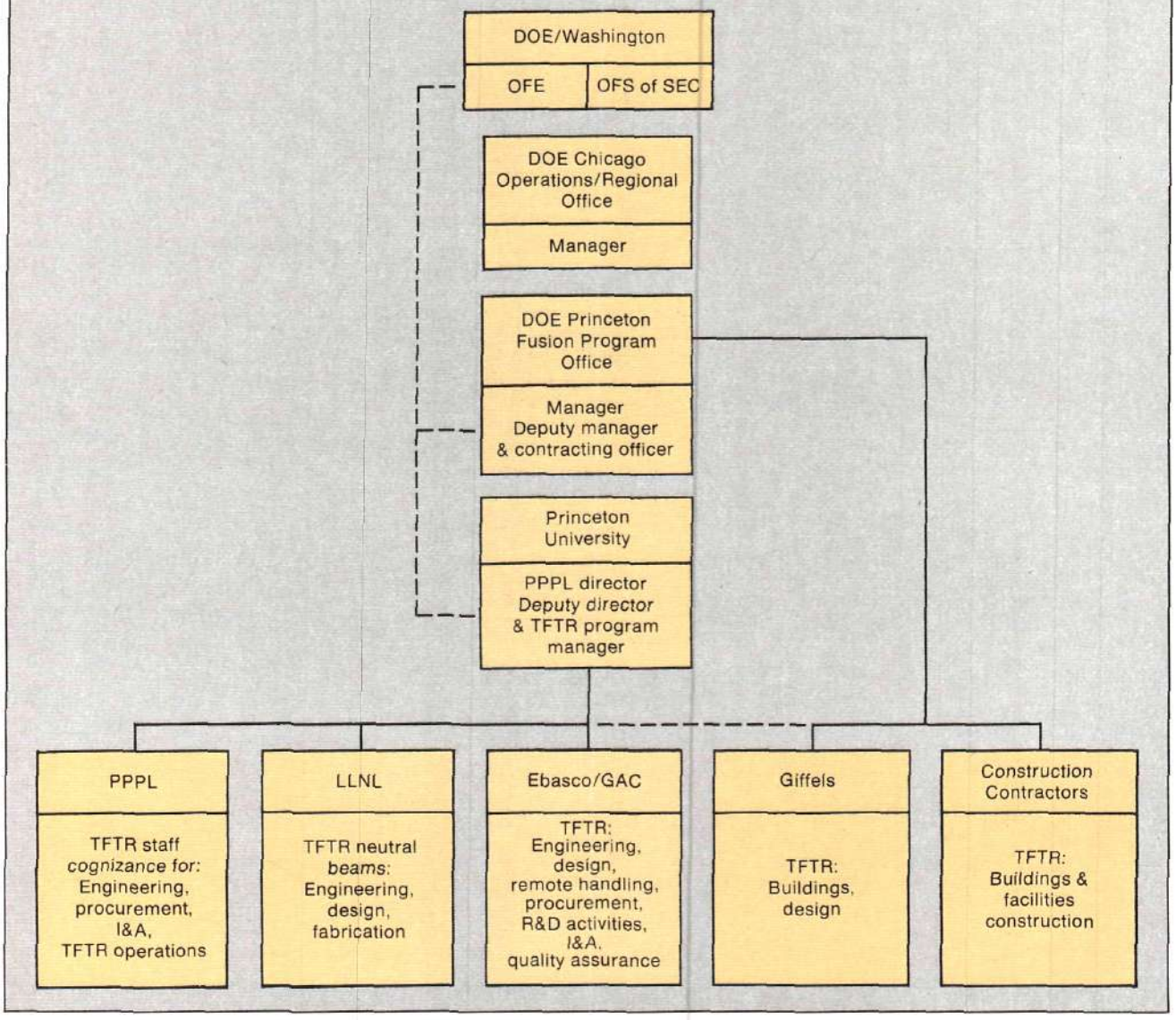
The TFTR Example

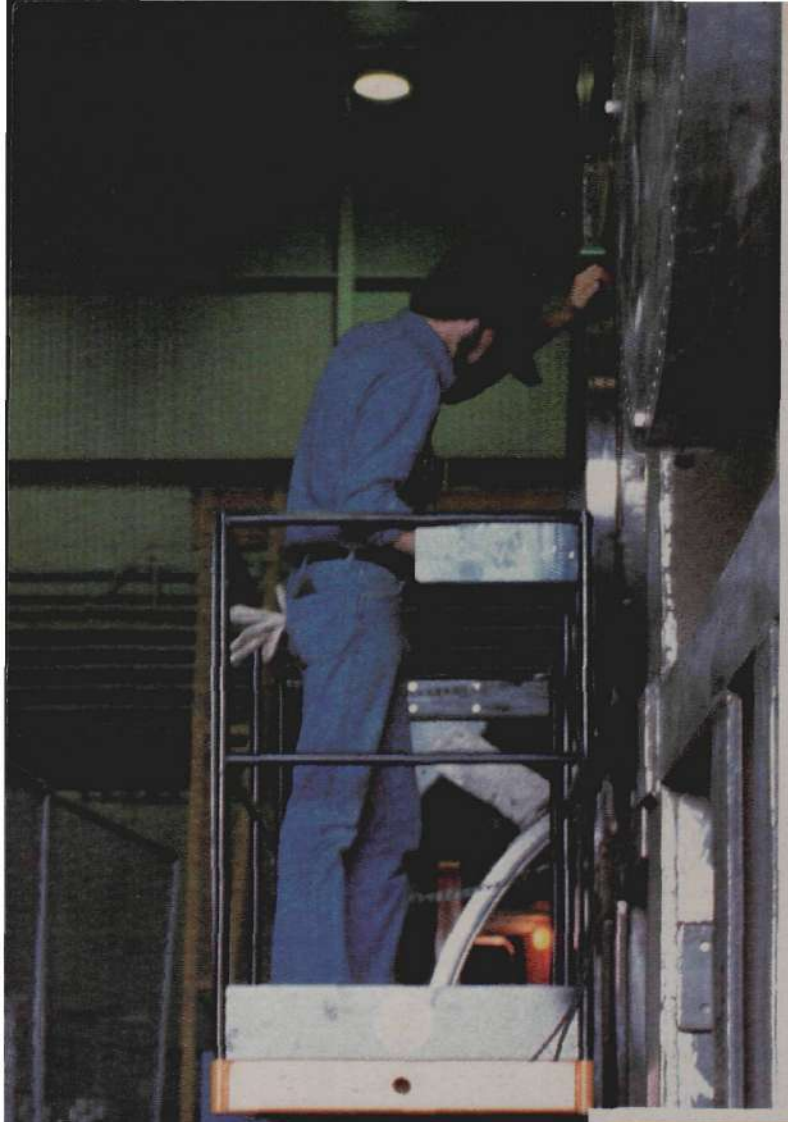
The Ebasco TFTR project organization is a line organization, with responsibility assigned for specific functional areas and for tasks of the work-breakdown structure (see Figure 3). Overall organization relationships among the several organizations involved in the TFTR project are specified in Figure 4, which shows that contract authority and responsibility go from the office of the secretary of the DOE in Washington to the manager of the DOE Chicago Operations and Regional Office, to the contracting officer (deputy manager) of the DOE/Princeton Area Office, to Princeton University where it is exercised by the Princeton Plasma Physics Laboratory (PPPL) director, and, through him, by the man who is both PPPL associate director and TFTR program manager.

The DOE decided at the beginning of the TFTR program that engineering and construction of TFTR buildings and facilities would not be performed by the TFTR industrial subcontractor but, rather, by other contractors reporting directly to the DOE's Princeton Fusion Program Office. It was also decided that design of the neutral beams would be performed by a national laboratory under contract to Princeton University.

As a result, it became necessary for PPPL's associate director and TFTR program manager to set up a coordi-

FIGURE 4
MAJOR ORGANIZATIONS' RELATIONSHIPS IN THE TFTR PROGRAM





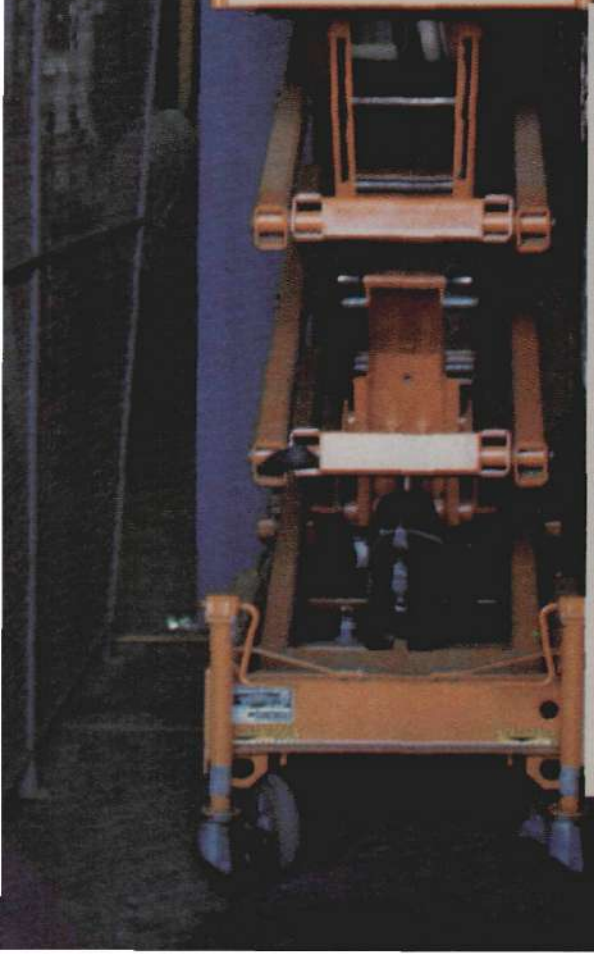
nating mechanism. With good organization planning, however, it should not be necessary to superimpose a coordinating mechanism. The outstanding accomplishments of the TFTR project are being achieved because of excellent PPPL program leadership, extremely competent staffs, and excellent esprit de corps among all organizations involved, not because of initial organization planning.

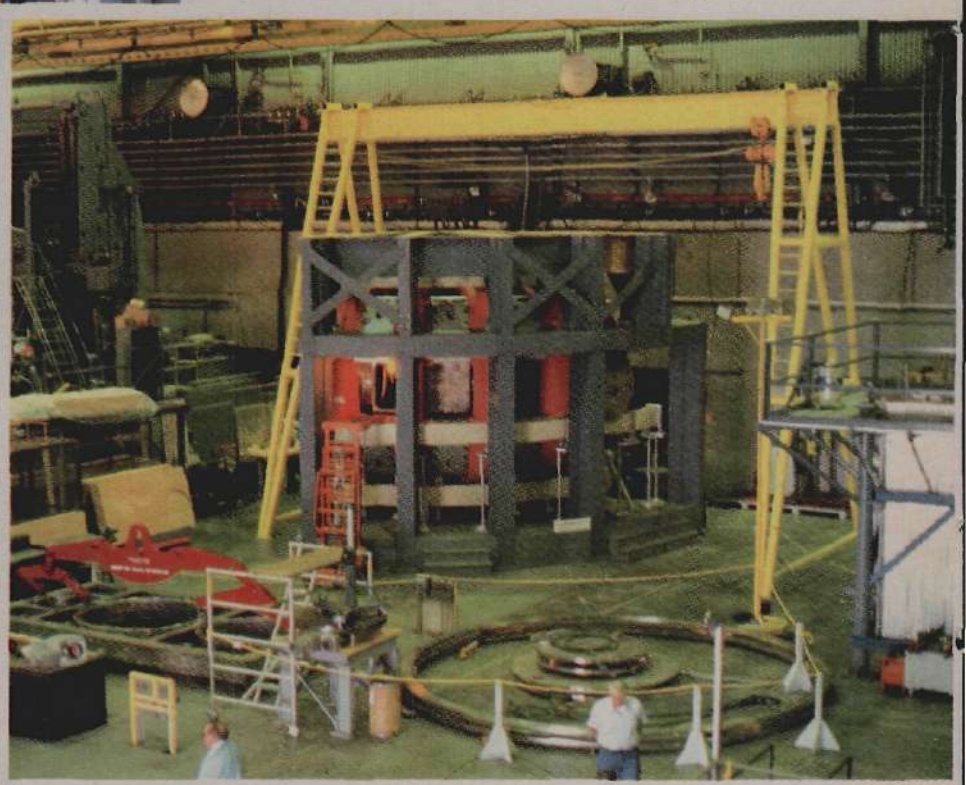
In general, large engineer-constructors and large manufacturers are likely to propose the soundest organization plan. Nonprofit organizations, national laboratories, and universities are least likely to propose the soundest plan.

A Strong and Experienced CFE Director. One of the most important assets an organization should bring to the CFE is a strong and experienced CFE director. Such a person should possess qualities of leadership and character and have the vision and ability to formulate and execute programs. He must be a *doer*, a person who can drive tasks through to completion and get the job done. He must be able to portray the CFE program effectively and to interface easily with peer groups in government, industry, national laboratories, and universities. He must have skills in both management and fusion technology and the charisma that inspires others to follow him.

Undoubtedly, large engineer-constructors, large manufacturers, nonprofit organizations, national laboratories, and universities all could find one (only one is required) proposed CFE director who would be sufficiently outstanding to perform effectively the job of director. Therefore, each of these kinds of organizations can be rated equal in this regard.

A Strong and Experienced CFE Management Staff. Another consideration of great importance is the extent to which a home office organization is willing and able to





provide the CFE with an outstandingly competent on-site management staff. The ability of the large engineer-constructor to provide management skills to the CFE is suggested by the kinds of management people he has in large numbers in his home office and project management staffs.

These include people experienced in depth in: project management, engineering, planning and scheduling, estimating, cost control, budgeting, progress-reporting, system design descriptions, configuration management, procurement, vendor control, quality assurance, construction management, contract administration, expediting, and traffic.

In general, large engineer-constructors are most likely to be able to assign the various types of management staff in the quality and quantities required. Managing major projects, including the most technically sophisticated multibillion-dollar projects, is their major business. Next would be large manufacturers. Least likely would be nonprofit organizations, national laboratories, and universities.

A Strong and Experienced CFE Engineering Staff. Another consideration of great importance is the extent to which a home office organization is willing and able to provide the CFE with an outstandingly competent engineering staff. It is suggested that the staffing of the CFE with strong and experienced engineers in all of the required specialty fields of engineering can best be performed by the organization having the highest probability of being responsive to the following criteria; that is, being best able to provide the right kinds and numbers of engineers for overall systems engineering; design engineering for the fusion device; design engineering for supporting plant systems; design engineering for manufactured equipment; procurement, including expediting and traffic; quality assurance (QA), including vendor QA at manufacturers' plants; construction, installation, and assembly; start-up and test-operation; and operation.

The large engineer-constructor appears uniquely suitable to provide the CFE with highly qualified engineers over a broad spectrum of engineering specialties. The primary characteristics of the large engineer-constructor are not plants, machinery, and equipment. They are engineering competence, independence, and the ability to employ and retain top-level engineers. Let me elaborate on each of these qualifications.

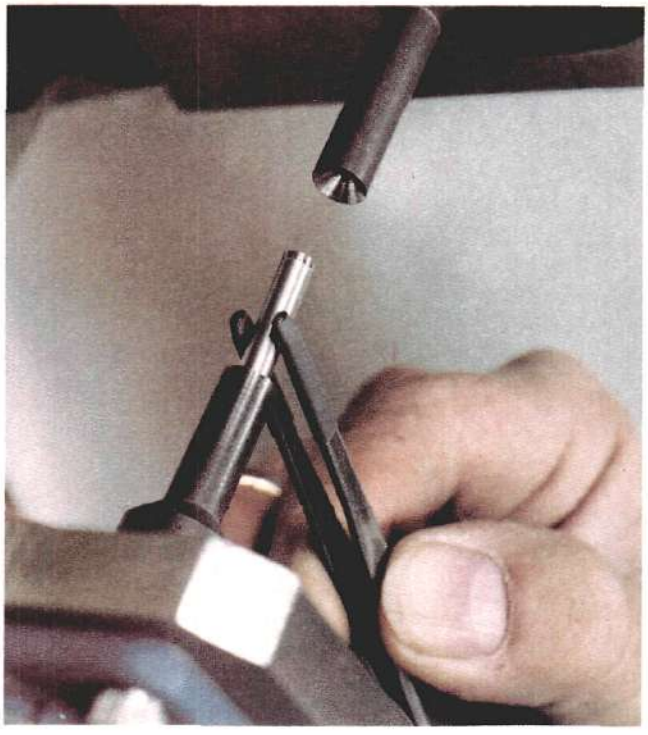
Engineering Competence. The large engineer-constructors employ thousands of engineers and a select group of scientists who, on a professional basis, perform engineering studies, concept evaluations, design engineering, estimating, construction and installation, startup and testing, and plant operations analysis for government and industry throughout the world. That is their business.

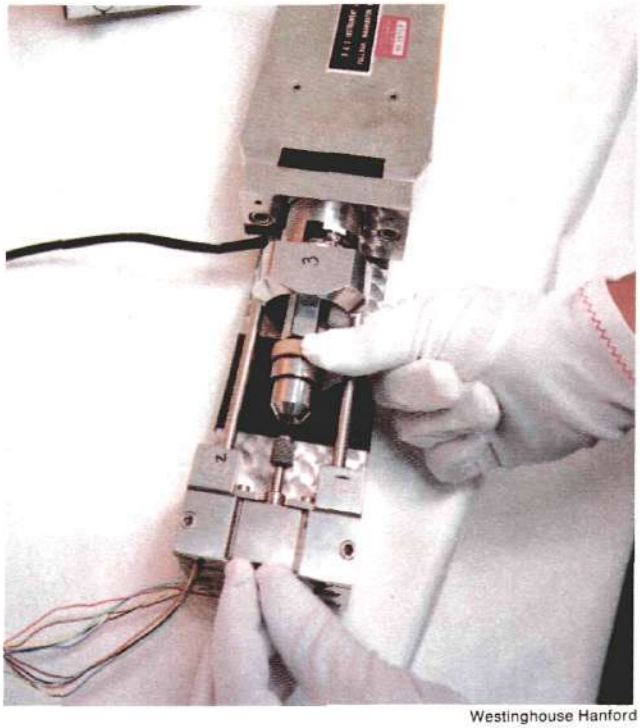
Independence, Objectivity, Neutrality. The large engineer-constructor is independent in making professional judgments. Living by his reputation, he cannot afford to be biased by political, regional, or similar considerations. He is objective in the development and application of technology, in the solution of complex design problems, and in the assessment of engineering risks. He has "know-how" gained from years of practical experience. He is neutral among systems and equipment and among the vendors of such systems and equipment.

Ability to Employ and Retain Top-Level Engineers. The large engineer-constructor is uniquely able to employ top-level engineering staffs. The top-notch engineer typically relishes the idea of practicing the profession of engineering in a company without a product to sell and

Far left: The neutral beam injector for the Princeton Tokamak Fusion Test Reactor, now under construction. Center: A mock-up of the completed TFTR in the Princeton Plasma Physics shop. Left: coil winding for the magnets of the TFTR at Princeton.

Photos by Carlos de Hoyos





Westinghouse Hanford

Fusion materials testing at the Hanford Engineering Development Laboratory. Above: A wire nearly as thin as a human hair is placed in a miniature tensile testing machine for basic mechanical properties. The miniaturization of specimens is being developed in response to fusion research needs, since test locations are limited in volume. Top right and left: Materials test capsule is positioned in a machine developed by Westinghouse Hanford to perform rapid examination of experimental capsules by laser. The pressurized tube, less than an inch long, is filled with helium gas that expands under irradiation.

in being part of an organization dedicated to independence, objectivity, and neutrality.

The ability of the large engineer-constructor to provide diversified and experienced engineering skills to the CFE is suggested by the kinds of engineering people he has in large numbers in his home office engineering staff.

These include people who are broadly experienced in systems engineering, engineering physics, mechanical engineering, electrical engineering, civil engineering, chemical engineering, industrial process engineering, nuclear engineering, instrumentation and control engineering, operations engineering, reliability engineering, electronics engineering, vacuum systems engineering, environmental engineering, safety engineering, metallurgical engineering, corrosion engineering, applied mechanics, metallurgy, chemistry, geology and seismology, information sciences, stress analysis, superconductivity, environmental science, rotating equipment, electrical equipment, plant start-up, computer systems, and operations analysis.

The large engineer-constructor has outstanding capability in systems engineering. For example, with respect to large nuclear power plants, Ebasco has developed reference plants that incorporate nuclear steam-supply systems of General Electric, Westinghouse, Combustion Engineering, and Babcock & Wilcox, respectively, into total nuclear steam-electric stations. Each of these reference plants is an interrelated complex of more than 90 engineered systems.

For each reference plant, a format delineation is made of design requirements, including process, structural, system configuration, maintenance, surveillance and in-service inspection, instrumentation and control, quality assurance and applicable codes and standards; a design description detailing each system, showing system performance characteristics, system arrangement, component design description, I&C and system interfaces; system

limitations; operation characteristics; casualty events and recovery; and maintenance. Other large engineer-constructors and large manufacturers use similar methods of systems engineering. This kind of disciplined engineering carries over from one project to another.

In general, large engineer-constructors are most likely to be able to assign the various types of engineers of the quality and in the quantities required. Providing the full spectrum of engineers required for complicated engineering projects is the engineer-constructor's major business. Next in rank would be large manufacturers. Least likely to provide the best engineering staff would be nonprofit organizations, national laboratories, and universities.

Fusion Community Advice and Assistance. Another consideration is what kind of an organization would have the best rapport with the fusion community (which is largely science-oriented rather than engineering-oriented) and thereby be able to obtain enthusiastic advice and assistance from it? Such advice and assistance is needed on the basis both of formal reviews and of frequent informal meetings and telephone conversations. The CFE's contribution to the development of fusion will be maximized to the extent that the full knowledge and experience of the fusion community as a whole is reflected in its programs and activities.

In general, the advice and assistance of the fusion community probably can best be obtained if the CFE is operated by a national laboratory, a university, or an ad hoc nonprofit organization with representation of national laboratories and universities. Large engineer-constructors and large manufacturers would probably rate second in this regard.

End-Product User Advice and Assistance. If the objective of the CFE is validly conceived primarily as the achievement at the earliest practicable date of commercial fusion electric power that is safe, reliable, environmentally compatible, and economically competitive, it is of the utmost importance to obtain the continuing advice and assistance of the end-product user, the electric utility industry. Many who are involved in fusion believe that, if necessary funding is provided, a first-of-a-kind fusion electric plant can be developed by or shortly after the year 2000. That is only 20 years away.

Conceivably, the FED could be followed by a first-of-a-kind fusion electric-generating plant. With this time scale a possibility, it is imperative that the electric utility industry be brought into the development process in a meaningful way at an early date. The advice and assistance of this industry is needed to identify what would be required of a fusion electric plant to make it a viable commercial plant in an electric utility system. Considerations of ability to follow load swings, allowable plant investment costs, operating characteristics, operator training, and many others of this kind are not only important, but may help to influence fusion plant design during the course of the development program.

In general, large engineer-constructors who have performed engineering services for the electric utility industry over many years and who are relied upon by the industry as their consultants, plant designers, constructors, and operations results evaluators would be rated highest from this point of view. Next would come the large manufacturers, who, likewise, have a long record of working with the electric utility industry. Rated lowest in this regard would be nonprofit organizations, national laboratories and universities.

Broadly Based Industrial Participation. Being able to obtain broadly based industrial participation in the activities of the CFE is another important consideration. Appointing industrial members to a formal advisory board is not enough. Neither is it sufficient to invite industrial companies to assign people to work at the CFE, or to parcel out task assignments on a contract basis.

A broader participation, based in part on each company's normal role in industry, is necessary. The CFE should require the industrial contractor selected for the FED to prepare bid specifications on equipment, components, and hardware systems and to invite qualified manufacturers and other industrial organizations to submit proposals or quotations. This is probably the best way to obtain realistic involvement of a broad range of industrial companies. Each company, then, would determine the types of services, equipment, components, and manufactured systems it feels qualified to provide, utilizing its staff, shops, and other facilities.

In general, the large engineer-constructors probably would be best qualified from this point of view. This is how they operate in the performance of their normal engineering and construction operations. They know the capabilities of manufacturers, specialty shops, industrial laboratories, and other organizations with unique capabilities. They continually evaluate manufacturers' capabilities, negotiate procurement contractors with them, and award billions of dollars of subcontract work to them. Next able to obtain a broadly based industrial participation would be the large manufacturers. Least able would be nonprofit organizations, national laboratories, and universities.

Summary Evaluation of Potential CFE Contractors

In summary, based on the nine overall criteria identified above for judging the organization best able to organize, staff, and operate the CFE, I conclude that

(1) Large engineer-constructors with advanced-technology capability are most likely to be effective.

(2) Large manufacturers with advanced-technology capability are next likely to be effective.

(3) Nonprofit organizations, national laboratories, and universities with advanced-technology capability are least likely to be effective.

Furthermore, the strongest organization as a CFE contractor would be a team consisting of a large engineer-constructor as prime contractor and one or more large manufacturers as subcontractors.

Leonard F.C. Reichle is executive vice president of Ebasco Services Incorporated. His article is adapted from a Sept. 1980 presentation at Georgetown University's workshop on "Mobilization of the Private Sector in Effective Development of Fusion Energy," sponsored by the National Science Foundation.

"The environmentalist-terrorist groups are merely infantry divisions deployed by some of the most powerful political forces in the United States."

—Robert Greenberg
Editor, Investigative Leads

Over the last decade, the United States and other industrialized countries have been under all-out attack by the forces of the so-called environmentalist movement. Radicalized youth, "social-activist" lawyers of the Ralph Nader variety, and "expert studies" have all been combined to convince many that growth and prosperity are things of the past.

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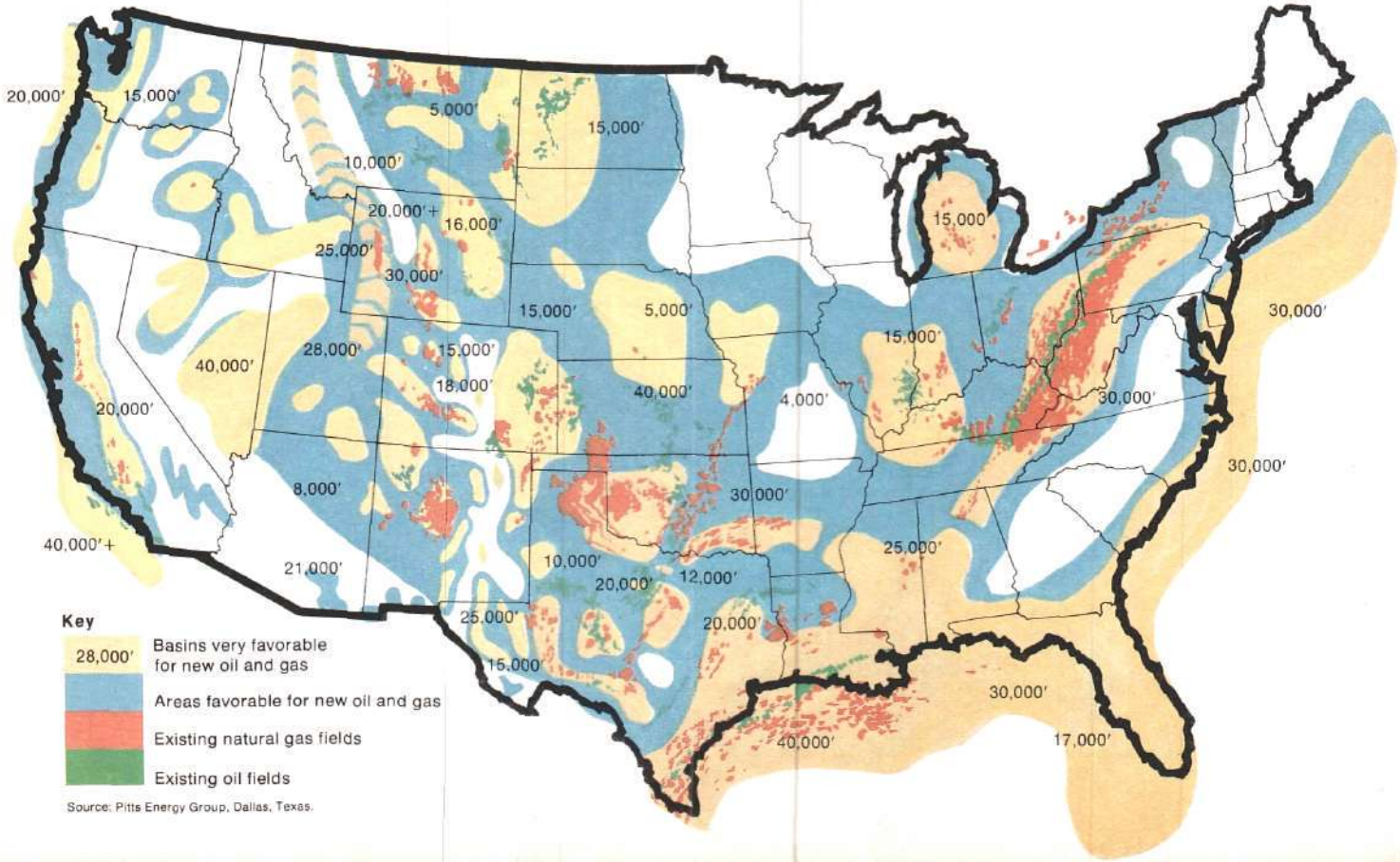
The latest geological evidence indicates that only 2 percent of the nation's potential oil and gas production regions are being exploited today. Now these untapped hydrocarbon reserves can be charted using a new advance in electromagnetic mapping.

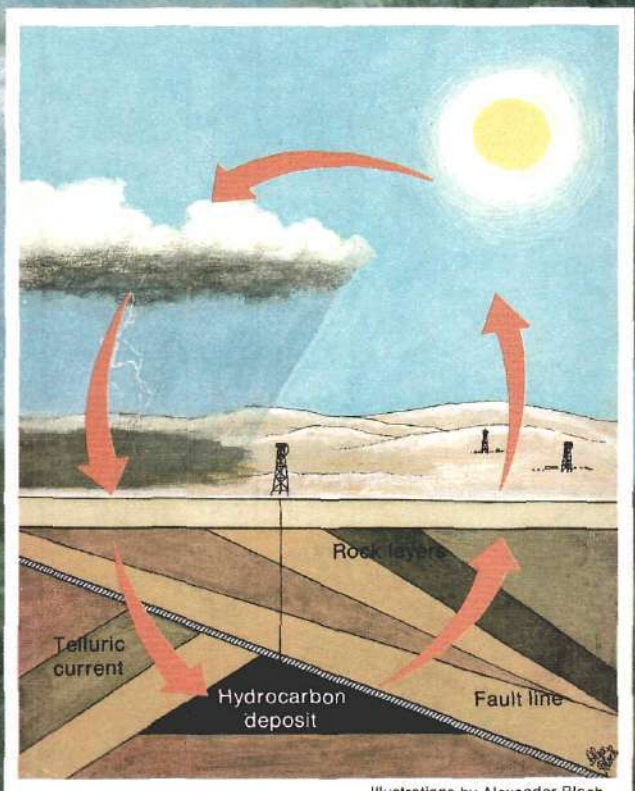
Mapping America's Vast Oil and Gas Wealth

by William Engdahl

RECENT GEOLOGICAL ESTIMATES continue to belie the notion that the world's petroleum resources are in danger of imminent exhaustion. Last September, for example, the director of the U.S. Geological Survey pointed out the existence of a reef along the Continental Slope extending from Maine to Florida, 15 miles wide, 20,000 feet thick, and estimated to contain between 2 and 15 billion barrels of recoverable oil. The Geological Survey also noted that a region in the eastern part of the Appalachian Overthrust has "tremendous potential" for oil and natural gas production. According to Dr. H.A. Merklein, a geophysicist at the University of Dallas, U.S. domestic oil and natural gas production could jump from a current level of 5.8 billion barrels of oil equivalent to 7.5 billion by 1990 and 9.7 billion by the year 2000—if accelerated exploration and drilling in the as yet untapped regions occurs.

Unfortunately, the implications of such findings have tended to get ignored amid the pervasive theorizing about





Illustrations by Alexander Bloch

The electric circuit formed from elements of the atmosphere, clouds, and different layers of the earth's surface. Fault lines (the hatched line), hydrocarbon deposits (the solid black area), and other geological features act as active and passive components of this circuit. The photographs show the prospecting jeep that carries Talbert's Electro-Seise mapping device in action in south Texas.

the finiteness of natural resources. The actual resource problem that is waiting to be addressed is not whether the United States has sufficient oil and natural gas reserves (it undoubtedly does), but how the largely unexplored oil and gas production regions can most efficiently and economically be mapped and exploited to supply the nation's growing energy needs.

In large sections of the unexplored and the known oil and gas areas, conventional seismic techniques cannot be employed because of complex subsurface faulting and stratification. However, a recently developed electromagnetic mapping technique that can detect the distinct electromagnetic field emitted by hydrocarbon deposits has already demonstrated striking success when it was used to map complex geological formations in Ohio, Alabama, Oklahoma, and south Texas.

The technique, the Electro-Seise system, was developed by applied physicist and inventor Richard G. Talbert (Talbert 1976). Talbert's advanced electromagnetic mapping system is able to locate and map hydrocarbon deposits from above the ground with extreme accuracy, greatly reducing trial-and-error drilling. The system can also differentiate between oil and natural gas deposits and project the structural configuration of deposits, information that greatly facilitates drilling when it takes place.

The economics of the Electro-Seise system are also promising. The bulk of America's untested oil and gas zones lies 15,000 feet and more beneath the surface of the earth, compared with average depths of around 5,000 feet for already exploited deposits. The fact that drilling costs increase exponentially the deeper the well makes it imperative to have extremely accurate geophysical mapping techniques if the development of new hydrocarbon basins is to be economically feasible.

The major advantage of Talbert's Electro-Seise system is that its accuracy actually increases with the depth of the hydrocarbon basins it is mapping. This is because there are stronger electromagnetic currents above the deeper deposits, a result of the greater heat, pressure, and motion deep below the earth's surface that heightens the process of ionization within the deposits. By increasing the certainty that drilling probes will be successful, Electro-Seise makes the exploitation of wells deep within the earth a far more practical undertaking.

Infinite Resources

The development of this highly sophisticated mapping technique, which could quickly open up previously inaccessible oil and gas regions for development, underlines a broader scientific point. The very notion of finite natural resources is a spurious concept. Petroleum is no more a natural resource than any of the other material inputs of modern society; it is available and useful to society solely as a result of the development of a technological base that allows society to extract it and use it. One hundred years ago petroleum was not a natural resource, any more than uranium is today for an aboriginal tribe in Australia or deuterium is before the advent of commercial fusion power.

Reserves of hydrocarbons are properly defined by the availability of economical technologies. At the present cost of hydrocarbon extraction, many experts estimate that the world still has hundreds of years worth of oil and natural gas supplies. The question of future resource availability is purely one of developing and applying new technologies. The electromagnetic mapping technique described in this article exemplifies the way in which a new technology can redefine an economy's resource base; the Electro-Seise technique extends the scope of recoverable oil and gas reserves by permitting efficient resource mapping in areas that were previously beyond the reach of economical exploration.

The main resource development and scientific challenge that lies ahead is the development of thermonuclear fusion, which can provide unlimited, clean energy from the deuterium in ordinary seawater; revolutionize industrial processing techniques; and completely redefine society's resource base. Over the next two decades, America's increased energy needs must be met through increased production from conventional fossil fuels and nuclear fission. In this perspective, Electro-Seise can play an important part in unlocking our untapped fossil fuel resources.

Telluric Currents

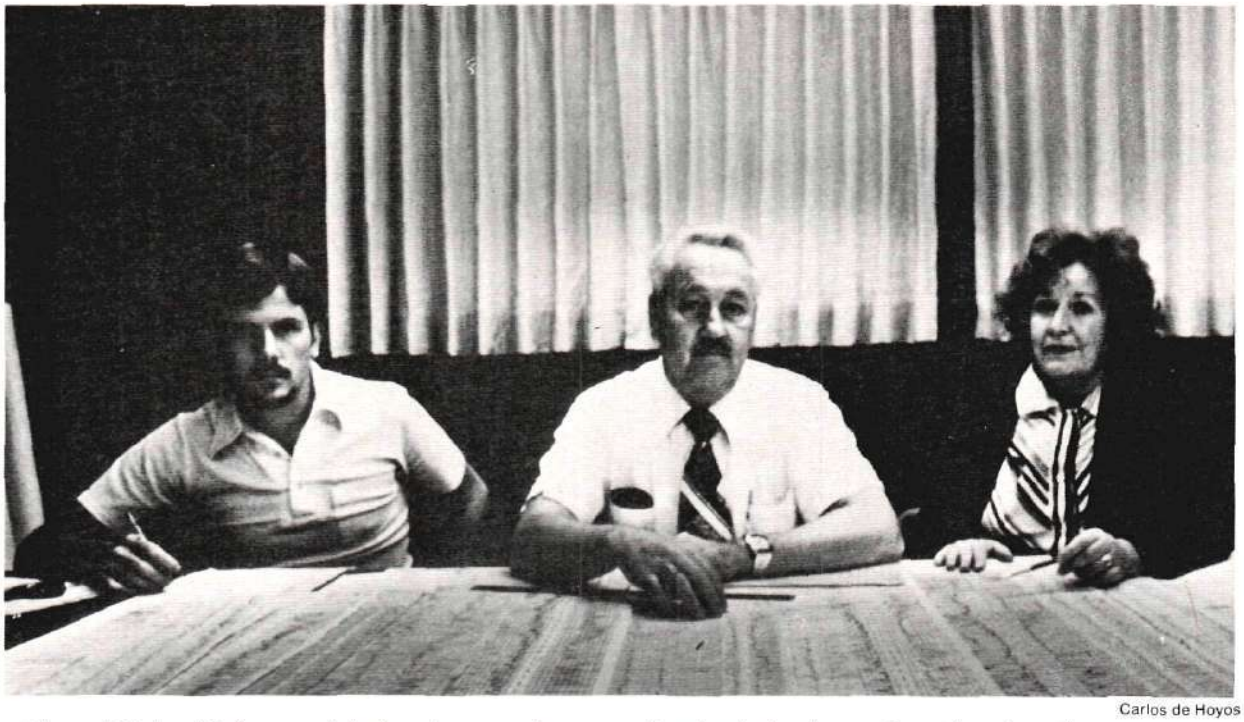
Talbert's Electro-Seise system and all electromagnetic mapping techniques exploit the existence of telluric (earth) currents, naturally caused electromagnetic currents in the earth's surface that provide information about the structure and composition of the subsurface. The existence of such currents has been recognized for more than 100 years. However, they were not used to enhance geological exploration until 1921, when Marcel Schlumberger first conducted field experiments measuring them. Much of the present knowledge about telluric currents must be credited to the French and Russians, who have made extensive use of them in geophysical prospecting (Schlumberger 1939, Berdichevskiy 1965). Telluric currents were defined by L.L. Nettleton in 1940 as "irregular natural currents on a large scale within the earth which are intimately related to diurnal magnetic variations and have corresponding diurnal and also short-period variations. They are particularly active at the time of magnetic storms" (Nettleton 1976).

The telluric currents measured at different points on the earth's surface vary, indicating lateral changes in the electrical properties of subsurface formations. This characteristic of telluric currents is particularly useful for locating and mapping geological features such as faults, carbonate banks and reefs, salt and shale masses, and the earth's basement topography.

Since Nettleton's early definition, extensive research has been carried out on the sources of the currents, which has shown them to be both extraterrestrial and terrestrial. The extraterrestrial sources are thought to be a result of the magnetic fields generated in the ionosphere by solar activity. These magnetic fields in turn give rise to a large electric field that includes the earth in its circuit. The most familiar evidence of this electron flow is lightning and other static electric discharges.

The telluric currents derived from extraterrestrial sources, which range in frequency from cycles per second

Photos by Carlos de Hoyos



Carlos de Hoyos

Hilda and Richard Talbert and their assistant study conventional seismic charts of an oil region. The more precise information provided by Electro-Seise enables them to detect whether untapped oil remains in known fields.

Richard G. Talbert, Scientist & Inventor

The evolution of the scientific thinking of Richard G. Talbert, the man who developed the Electro-Seise system, is as interesting as the technology itself. Talbert studied physics in the early 1950s as a protégé of the late Dr. F.E. Ronald, a geochemist who was then associated with California Institute of Technology. In a recent interview, Talbert explained that the evolution of the Electro-Seise system goes back to the radiometry surveys that he conducted with Ronald during the uranium boom of the early 1950s.

"Certain of the experiments we conducted led us to develop the electrical circuitry that differentiates between terrestrial and extra-terrestrial currents. For example, we would drill a shot-hole and shoot half a stick of dynamite into the hole, thereby disturbing the electromagnetic field. We would then measure the field after everything had resettled. More and more, we became involved in core drilling, mapping radiation anomalies to discover the source of the background electrical currents. All of this work led into geology. My personal education evolved from this early work with electromagnetic fields."

From his work at Cal Tech, Talbert founded the Ontario Testing Laboratory, where he did early work in ion-exchange columns with resin beds to separate some of the rare earth elements. In the course of this work he discovered that the electromagnetic charge was more indicative than pH in determining the ionization in a charged bed. "The first unit we used was a radio frequency unit," Talbert recounted. "That method was very inaccurate, but constant refining of the signal and development of the type of electrode that would respond took us off the radio frequency spectrum into the type of sensor that is used in the Electro-Seise system."

H. Wayne Hoylman, a geophysicist with Gulf Oil, greatly encouraged Talbert to develop his early thinking on use of telluric current for determining the presence of hydrocarbons. "Hoylman's interest was in the electromagnetic spectrum," Talbert related. "Hoylman is the only geophysicist I know who was looking at the problem in this same way. He was invaluable in the early years." Hoylman, who is credited as being the developer of the airborne flux-gate magnetometer, had done work in the radiofrequency signal spectrum in the Army during the war and had then noticed the effect of minerals on the signal.

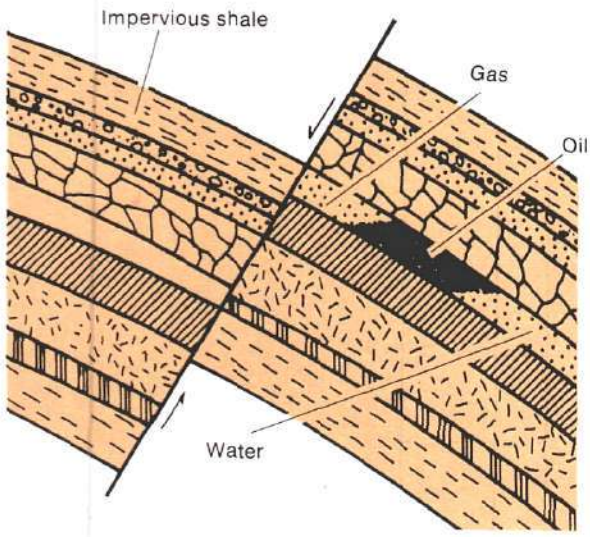
Talbert is currently president of Texas Electro-Seise Inc. of Fort Worth, Texas and has applied his method to unravel complex geological terrains in Ohio, Alabama, Oklahoma, and south Texas.

to cycles per hour, are the source of the background electron flow that is registered by all known telluric devices. From the standpoint of electrical prospecting, this background flow constitutes "noise," which must be distinguished and filtered out from the electron flow associated with hydrocarbon deposits in the earth's subsurface.

It is theorized that the terrestrial side of telluric currents results from anomalies generated in mineral deposits. In general, different substances have different electrical conductivities. Therefore, the existence of mineral deposits within the earth's subsurface gives rise to areas of differing electrical potentials, which would explain the measurable electromagnetic fields above such deposits. There are, of course, other discontinuities within the subsurface, the most dramatic of which is faulting. Faulting involves a shifting in the earth's crust in which adjacent strata with different chemical and electrical properties are displaced parallel to the plane of fracture and thrust into contact with each other.

The heightened telluric activity that has been measured above hydrocarbon deposits is thought to be the result of processes of oxidation and reduction occurring on the borders of these deposits and the resulting flow of an electrical current.

The chief problem that had to be tackled in applying the knowledge of telluric currents to prospecting was developing techniques for identifying the stronger electromagnetic currents above the hydrocarbon deposits amid the complex, interactive electromagnetic field generated by the hydrocarbons, other minerals, geological anomalies such as fault lines, and atmospheric currents from extraterrestrial sources.



Oil and gas deposits are entrapped by faults in the earth's crust. Faulting also brings geological strata with different chemical and electrical properties into contact, which gives rise to a measurable electromagnetic field along the fault line.

The Electro-Seise System

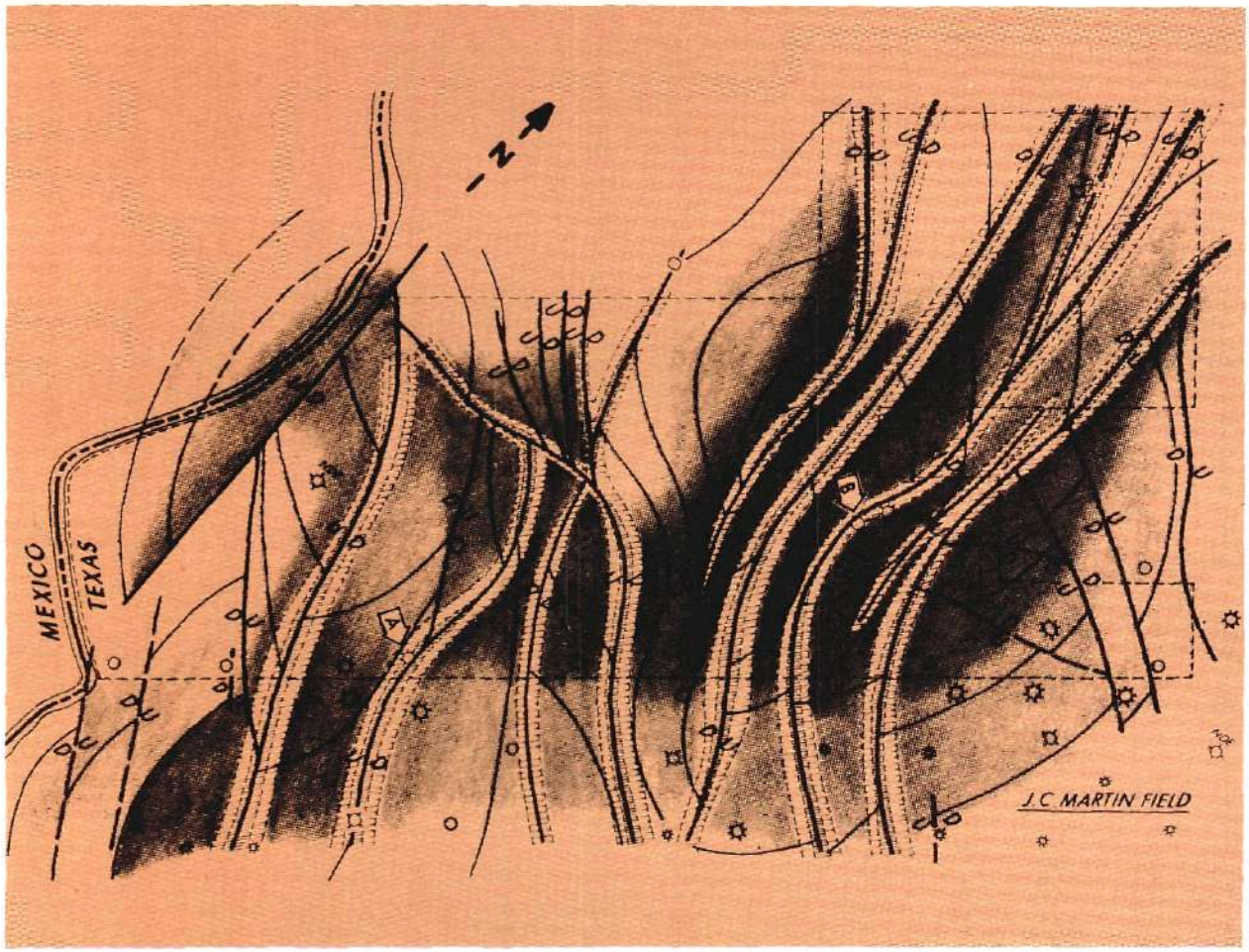
Before the development of Talbert's Electro-Seise system, all passive electrical prospecting methods—those which measure naturally occurring currents and do not propagate their own signal—were based on measurements obtained from sensors located in the ground. The limitation of these methods was that they necessarily ignore the differing electromagnetic fields escaping from the surface, which are available for measurement and subsequent interpretation as to their origin.

Richard Talbert began extensive work on his aboveground technique in the late 1960s (see box). He gathered his first field data in 1970 in California, where his surveys located faulting associated with entrapped oil. Since that early work, Talbert's system has undergone continuous refinement following the gathering of thousands of miles of data by both ground and air vehicles. As a result of experience gained over an extremely wide variety of known types of hydrocarbon reservoirs, he has been able to refine his method to the point that Electro-Seise is able to directly detect and delineate hydrocarbon formations. The system is further able to differentiate between the presence of oil or gas in the formation and make a determination of qualitative structural configurations, including such essential drilling intelligence as magnitude of fault, the direction of its throw, and its strike or angle. This information represents a substantial enhancement of the data that can be obtained from traditional seismic techniques and promises to keep exploration costs down—an increasingly important factor in light of capital losses resulting from such recent government actions as the imposition of the costly crude oil windfall profits tax on wellhead oil production.

The Electro-Seise system is based on a sophisticated sensor, which is suspended in the air and carried by either a ground vehicle or an airplane. As the sensor moves along a selected profile line, a signal is generated by the interaction of the sensor with the natural electromagnetic field. The electrodes of the sensor are specially designed to measure minute variations in a low frequency band where telluric currents occur. The electrodes are in constant rotation, enabling them to pick up the slightest change in density in the electron flow above the earth's surface. The development of such precision instrumentation for use in geophysical prospecting was, interestingly, one of the numerous spinoffs of the NASA space program.

The signal generated by the electromagnetic field is recorded both in analog or continuous form on conventional continuous graph paper and simultaneously in digital form on magnetic tape for storage and transmission. The analog graph enables the operator to identify data of interest and make on-the-spot decisions about the validity of the data.

After each day's survey, the raw field data stored on the magnetic tape are transmitted via phone hookup or courier to a computer facility at a central office. There, the computer outputs data in four formats: tabulated digital printout, digital chart (a more detailed representation of the original analog chart), and later, where interest warrants, a contour map and oblique projections (cross-sec-



The Electro-Seise survey made of Mecom Prospect in Zapata County, Texas by R.G. Talbert in 1975. The heavy black lines are fault lines, where a fault structure in the subsurface intersects the earth's surface. The dark shaded areas are those where there is a high probability of hydrocarbons; the light shaded areas indicate fair probability.

tions of the geological zone). The final assessment of the area under study is made from the collective data.

Because of the extreme complexity of most subsurface geology, it takes successive readings of a selected zone from a number of different directions to accurately unravel it. By proceeding in this manner, it becomes possible to filter out the unwanted background noise produced by the earth's electromagnetic field and the electromagnetic currents above geological formations other than hydrocarbon deposits. Talbert emphasizes that the accuracy of his system depends on the successive readings and the designing of a sufficiently large and varied grid.

Starting with a grid of approximately 10 square miles in dimension, the Electro-Seise method proceeds by taking three sets of readings of the zone. The first reading is to establish the average or background telluric activity of the geological zone. The second is to map fault structures, where hydrocarbon deposits get trapped. Fault lines will register a relatively strong signal, because faulting brings different geological strata with differing electrical potentials into contiguity, giving rise to a more intense electromagnetic field on the surface above them.

Once the fault structure of a given zone is delineated, the zone is traversed for a third time, this time to map the actual hydrocarbon deposits. These deposits show up on the analog curve as the areas of the greatest signal activity. An operator can be reasonably certain that he has pinpointed a hydrocarbon deposit when intense signal activity recorded during one survey coincides with intense signal activity measured during a second survey taken from the opposite direction.

Applications

Seismic data has been notoriously ineffective for delineation of subsurface geology in certain regions of Ohio, because of the presence of glacial deposits or fills. In 1978, Electro-Seise was brought in by the exploration subsidiary of Republic Steel. In an effort to determine whether the Electro-Seise telluric system was applicable where seismic methods had not been, Paul Shick, who was then the director of oil and gas exploration for the company, took Talbert over acreage where the company had previously drilled 40 to 50 wildcat wells, some of them productive, some not.

Shick recently confirmed in an interview that the map produced by Electro-Seise successfully indicated where

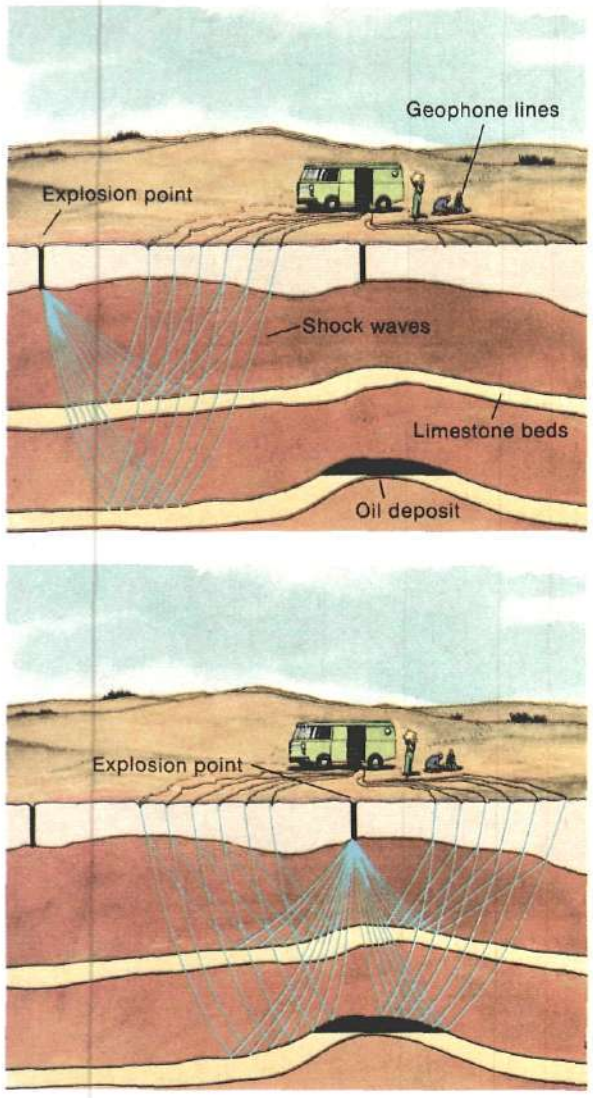
production would be good and where bad, "with greater than 95 percent accuracy." "These were outstanding results," he stated. "If we had had Electro-Seise at the beginning, we could have gotten the same production from only 30 wells instead of almost 50." Even with the production data from the approximately 50 wells, Republic had not been able to successfully map the region with conventional seismic and other approaches because of the very subtle structural relief present.

Based on the Ohio results, Republic used Electro-Seise to map two areas in the Black Warrior Basin of Alabama in 1979, one 85,000 acres and the other, 65,000 acres. Before the company was forced to retrench oil and gas exploration because of recession-related losses in its steel operations, eight rank wildcats—that is, wells far from any previous drilling—had been completed. Published results of that drilling confirm that the knowledge of the geology, exclusively mapped in this case by the Electro-Seise system, led to a major discovery of six successful wells, several of them with multiple deposits. Of the two unsuccessful wells, one was plugged for cost reasons after an engineering failure; however, the map indicating the presence of rock strata was confirmed. The other well did not disprove the mapping, but it was not taken to a sufficient depth, again for economic reasons. A 75 percent success rate for rank wildcats is considered outstanding. The domestic industry average runs between 10 and 21 percent. Averaged over the 11 years to date, Electro-Seise has yielded a 65 to 75 percent success rate.

With the remarkable precision of instrumentation developed in recent years as a spinoff of the space program and the qualitatively different approach of tellurics compared to conventional seismic methods, Electro-Seise's instrumentation is able to delineate structural relief faultings to an accuracy of within 2 feet. Talbert credits this remarkable accuracy to "recent improvements in the recording of field data and the digitizing of wave-form measurements."

Unlike other existing electrical profiling technologies now in use, such as that employed by Aminoil in its southwest exploration district (*Oil & Gas Journal* 1980), Electro-Seise is a mobile system, because it does not depend on in-ground electrode measurement. Through this advantage, Electro-Seise has been able to greatly reduce the time and therefore the cost of exploration. It can cover approximately 10 line-miles (miles of survey line) per day carried on a road vehicle and 40 per day by helicopter. This speed makes it economical to repeat runs to confirm accuracy in difficult or subtle fault zones. Ground vehicles can cover rough terrain at 5 miles per hour and up to 15 mph on hard-surface roads. By helicopter, surveys are usually made at 40 mph, with hover modes of less than 30 mph for detail work. Microwave positioning equipment on the helicopter permits a range accuracy of 3 meters within 50 miles.

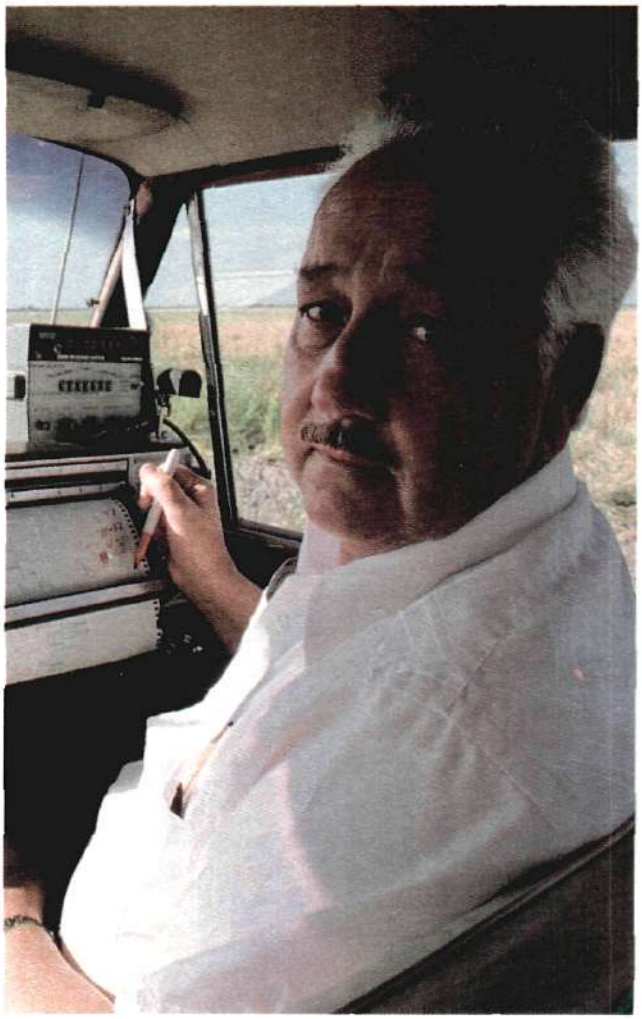
In a different geological situation in Ellis County, Oklahoma, the Electro-Seise system was used to confirm an earlier seismic interpretation of a deep, faulted feature. The Electro-Seise mapping differed radically from the prediction made by the earlier seismic survey. Electro-Seise not only predicted such a fault did not exist, but it



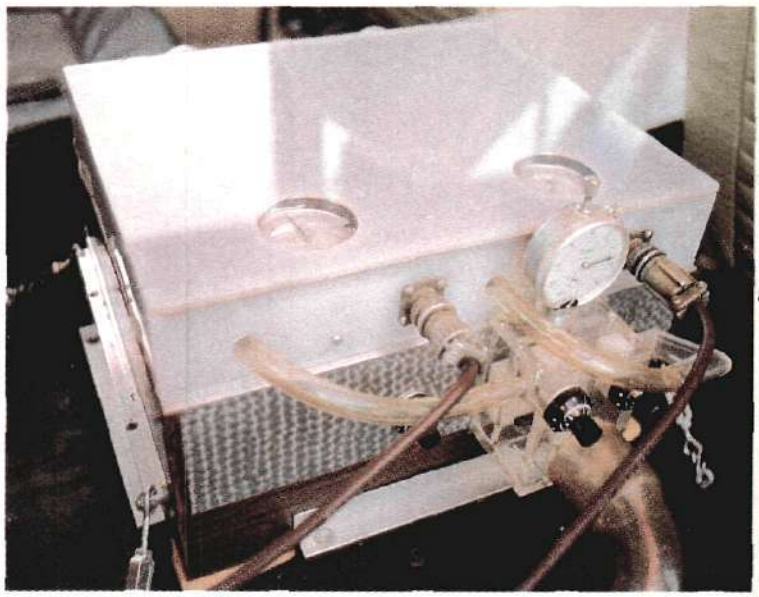
SEISMIC MAPPING

Most traditional geophysical mapping is carried out by seismic methods. In this method, man-made shock waves are sent into the earth by an artificial explosion; the seismograph then deduces the subsurface structure by measuring the transit times of the shock waves. After the geophysicist has determined the area to be surveyed, a large shallow hole or series of holes is drilled, and nitroglycerin or dynamite is loaded into them. Geophones, electric cables attached to measuring devices, are then wired into the earth along the line to be measured.

The detonation sets off shock waves, which travel downward and are reflected back to the surface from the rock layers. The transit times of the shock waves vary with the density of the rock they travel through, allowing a mapping of the subsurface geology. The results from a seismograph mapping point to geological structures which may contain hydrocarbons.



Left: Richard Talbert, inventor of the Electro-Seise system, rides in a specially designed prospecting jeep.



Photos by Carlos de Hoyos

Above: The two-electrode sensor device, the central component of Talbert's system.

predicted the existence of productive sands. Drilling has subsequently borne out both predictions.

In another portion of the same Ellis County acreage, Electro-Seise confirmed a seismic prediction of a deep-faulted structure and predicted it would be productive. Subsequent drilling confirmed this also. This well, lying at a 17,000-foot depth in the Anadarko Basin, is the deepest to date that the Electro-Seise system has confirmed as valid, although present drilling in a portion of this same survey area will go to a 19,000 to 20,000-foot depth. The vast majority of drilling in the United States to date has been 5,000 feet or less.

A still different type of geophysical problem was presented in the Mecom Prospect in Zapata County in south Texas on the Mexico border. This is an extremely complex geological fault zone. Two earlier seismic surveys of the area were unable to produce a seismic map because a 6,000-foot shale formation interfered with the velocity line of the seismic tests. When Electro-Seise began its survey of the area, the subsurface was regarded as unmappable by conventional means. The two surveys had been able to map only one fault line in the entire area. The Electro-Seise survey succeeded in delineating the extremely complex and unusual fault structure of this region, and subsequent drilling carried out in accordance with the Electro-Seise survey yielded 18 successful wells.

Ninety-eight percent of America's potential oil and gas regions are still untested. The Electro-Seise system's proven capability suggests a vital new advance in the science of geophysics to help get these regions into production.

William Engdahl is a contributing editor to Fusion magazine. His articles on the problems of oil and gas development have been reprinted in numerous journals. Dr. Steven Bardwell, director of plasma physics for the Fusion Energy Foundation, collaborated in the preparation of this article.

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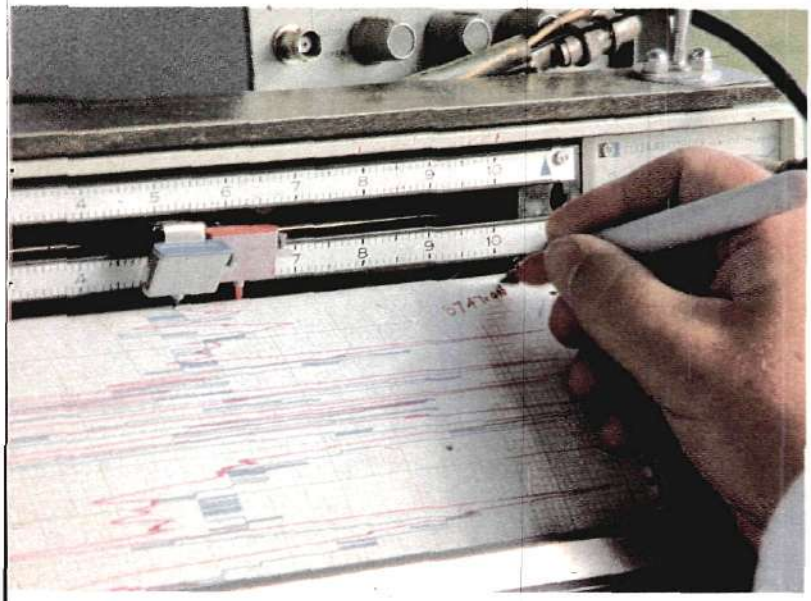
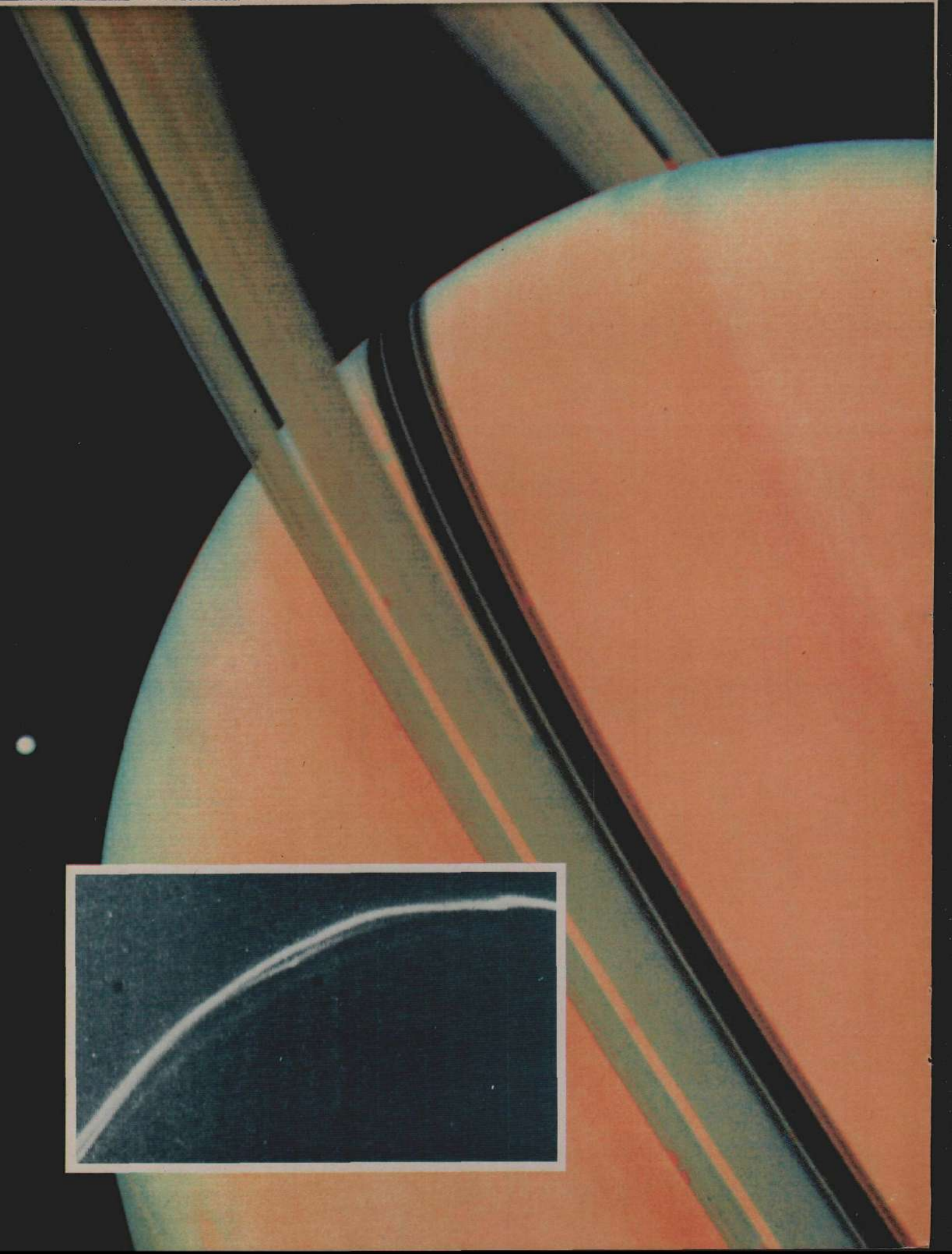
Right: Talbert and his assistant plot information from an Electro-Seise mapping of a potential oil region.



Above: The sensor in action: telluric currents emitted by hydrocarbon deposits deep within the earth's surface are recorded on an analog graph.

Left: Examining seismic charts of older oil fields. Above: Hilda Talbert transfers information from seismic charts to a map. Seismic charts of known oil deposits are often used to test the accuracy of an Electro-Seise reading of the same area.



Saturn Results Challenge Existing Scientific Theories

by Marsha Freeman

As the Voyager 1 spacecraft sped past Saturn Nov. 12 and headed out on its infinite journey beyond the solar system, it left behind a wealth of scientific data that has already begun to overturn accepted theories of physics and celestial mechanics.

The flawlessly executed Voyager flyby was a technological achievement for America that ranks with NASA's finest hours.

By closed-circuit television at NASA headquarters in Washington, D.C., NASA personnel and invited guests (including this reporter) watched the photographs as they appeared from Voyager, nearly 1 billion miles away from Earth. For the NASA scientists, as well as other Americans watching the results on television, it was a thrilling occasion of the sort not seen since the Apollo moon shots a decade ago.

The Voyager 1 space probe has opened new vistas for science, providing more direct observational data about the nature of the universe than all of man's previous researches taken together. The evidence recorded by Voyager shows that the movement of celestial bodies cannot be explained within the framework of the reductionist Newtonian system.

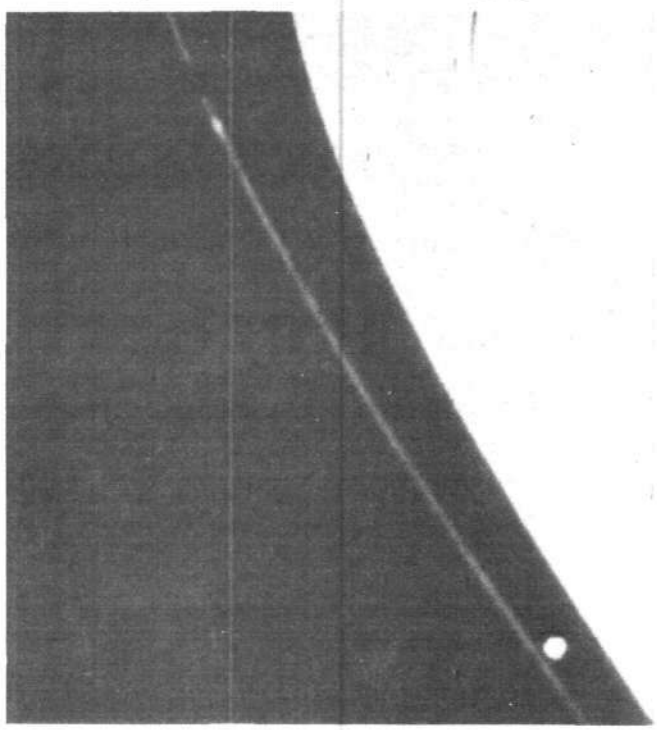
Voyager has also uncovered information about hydrocarbons that is extremely important in identifying the origins of life on Earth. The discoveries regarding hydrocarbons, complex molecules of hydrogen and carbon, will also provide a major boost to organic chemistry.

Hundreds of Surprises

Nearly everything that Voyager observed near Saturn was unexpected. But as one of the scientists at the Jet Propulsion Lab commented, "If we knew what we were going to find, there would have been no reason to go there."

Dr. Bradford Smith, head of the Voyager camera team, stated: "In this strange world of Saturn's rings, the bizarre has become commonplace. . . . We may have to develop a whole new breed of celestial machinations to account for the newly revealed Saturnian mysteries."

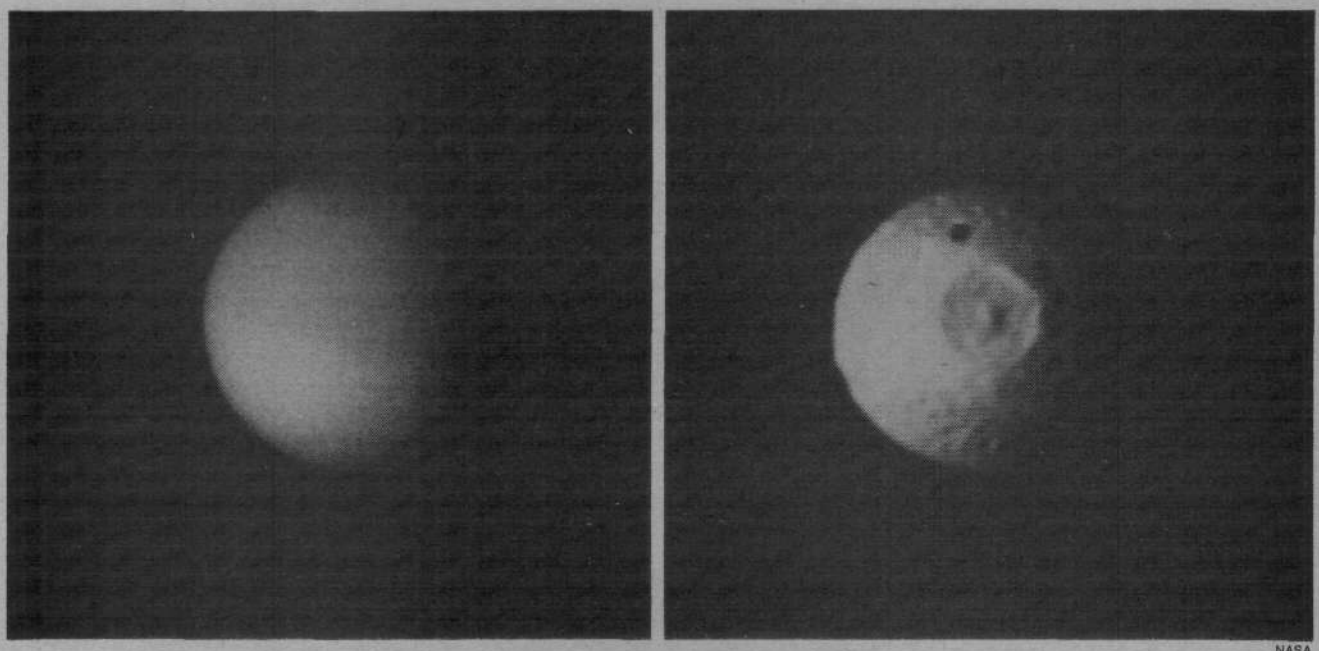
The most intriguing finding over the past week was the apparent braided or twisted structure of Saturn's outermost F-ring. First observed by the Pioneer spacecraft one year ago, the ephemeral F-ring is probably only 50 miles in diameter and has varying densities that show up in pho-



Photographs by NASA

Opposite: Saturn and one of its moons, Dione, photographed by Voyager 1 Nov. 3, 1980 from 8 million miles. The limb of the planet can be easily seen through the 2,170-mile-wide Cassini Division that separates ring A from ring B. The view through the much narrower Encke Division, near the outer edge of ring A, is less clear. Beyond the Encke Division (at left) is the faintest of Saturn's three bright rings, the C ring, barely visible against the planet. Inset: Saturn's F ring, the outermost ring, photographed at a range of 470,000 miles. Two narrow, braided rings that trace distinct orbits can be discerned. Also visible is a broader, very diffuse component about 20 miles wide and "knots," probably clumps of ring material (but possibly "minimoons").

Above, just inside the F ring (bottom) is Saturn's 14th satellite. This photograph, taken at a range of 4 million miles, shows variations in the brightness of the thin F ring, which is less than 60 miles wide. The "gap" in the ring (left center) is not real, but the location of a mark engraved on the Voyager camera.



NASA

Right: Mimas, one of the smaller Saturnian satellites, has a low density, implying that its chief component is ice. This photograph shows a large impact structure located on that face of the moon that leads Mimas in its orbit. The structure, about 80 miles in diameter, is more than one-quarter the diameter of the entire moon and may be the largest crater diameter/satellite diameter ratio in the solar system. Left: The satellite Titan, whose surface is believed to be shrouded by aerosols rather than the convective clouds found in the atmospheres of Jupiter and Saturn.

Revitalizing the U.S. Space Program

The NASA budget this year is a little more than $5 billion, less in absolute dollars than the budget was in 1965. To revitalize the U.S. space program and again have the economy reap the benefits ($14 generated in new jobs, factories, and products for every $1 invested) of a top notch space program, the Fusion Energy Foundation has proposed that the new administration do the following:

First, reinstitute the funding for the various NASA projects killed or wounded by the Carter administration. These include the Shuttle program; the Galileo mission to Jupiter scheduled for 1986; the Solar Polar mission delayed and nearly canceled for lack of funds; OPEN mission, the Origin of Plasma in the Earth's Neighborhood; the Halley's comet fly-by; the Venus probe and soft-landing mission; the Large Space Telescope mission; various space industrialization programs; and the Grand Tour of the Solar System program.

Second, reinstitute NASA's public educational programs, including university fellowships, public school curricula, training courses for science teachers, and the publication of science books and pamphlets. This should be accomplished directly through NASA, not through the National Science Foundation or the Department of Education.

Third, redirect the energy-related research conducted by NASA, which, under the leadership of the Department of Energy, has devolved into soft-energy research—solar and windmills. NASA and the DOE or its successor agency should collaborate instead on advanced technology work, such as plasma propulsion, conversion technologies like thermionics and MHD for space and ground-based systems, nuclear reactor designs for space, and fuel work in hydrogen.

tographs as light and dark areas. It is a twisted braid of at least two strands, much like the double helix structure of DNA molecules.

The braided F-ring, as many other phenomena observed by Voyager, runs counter to what scientists operating in the framework of classical Newtonian physics expected to find. Newtonian physics can explain the structures after the fact, but cannot explain how they were formed.

"It is like the problem of the old Ptolemaic conception of the solar system being Earth-centered," commented FEF director of plasma physics Dr. Steven Bardwell. "Any new data could always be 'fit' into the old model, but the model was totally unable to help scientists find out anything new about the universe," he said.

Commenting on the unexpected braided structure of the F-ring, Dr. Morris Levitt, executive director of the Fusion Energy Foundation, said, "It perfectly exemplifies the type of harmonic geometry that Kepler [the 16th-century astronomer] said was there." The Newtonian system would

have expected that the orbital path of the chunks of rock that make up the F-ring would be a circle or an ellipse, Levitt said.

Two of the three new moons observed by Voyager for the first time lie just on either side of the F-ring. Some scientists have posited that these two may be "shepherding satellites" that keep the particles in the F-ring from flying away, but no one has yet guessed at the origin of the braided structure.

Voyager has also indicated that some of the particles in the F-ring, and most likely others of Saturn's rings, are made up of charged particles that would interact with Saturn's natural magnetic field. This interaction could also determine the shape and density of the rings.

One of Saturn's 15 moons is the largest known moon in the solar system and the only one with an appreciable atmosphere. This moon, Titan, has just been observed to contain an atmosphere made up of carbon molecules. These organic molecules, methane and others, are similar to those of early life on Earth.

Even though it is unlikely that there is any life on Titan because of its extreme temperature, scientists may find there hints about how life evolved on Earth.

Saturn's 14 other moons have many other remarkable features that challenge accepted interpretations of physics. Two of the smallest appear to be on nearly the same orbital path. Since they travel at different speeds, this should lead to a collision as one moon catches up to the other. There is evidence, however, that these two moons have been in existence the same billions of years as Saturn's other moons. Therefore they must alter their orbits as they approach each other to avoid a collision, the first known example of the "horseshoe" orbit postulated by celestial mechanists 80 years ago.

The large moon, Iapetus, more than 200,000 miles from Saturn, appears to be made up of two distinctly different substances: one reflects light and one does not. Even when the sun is shining directly on one side of Iapetus, it appears dark. Other smaller moons closer to the planet show evidence of hundreds of impact craters, some so large that there is no explanation of why the moon was not blown to bits on impact.

As the data from Voyager continue to be processed by the banks of computers at the laboratory, many new features of the Saturnian system will become known. All expect that the new data will continue to add to the new list of questions scientists already have.

The 'Path of Excellence'

Scientists who have seen planetary exploration projects scheduled for the 1980s go down to budgetary defeat over the past 10 years have found new cause for encouragement in the spectacular results of Voyager's technological feat.

"In the middle 1970s we became distracted as a people," commented Dr. Bruce Murray, director of the Jet Propulsion Laboratory where the flight was directed and monitored. "We who created a society based on excellence and achievement lost that concept. We dropped the ball," he said.

"The real question is 'Do we want to continue on the path of excellence? Do we want our children to do things for which they can take pride?' If we intend to excel, to do things we can be proud of, space exploration should be among them," the scientist said.

U.S. Forestry Official Approves Oil Exploration Leases

George Olson, Supervisor of National Forests for North Carolina, ruled in late September that the government should lease federal land for oil and gas exploration in what could be one of the nation's most mineral-rich regions, the Appalachian Overthrust.

A recent study by the U.S. Geological Survey indicated that a vast, untapped belt of potential oil and gas resources lies along the Appalachian range from Pennsylvania down to Alabama. After the release of the Geological Survey study, AMOCO, the nation's largest domestic oil producer, applied for exploration leases on 220,000 acres of federal land in the Pisgah National Forest and the Nantahala Forest in western North Carolina.

However, the entire area, like some 120 million acres of mineral-rich land in Alaska, has been closed to development and even exploration under phase two of the Roadless Area Review Evaluation program—RARE II—initiated by Agriculture Secretary Robert Bergland. In explicit violation of the Eastern Wilderness Act of 1975, which calls for "evaluation of resources before there is withdrawal" of lands from use, Secretary Bergland has been using the category "further study required" to place vast acreages off limits to explorers and developers, pending possible designation of the areas as permanent wilderness.

Olson's decision regarding the Pisgah National Forest area, which is thought to contain large deposits of uranium and other minerals, as well as oil and gas, was welcomed by local groups that have been seeking to develop the area. Hamilton C. Horton, an attorney in Winston-Salem, who has been involved in a legal fight to reverse the regulatory lock up, said in an interview, "This is the only place in the country that I know of where the Forestry Service has made such a ruling in recent years."

Horton attributed the ruling to powerful lobbying by groups willing to fight the tangle of federal restrictions on energy development, such as the Save America Club with which he is associated (see *Fusion*, Dec. 1980, p. 25). Horton cautioned, however, "We are not out of the woods on this issue," noting that Bergland's office has often overridden the evaluations of seasoned professionals like Olson in favor of the views of new staffers with a bias toward the no-growth philosophy of groups such as the Sierra Club. Olson's ruling could still be overturned by Washington.

—William Engdahl

Parpart Lectures at Lawrence Livermore

"How to end the present theoretical impasse in inertial confinement fusion" was the subject of an invited talk given by FEF research director Uwe Parpart at the nation's largest fusion laboratory, Lawrence Livermore National Laboratory in California, in October. The presentation to a full house of more than 100 fusion scientists was part of a tour of the laboratory's facilities by Parpart and FEF European representative Jonathan Tennenbaum.

A New Concept of Energy

Present difficulties in understanding what happens in a dense plasma under conditions of isentropic compression by strong shock waves can be overcome only by the development of a new concept of energy, Parpart said. Such a conception is in fact emerging out of work done by the FEF in the fields of economics and the mathematics of Bernhard Riemann.

Parpart went on to describe the essential features of the LaRouche-Riemann econometric model, a method of computer modeling developed by the FEF on the basis of the economic theory of Lyndon LaRouche. Parpart emphasized the key distinction between ordinary methods of "national income accounting," which obscure the difference between productive and nonproductive investment, and the *causal* parameters employed in the LaRouche-Riemann model. This model is unique in taking innovations in technology and consequent increases in productivity as the basic phenomena in an economy and basing the definition of parameters such as productive labor force and real surplus on those phenomena.

The same difficulties that render traditional GNP accounting incapable of analyzing an economy are at the root of the present deadlock in parts of theoretical physics, particularly quantum electrodynamics. In this case, as in many others, the attempts to "smooth over" or ignore the singularities defining changes of phase, trying to impose a linearized mathemetics on a physical reality that is essentially nonlinear, have led to apparently insoluble paradoxes.

The Importance of Riemann

Historically, Parpart pointed out, the foundations for a coherent mathematical treatment of nonlinearity were already laid by Bernhard Riemann more than 100 years ago. Unfortunately, Riemann's methodology has been passed down in a severely truncated form, and the full implications of his work have not been realized to this day.

Parpart cited as a crucial example of this Riemann's paper "On the Hypotheses of Geometry," in which Riemann polemicizes against exactly those *a priori* assumptions of "linearity in the small" that prevented Einstein and others from reconciling general relativity with the existence of a quantum of action.

What has not been understood, said Parpart, is that Riemann's work in such disparate fields as shock waves, electrodynamics, prime numbers, and Abelian functions was all part of a coherent program for attacking fundamental problems in physics.

Thus it is no accident that Riemann's work on shock waves inspired Schrödinger's early work on a wave-mechanical theory of particles, nor that recent work on particlelike phenomena—solitons—in plasmas and other media has revealed astonishing connections with Riemann's masterpiece of "pure mathematics," the theory of Abelian functions.

Parpart concluded by posing the challenge of reviving Riemann's methodology in its full extent, drawing rigorous conclusions from the coherence of physical theory and economics. Parpart's presentation was followed by a lively discussion ranging from questions on the LaRouche-Riemann model to the validity of the Second Law of Thermodynamics.

—J. Tennenbaum

FEF's Freeman Tours Northwest

Marsha Freeman, the Fusion Energy Foundation industrial research director, received an excellent reception during a 10-day swing through the Northwest in late October to publicize the passage of the McCormack fusion legislation. "Science experts like Freeman are feverishly hailing the new law as a milestone in energy legislation," the *Wapato Independent* of Wapato, Wash. reported Oct. 29.

In all, a half-dozen newspapers and a dozen radio stations in Washington (the home state of Rep. Mike McCormack who sponsored the fusion bill) and Oregon carried lengthy interviews with Freeman. She reviewed the potential economic impact of the fusion legislation, which she compared to the economic leverage of the Apollo space program of the 1960s, and pointed out the particular significance of the $20 billion fusion program mandated by the bill for the Northwest, where Westinghouse's Hanford Nuclear Reservation is already constructing a facility to test and develop new materials to be used in fusion. The *Toppenish Review* highlighted Freeman's comments on the promise that cheap energy supplied by fusion holds for agriculture. "Farming relies heavily on both electrical and gasoline energy both directly and indirectly, she noted. And fusion will provide tons of low-cost electricity as well as help in the mass production of hydrogen," the Washington paper reported.

A sampling of the press coverage of Levitt's press conference in Monterrey.

FEF Director Levitt Addresses Economists' Meeting in Mexico

"Carter will drive the U.S. to a collapse. Dr. Levitt, on the other hand, recommends policy changes." *El Sol de Mexico,* one of the country's leading dailies, thus headlined its coverage of a press conference held by FEF executive director Dr. Morris Levitt in Monterrey, Mexico Oct. 28. *El Sol* and other national and regional newspapers highlighted Levitt's prognosis that unless Carter's economic policies are reversed, the U.S. economic collapse will deepen and "will inevitably sweep Mexico."

Levitt was in Monterrey, a city in Nuevo León (the northeastern state of Mexico that borders Texas), to address the Economists Association of Monterrey on the LaRouche-Riemann econometric model. His trip followed a highly successful seminar on the model and its application to Mexican planning cosponsored by the FEF and the Mexican Association for Fusion Energy (AMEF) in Mexico City in September. The Monterrey economics seminar was attended by private-sector economists, chief economists for many of the state's industrial firms, and government officials. The economists expressed their frustration with conventional econometric models of the Wharton School type and were extremely interested in the thermodynamic approach pioneered by the LaRouche-Riemann model.

Levitt also was the principal speaker at a two-day conference on nuclear power and the universities sponsored by the engineering faculty of the state university of Nuevo León.

In addition to promoting interest in the model and its applications for Mexico's development, the forums cosponsored by the AMEF and FEF are playing a very important historical role in pointing out the potential—and necessity—for collaboration between Mexico's state and private sectors. Such collaboration, a prerequisite for Mexican industrial development, has been stifled by a long history of conflict between the two sectors dating back to the 1910 Mexican Revolution, a conflict that has been fanned by interests hostile to Mexico's industrialization.

FEF Conferences Present Program for Reindustrialization

Programs featuring fusion, high technology, and the LaRouche-Riemann model have continued to draw large audiences to the series of conferences on reindustrialization policy sponsored by the Fusion Energy Foundation this fall.

The Nov. 5 Pittsburgh conference featured a presentation on the LaRouche-Riemann model and its theoretical basis in hydro-thermodynamic concepts by Carol White, author of *Energy Potential* and *The New Dark Ages Conspiracy.* The second book tells the story of the British oligarchy's efforts to suppress technological development over the last several centuries.

White's point that subjective, political decisions, not merely objective criteria, determine economic events and must be taken into account in any econometric model sparked interested response from the audience, drawn mostly from the city's industrial firms.

Other presentations were given by Dr. William D. Jackson, director of the U.S. magnetohydrodynamics program between 1974 and 1979; FEF industrial research director Marsha Freeman, who presented a program for revitalizing the nation's steel and coal industries; and FEF regional representative Steve Douglas, who spoke on the stalled Lake Erie-Ohio Waterway Project.

Other conferences have been held in Los Angeles, Chicago, and Boston. The Oct. 15 Los Angeles conference featured presentations by pioneer fusion scientist Dr. Friedwardt Winterberg; Dr. N.W. Snyder, the designer of Parson Engineering Company's North American Water and Power Alliance plan; and FEF research director Uwe Parpart. The Chicage conference was addressed by Dr. Robert Moon, professor emeritus of the University of Chicago; Charles B. Stevens, FEF director of fusion engineering;

David Diehl, former head of the Michigan Corn Growers Association; Ron Thilen, president of the Illinois Conference of Cement Masons and Plasterers; and Criton Zoakos, editor-in-chief of the *Executive Intelligence Review*.

The Oct. 30 conference in Newton, Mass. was opened by State Rep. Thomas Norton (D-Fall River), chairman of the Energy Committee of the State House of Representatives. Presentations were given by Dr. Bruce Montgomery, associate director of the MIT Plasma Fusion Center for Engineering Studies, and David Goldman, economics editor of the *Executive Intelligence Review*.

Overall, the presentations have excited audiences with their emphasis on reinvigorating the nation's strong scientific and technological traditions and their rejection of the prevailing austerity policies.

FEF in the News

The *Journal of Commerce*, Oct. 27
"Industry Cast As Key Figure in Fusion Energy Development," UPI release by LeRoy Pope

. . . Charles B. Stevens, an engineer for the Fusion Energy Foundation of New York, said the role of industry now must grow steadily and ultimately become paramount. . . . There are a dozen or more major American companies and numerous smaller firms already involved in fusion and, Mr. Stevens said, hundreds more now will be drawn in.

The more important contracts will go to high technology companies but, Mr. Stevens said, as the fusion movement advances it will generate a vast number of contracts for buildings, machinery, vehicles, site preparation and other more conventional work.

New York Times, Nov. 9
"The Case for Nuclear Energy" by Harriet King
[In the eastern Washington state area] Energy remain[s] the main employer for a highly paid and skilled nuclear workforce drawn from the adjoining cities of Richland, Pasco, and Kennewick—communities fervently pronuclear. *Fusion* magazine is sold in local supermarkets here, and Ralph Nader was jeered out of town recently.

Denver Post, Nov. 13
"Plan Aims at New U.S. Water Supply" by Jim Kirksey
A "grand design" to nearly double the amount of fresh water available for use in the United States by channeling runoff from Alaska and the Yukon Territory in Canada was outlined in Denver Wednesday night.

The plan is being espoused by the Fusion Energy Foundation as part of its overall scheme to rebuild the U.S. economy through the use of high technology, especially nuclear fusion.

Rocky Mountain News, (Denver) Nov. 13
"Return to Economics of Production Urged"
The United States needs a return to the old economics of production, the editor-in-chief of the *Executive Intelligence Review* said Wednesday at a press conference in the Brown Palace Hotel.

Criton Zoakos, in Denver for a conference cosponsored by the Fusion Energy Foundation to promote a fusion nuclear reactor program and a return to production economics, said that the election of Ronald Reagan as president means that the people have repudiated the economic policies of the Carter administration and its predecessors. . . .

FEF Membership News

A Membership Campaign for 1981

by Harley Schlanger

Harley Schlanger joined the staff at FEF headquarters in New York in October 1980 as director of membership. He was formerly the FEF coordinator in the Southeast. This column will be a regular feature of Fusion, *to keep FEF members up to date with overall activities and plans.*

* * *

In 1980 the Fusion Energy Foundation achieved one of its major goals with the signing into law of the Magnetic Fusion Energy Engineering Act of 1980. For six years, we have promoted fusion energy research as the key frontier technology required for global economic development. Leading the fight against the small, vocal, antinuclear minority in America who have threatened to impose on us a New Dark Age under the guise of "limited resources," we have demonstrated that we speak for the interests of the majority, and that the majority can be mobilized when provided with strong leadership.

During this time, we have expanded as an organization, with nearly 14,000 members and 93,000 subscribers. Imagine what we can accomplish with 50,000 members!

This is our immediate target—a membership of 50,000, representing the most concerned, active, and informed citizens committed to restoring to our nation the idea of progress.

Goals for 1981

We are setting three goals for 1981:

(1) To promote credit and tax policies that stimulate productive investment and facilitate bringing new technologies on line. In particular, the United States must promote advanced research and development in nuclear, steel, and coal technologies, while encouraging a greater role for

Continued on page 54

An Open Letter to Fusion Readers and FEF Members

Science and the First Amendment: Who Is Trying to Silence the FEF?

Dr. Morris Levitt
Executive Director, FEF

There is an excellent chance that if you are reading this article, you were first introduced to *Fusion* and the Fusion Energy Foundation through one of our airport distributors. Recently there has been a systematic effort to reduce access by the FEF to the public at airports. This has occurred in conjunction with slanders against the FEF in newspapers that serve the communities near the airports, along with other forms of harassment. Because of the increasing intensity of these efforts and their harmful effects I am taking time out from my scientific and administrative duties to report to you the scope of the attacks on the FEF and who the culprits are, and to suggest a few remedial measures.

The typical form of recent newspaper articles has been to coyly ask readers something like "Do you know where the money you give the FEF at airports really ends up?" This is coupled to the theme that the FEF is deviously concealing its connection to a political figure, former Democratic presidential candidate Lyndon H. LaRouche, Jr. This alone would be onerous enough, even by today's corrupt journalistic standards, since Mr. LaRouche has been a frequent and well-known contributor to *Fusion* whose activities and role as an FEF founder have been straightforwardly noted in the magazine. But there is much more involved.

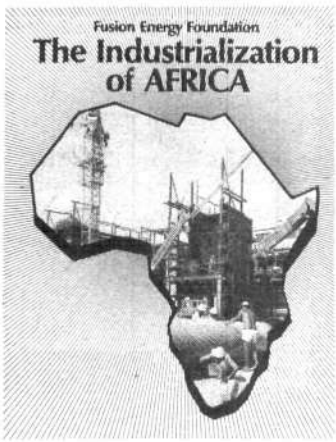
Let us go right to the heart of the matter so that the record can be set straight once and for all. We at the FEF find ourselves confronted with pure and simple *McCarthyism;* its form has been slightly updated to fit the degenerate journalistic and political mores of the 1970s.

Our story begins with two telltale slanders against the FEF. The first appeared in the March 30, 1979 issue of William F. Buckley's allegedly conservative magazine, the *National Review.* Therein, writer Gregory Rose made the outrageously lying charge that money contributed to the FEF ended up in such places as the "Palestine Liberation Organization." The reason for this scurrilous lie was clear from Rose's location of his witting fabrication right next to extensive moaning and groaning that *the FEF had just been granted tax-exempt status* by the Internal Revenue Service. So slander number one came from the "right" at the time of the first indications of FEF financial and organizing success.

At about the same time a somewhat milder but similar piece of sniping against the FEF emanated from another quarter, the ostensibly more respectable pages of *Business Week.* The latter, it should be noted, has recently become a leading advocate of the sunset policy of phasing out U.S. heavy industry, including nuclear.

Target: LaRouche

I shall return to the case of Mr. Buckley and Mr. Rose in a moment. Suffice it to say here that in addition to the FEF, their target was Mr. LaRouche, the noted economist who is credited as one of the principal intellectual authors of the European Monetary System. The ongoing slanders against Mr. LaRouche would make Joseph Goebbels blush with embarrassment, and that brings us to principal source number two.



FEF's programs to develop the Mideast, Africa, India, and Mexico have drawn fire from a small antiprogress faction.

Throughout 1980 a multipart series of slanders against Mr. LaRouche appeared in the New York City neighborhood weekly "giveaway" newspaper called *Our Town.* The author, Dennis King, libelously defamed Mr. LaRouche as a "Neo-Nazi" and extended the smear of antisemitism to include the FEF, whose pronuclear fund-raising activities were again given extensive attention. Mr. LaRouche has filed a $20 million libel suit against *Our Town* and was recently granted an award by a French court in a similar action against the *International Herald Tribune* (a daily

controlled by the *New York Times* and the *Washington Post*), which had repeated some of these *Our Town* slanders.

Before looking inside the slander network behind these operations, two more recent articles should be cited to complete the general picture. *Hustler* magazine, the pornographic publication of Larry Flynt, printed a slander in November modeled on the *Our Town* series that labeled Mr. LaRouche as a right winger. Meanwhile the more respectable *Energy Daily*, edited by Llewellyn King, and the newsletter of a group called Americans for Nuclear Energy each printed items that exactly contradict the *Hustler-Our Town* slanders by rehashing the *National Review* lies that the FEF was "pinko" or "Soviet-connected."

With these various hardcore pieces in circulation, "softer," but more pervasive, locally generated articles began to appear in conjunction with political harassment of the FEF airport distribution operations.

Lowest Common Denominator

What is the common denominator in this fabric of lies and deployments against the FEF?

The answer is that these slanders are authored and conduited by the lowest forms of extremist politics and organized crime in our nation. This is the political and crime combine in the United States whose overall policy is *drugs and deindustrialization.*

What I present below are the leading evidentiary items from a massive investigative dossier that I commissioned by private investigative and law-enforcement specialists. The challenge to the reader is to conceptualize—as we have done—how the key pieces fit together into a coherent and unique pattern:

(1) The controller of *Our Town* is attorney Roy Cohn. Yes, this is the same Roy Cohn who was the principal witchhunter and hatchet-man for the late Senator Joe McCarthy. Since that time, Cohn has been the top lawyer for the biggest drug-running mobs in America (including the Bonnano gang and New York's Studio 54 disco) as well as a key figure in the Anglo-Canadian Permindex Corporation. The latter entity was named by the French government as being behind the numerous assassination attempts on General deGaulle and by former New Orleans district attorney Jim Garrison as being involved in the John F. Kennedy assassination.

The publisher of *Our Town*, Ed Kayatt, is a *convicted* swindler. His author, Dennis King, was arrested in October for illegally selling plagiarized term papers to New York college students. Furthermore, it has been admitted (on tape) by writers Howard Blum and Paul Montgomery of the antinuclear *New York Times* that the *Times* conceived the entire slander project, which was then conduited through the neighborhood weekly *Our Town*.

This particularly dirty form of antisemitic "black propaganda" was undoubtedly conceived in part to counter the coordinated efforts by Mr. LaRouche and the FEF to present an economic development plan for the Mideast that would be the basis for peace and security for all parties in the region. Obviously, our adversaries have preferred chaos and Khomeini-style "Dark Ages" regimes.

(2) The nominally conservative *National Review* editor William F. Buckley is a leading public advocate of decriminalizing drugs and of removing criminal penalties for sexual abuse of children in the schools. Immediately after penning his slander, Buckley's author Gregory Rose went to work for ultraliberal congresswoman Bella Abzug and became a featured writer for the *Daily World*, the newspaper of the Communist Party USA. FBI documents made available to us officially characterize other of Rose's McCarthyite smear efforts as nothing but lies and fabrications.

(3) *Hustler* magazine not only is pornographic, but also is a leading news outlet for the dope lobby. It is one of the locations through which the thorough investigator can begin to trace out the connections between

Wide World

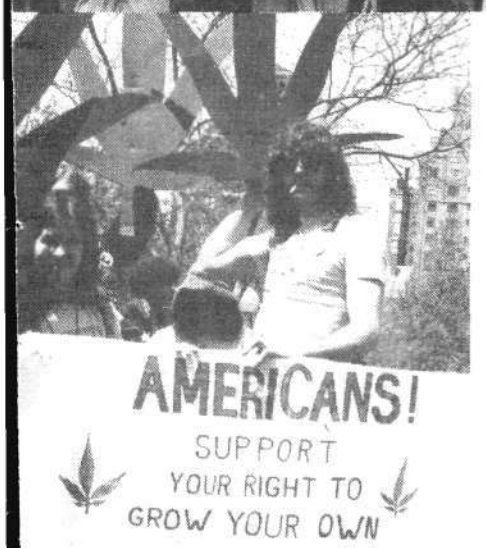
the drug mob and antinuclear terrorism (most prominently involving the so-called Yippies). *Hustler* is closely connected to the major drug decriminalization lobby, NORML, as are *Playboy*, William F. Buckley, and Roy Cohn. In fact, the author of the *Hustler* slander, Michael Chance, is on the editorial board of the leading pothead publication, *High Times*. (You can see Chance every Wednesday night on New York City cable channel D at 10:30 P.M. advising drug smugglers on the safest routes into the country as well as the going market rates for marijuana, hashish, cocaine, etc.)

(4) The Americans for Nuclear Energy is a creation of Georgia Congressman Larry McDonald, also known as an ultraconservative. McDonald's staff, though, featured John and Louise Rees, individuals still connected to the ultraliberal Institute for Policy Studies (IPS), a hotbed of antinuclear, antiindustry, and environmentalist activism. The IPS is most notably a major linkage point for the likes of Philip Agee, the former CIA agent who, since he became radicalized, has been responsible for blowing all sorts of U.S. intelligence capabilities. Strange connections indeed!

But Mr. McDonald is, after all, the top congressional associate of the Heritage Foundation. Nominally conservative, this foundation is simultaneously a principal source of slanders against the FEF and a directly British-controlled vehicle for leading U.S. in-

Philip Ulanowsky/NSIPS

A young Roy Cohn in his first McCarthy role and his current grass roots helpers, the Hare Krishnas and the pot lobby.



Linda Ray/NSIPS

dustry into the quagmire of Mrs. Thatcher's brand of deindustrialization economics. Furthermore, the pronuclear McDonald is one of only seven congressmen to have voted against the McCormack fusion bill.

This network attacking the FEF represents the constellation of forces that have been wrecking the United States strategically, economically, and morally. Most of them, like Buckley and Cohn, don't even bother to wear a thin political veneer any more. They are the drug and deindustrialization lobby. They have gone after the FEF just as they have gone after the nation's best business, scientific, and political figures over the last 30 years.

In actuality however, this grouping is just a tiny minority with no real political base except the drug-drenched Yippie types and the corrupt elements of the press. They continue to poison our national life only because their tactics and their threats of blackmail are tolerated. Now that the country has returned a clear mandate for change in the presidential election, this antiprogress minority must be deprived of its capabilities to obstruct the policies the nation needs.

Admittedly, the antiscience mob has certain assets at its disposal, which we have seen in action against us at various airports. Their operations have ranged from forcing our distributors to be located at tables together with members of the Hare Krishna cult (indicted in many places for drug-running and illegal possession of arms) to attempts to have us removed altogether. In many places we can identify who is directly running these deployments. For example, in Chicago it's the political machine of Mayor Jane Byrne; in Washington, D.C., it's Carter-controlled bureaucrats in the Federal Aviation Administration; in Atlanta, it's the drug-connected Emprise concession.

Everywhere, of course, we find the corrupted antinuclear press, ever ready to print exactly the same canned slanders they receive as if they were the result of original investigative reporting. This has then created the climate for the more overt moves to displace the FEF or reduce our visibility at the affected airports.

Agenda for Action

That brings us to our agenda for action against this pernicious operation. We have been attacked because we are acting effectively in the interest of the nation. We have helped catalyze a renewed commitment to progress, we have had a substantial victory with the McCormack fusion bill, and we are the fastest growing scientific organization in the country. Now let's see what kind of stuff we're really made of.

To clear the way for the great positive work of reindustrialization and science over the coming years we must get rid of the last obstacle to renewed progress in our nation: the wrecking crew I have named above. I call on you as a reader, friend, or supporter to join with us and act for yourself and the nation. Here's what you can do:

(1) Put pressure on airport officials to provide us with adequate sales locations, free from harassment.

(2) Help us to obtain full, high-quality legal assistance to combat the slander and harassment operations.

(3) Circulate this open letter.

All of these activities will be coordinated with a mobilization of FEF members in each region.

Most important, now is the time to move the country ahead. Getting rid of drugs, McCarthyism, and Malthusianism is simply the precondition for the proper conduct of the nation's affairs. It is time to restore the dignity of the First Amendment as the proper safeguard of our Constitutional republican purpose: to continuously perfect our own nation and the world through unrestricted scientific and economic progress.

Membership News

Continued from page 50

private industry in the development of commercial fusion and other advanced technologies. The government must also establish a national water policy.

(2) To repeal the National Environmental Protection Act, the legislation that established the Environmental Protection Agency. This will unshackle the nuclear industry domestically, allowing us to export nuclear technology. Repeal of the EPA will have the immediate effect of permitting full utilization of our coal-burning capacity, while enabling the longer-term implementation of new, more energy-efficient and environmentally safe technologies such as MHD.

(3) To put science back into the classrooms, from the elementary-school level to graduate programs. The collapse of education is one of the most serious threats to our nation's survival. Without a firm national commitment to reverse this, a future of drugs and cults will destroy our most precious resource, the minds of our youth.

These policies will not be adopted without a fight. Help us represent your interests. By joining the Fusion Energy Foundation, you can make sure that your concerns for the future will be voiced and that your voice will be heard. Members not only supply financial support for FEF educational activities in magazines, television, and conferences, but also play an active role in spreading our ideas.

I will be providing monthly updates in this column to keep you abreast of our progress toward achieving these goals. I will also provide reports on membership activity. If you have any questions, suggestions, or information that you would like to share, please write to me or call (212) 265-3749.

Now is the time to take the offensive. Stand up for America—join the FEF!

Carlos de Hoyos

FEF Membership Director Harley Schlanger

The Young Scientist

Makes Its Debut

The Young Scientist made its debut at a New Jersey Education Association conference in Atlantic City in mid-November. Here, Patricia Van Thof, *Fusion's* advertising manager, displays the magazine at the FEF exhibit booth. The exhibit, which included a mini slide show on *The Young Scientist*, met a good reception, especially from science teachers who want to include the magazine in their curriculum.

Carlos de Hoyos

Teller: We can build a fusion-fission hybrid in 10 years. Joseph Cohen/Energi

Teller: Hybrid Breeder Fastest Route to Fusion

In recent interviews, Dr. Edward Teller strongly recommended that the fusion-fission hybrid breeder reactor be pursued vigorously as the fastest route to achieving fusion energy.

Quoted in the Oct. 13 *Aviation Week and Space Technology*, Teller said: "The fusion-fission hybrid has been discussed in the last couple of years with increasing frequency, but it has not yet been elevated to the dignity of a project. It could be realized in 10 years in an economic fashion, using elements which are practically in hand today."

In an interview with the Swedish magazine *Energi och Utveckling* (*Energy and Development*), Teller elaborated:

"Now, the McCormack bill for fusion energy is the most exciting possibility, and $20 billion for 20 years is approximately the amount that is needed to make it practical. I have said from 1950 onward that we can have fusion no sooner than the year 2000, and the McCormack bill may make it possible, provided you add a lot of luck. . . .

"But we already have a plan which I think we can complete in 10 years, and which is much more sure. That is the fusion-fission hybrid. You start inside a long pipe with fusion, surround it with uranium—not critical. Altogether, you will probably get no energy, just enough to keep the machine running and very little extra. But you can make fuel for fission reactors, cheap enough for the whole world for thousands of years.

"At the same time, if we build these hybrids, we run into some of the engineering problems for the pure fusion reactor and we can learn whether and how we can make cheap fusion reactors. The hybrid has a double purpose. It is a source of fuel for fission reactors and it is practice for fusion reactors, practice in an economical reactor that does not need more government money to feed it."

Teller told the *Energi* interviewer that he did not like to be called the father of the hydrogen bomb because "I don't like the situation where my son has to say 'the hydrogen bomb is my kid brother.' "

* * *

Laser Focus Off Target On Beam Weapons

The October issue of *Laser Focus* in the "Comment" page disparages serious consideration of so-called directed energy weapons—laser and particle beams. Using the spurious argument for nonproliferation, *Laser Focus* takes a laissez faire attitude toward progress in science, ignoring the fact that a superpower science race does not necessarily lead to an arms race.

The latest round in the beam weapons debate goes back to the summer 1980 *Aviation Week*, which published extensive features by military editor Clarence Robinson concluding that the potential for deploying these weapons is far from negligible. Their use in antiballistic missile defense systems would have a profound strategic effect.

One source close to the dispute pointed out that *Laser Focus* is acting on behalf of Defense Secretary Harold Brown, branding warnings about Soviet development of beam weapons as "specious arguments," and attributing much of the stir to the "Lockheed gang of four" who recommended U.S. development of beam weapons.

However, after the Lockheed group testified before a Senate committee earlier this year, the Defense Advanced Research Projects Agency (DARPA) independently confirmed their projections. Also, a well-publicized critique showing that these weapons would be unfeasible, written by Dr. Richard Garwin of IBM and Dr. Costa Tsipis and his colleagues at the Massachusetts Institute of Technology, has been completely refuted by analysts in the Department of Defense.

Nevertheless, *Laser Focus* catalogues the "technical obstacles" to deployment of laser weapons, concluding:

"Directed-beam technology clearly deserves military attention. At some point in their evolution, these two technologies—laser and particle beam—will be considered for accelerated development, and later perhaps for deployment in weapons. Such consideration should also take into account any impact on arms control, and on other weapon systems such as the MX missile, for which a production decision is still three years off. . . .

"What's not needed is premature heating up of the discussion by economic and political advocates. That would perform a profound disservice to the laser community and possibly to the entire noncommunist world."

As for what will happen if the Soviets deploy beam weapons that we

do not have, *Laser Focus* has nothing to say except that we'll "shoot them down."

The danger of this approach is that U.S. technological superiority has dramatically eroded in recent years. The question at stake is not arms race *per se*, but whether American research and development personnel should be heavily deployed into frontier areas whose implications far outstrip narrow considerations of whether a deployable weapons system will emerge.

Early indications from research in beam transport are that a new realm of previously unsuspected self-organizing phenomena are accessed in the highly energy dense regimes found in these devices. That the understanding and control of these phenomena would have profound consequences in many areas, including controlled thermonuclear fusion research, should go without saying.

America's strength lies in developing its technological capabilities, both military and civilian, *in depth*, not in the pursuit of one or another *wunderwaffen*, that may for the moment seem to solve the strategic problems. Apart from the question of technological feasibility, there has to be serious discussion about strategic issues, including the whole question of ABM systems.

* * *

Business Week Pans Hi Tech Investment

Business Week's Nov. 10 cover story seems to be geared to discourage investment in small high-technology firms that are beginning to enter the market in a strength that has not been seen in years. The real whopper is that the article characterizes as high-tech investment areas only genetic engineering and computers.

What's particularly galling is that the article appears a month after the McCormack fusion bill was signed into law, giving national priority to achieving commercial fusion by the year 2000. There are going to be a lot of new companies moving in to develop cryogenics, special materials, and many other products to support this program.

Where has *Business Week* been?

John Schoonover

* * *

Science 80: Supporting the Luddites?

"The Bittersweet Harvest," an article in the Nov. 1980 issue of *Science 80* magazine, reports on a court case in California where the California Rural Legal Assistance group, a federal program, is suing the University of California for misuse of federal funds. The misuse?: research work on the mechanization of agriculture.

It's not bad enough that the American Association for the Advancement of Science, publisher of *Science 80*, states that it is not the role of the government to enhance man's continued mastery over nature—scientific progress. A Superior Court judge in Alameda County has ruled that the university must stand trial on the charge that it has unlawfully subsidized the development of labor-saving agricultural machines that benefit private agricultural concerns.

The U82 Tomato

The major case cited in the article is the U82 tomato, and the highly mechanized tomato-harvesting machine. The U82 tomato, developed by the University of California, has been genetically engineered to be used in conjunction with the tomato harvesting machine. The tomatoes are tough enough to resist harsh treatment, separate easily from the stem, have a square shape (so they don't role down the conveyer belt of the harvester), and all ripen approximately at the same time—all in all an amazing genetic engineering feat.

Eighteen to twenty-four harvesting machines can pick up to 25 tons of processing tomatoes in one hour.

The *Science 80* article makes the argument that an increase in technological improvements results in an increase in the rate of unemployment. This argument is as ridiculous as it is ancient. The ability of a society to constantly uplift its members culturally and economically is based on the replacement of stoop labor (i.e., migrant farm labor), with more productive high-technology jobs. That's how the U.S. workforce has gone from 94 percent of the population being engaged in agriculture during the time of the American Revolution, to 4 percent in 1980.

At the same time, productive employment and the standard of living have increased manyfold. And that is just what the U.S. Constitution explicitly calls for!

The article also asserts that the tremendous increase in productivity because of mechanization does not necessarily mean lower prices for the consumer. This is of course absurd. Can you imagine what the labor costs would be to the farmer? How many farm workers would be required to equal the output of machinery that can consistently harvest more than a ton of tomatoes per hour?

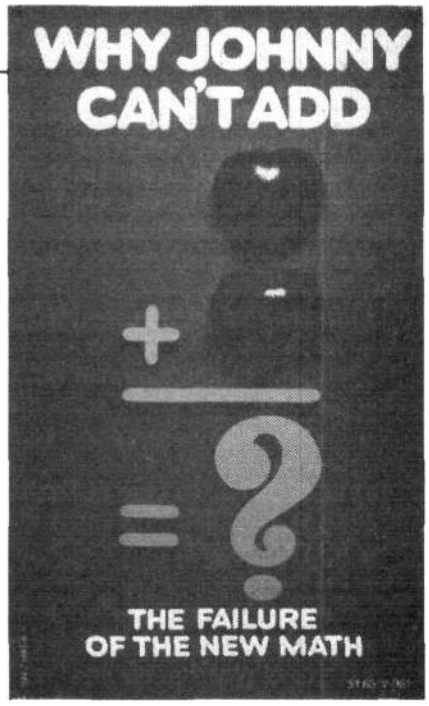
The trial against the University of California will begin in 1981. Although no one can predict the outcome, one thing is for certain. If science and technology are convicted of the crime of abolishing stoop labor, a very dangerous anti-Constitutional precedent will be set.

This item was contributed by Jerry L. Steering.

The Right Way to Teach Math

by Carol White

Why Johnny Can't Add: The Failure of the New Math
by Morris Kline
New York: Vintage Books, 1974
(paperback), $1.65



Recently I was pleased to come across *Why Johnny Can't Add*, a book written by Morris Kline in 1973. It brought back to me the days when I studied with Professor Kline at the Courant Institute at New York University in just such a program as he recommends in the book.

I believe that the Courant Institute was the only place in the country where a graduate mathematics department undertook to run the National Science Foundation's master's degree fellowship program for high school mathematics teachers. Although the institute's founder, Richard Courant, was no longer active when I attended in the late 1960s, his spirit nonetheless was still pervasive. And it comes through in Kline's book on the failure of the New Math.

The Courant Institute was modeled on the mathematics and science department at Göttingen University in Germany as it emerged in the 19th century under the leadership of Richard Courant's mentor, Felix Klein.

Felix Klein was the person most responsible for establishing the influence of Bernhard Riemann after his death. But Klein also concerned himself directly with the task of ensuring that Germany would have trained scientific and engineering cadre, by working with key industrial figures in Germany to foster coordinated government and industry support for mathematics and science education. He also intervened to ensure the highest level of mathematics and science training at the preuniversity level.

In Germany at that time, it was not unusual for fifth-grade teachers in the best schools to hold doctoral degrees. Mathematics and physics teachers in the academic high schools always held such degrees, and had been trained at universities such as Göttingen in the same program as future university professors. In fact, the program of future high school teachers was, if anything, more stringent. Those individuals who studied directly under Felix Klein were required to spend an extra year at the university, in which the focus of their training was teaching methods based on geometric constructions. Göttingen still has a hall filled with three-dimensional and higher-dimensional geometric models built by these students.

It is to this tradition that Morris Kline refers when he demands that high school and elementary mathematics instruction be developed around the process of construction rather than trapped in the *rigor mortis* of Euclidean proof structure and its current elaboration in so-called set theory.

As Kline says, and as he taught, a student does not become a mathematician by learning highly polished and sophisticated proofs. It is precisely in replicating the false starts that accompany genuine discovery that a student in fact discovers his or her own creative ability. One of the best ways to teach mathematics is to reproduce as far as possible the actual process of discovery and evolution of mathematical ideas, because the problems that were faced historically are usually still the conceptual problems confronting a student who is striving to master the discipline.

When Kline's book was published in 1974, perhaps one of its best features was the list it contained of 75 qualified mathematicians who joined Kline in publicly attacking the New Math. With what a sigh of relief the typical, otherwise intimidated parent must have read the book and had his own intuition confirmed. The book is full of enough angry one-liners to lighten the heart of the most oppressed parent. My favorite runs: "They [New Math students] are asked to accept the closure axiom. In the case of two integers, for example, this reads: The sum of two integers is an integer. Were the students not properly forewarned by this axiom would they have thought that the sum of two integers is a cow?"

Kline's Continued Relevancy

The book's continuing relevancy is underlined by the findings of the President's Advisory Commission Report on Science and Engineering Education for the 1980s and Beyond. The authors of the report document that although high achievers in math and science survive New Math programs and perform with the same competence as students did under traditional curricula, the average student has fallen way behind. Also, the introduction of the New Math into elementary and high school curricula is probably in large part responsible for the number of students electing to drop math and science after the 10th grade.

Of course, the environment in schools where drugs are freely circulated is not conducive to the serious study of any subject. And the anti-

science anarchist ("do your own thing") ideology peddled in schools today by the environmentalist movement is equally malignant.

As the government report on science and engineering education is at pains to repeat: this situation cannot be allowed to continue. Not only are children being prematurely shut out of career opportunities that require some technical competence and not only is the nation losing a valuable pool of skilled manpower and specialists, but a scientifically illiterate citizenry is not competent to make correct political decisions on industrial and defense policies.

The report issued by the President's Advisory Commission also points out a danger not foreseen by Kline. Many school boards under financial pressure have responded to the failures of the New Math by throwing out the baby with the bath water. There is now a dangerous tendency to eliminate math and science from the curricula entirely, except for the most rudimentary drill in calculation.

The recommendations of the President's Advisory Commission are excellent as far as they go. Like Morris Kline, the authors call for an intimate wedding of math and science curricula to developments in technology, both to expose students to future career possibilities and to awaken their excitement to the academic material. Unlike Kline, the authors only attack the New Math by implication, for its failure to educate the nonspecialist. Yet, it is quite clear that young American scientists and engineers currently have preeminence in spite of, not because of, the introduction of the New Math in the lower schools, which emphasizes abstract formalism in place of creative thinking and detaches mathematics from its roots in scientific application.

The one fault that I find with Kline's book is his tendency to treat in a pedestrian way the relationship of mathematics to science. It is true that mathematics is only a handmaiden of science, but not in the sense that Kline attaches to the statement. Science is not like an apple tree from which its fruit, technology, drops; it

is a horticultural system that continually creates and develops new trees. Science is the succession of new scientific theories from which technologies spring, a process Bernhard Riemann described as a nesting of higher-ordered manifolds.

How to Teach Math

Mathematics must be taught as mathematical physics, with students given the fullest acquaintanceship with modern technology as well as workshop construction. That is axiomatic.

But we can also teach the method of Riemannian geometry. The human mind works *projectively* by developing ordered series of conceptions, and then reflecting upon its own ordering process of concept formation. Geometry itself can be studied in precisely the way that Felix Klein elaborated in his *Erlangen Program.*

It is the relationship among geometries, projective and Euclidean, for example, as they are transformed into one another, that is the proper subject of *geometry.* If we are to carry through and enhance the work which Felix Klein began, it must be from this Riemannian standpoint.

Carol White, who taught math on the university level, is the author of Energy Potential: Toward a New Electromagnetic Field Theory *and* The New Dark Ages Conspiracy.

Books Received

The Energy Center. John F. Hemdal. Ann Arbor: Ann Arbor Science Publications, 1979. 239 pp., $37.50.

Science and the Cure of Disease. Efraim Racker. Princeton: Princeton University Press, 1979. 99 pp., $12.50.

Electricity in the 17th and 18th Centuries: A Study of Early Modern Physics. J.L. Heilbron. Berkeley: University of California Press, 1979. 500 pp., $42.50.

Population Malthus. Patricia James. Mass: Routledge and Kegan Paul Ltd., 1980. 461 pp., $43.50.

Reclaiming the West. Daniel Philip Wiener. New York: Inform, 1980. 379 pp., $75.

Sweden

Continued from page 20

Sweden, for example, and sell the Swedes power station equipment and raw materials such as natural gas.

Brezhnev's proposals appear to be bearing fruit. In late September, 60 leading Swedish businessmen—"the largest Swedish trade delegation to the Soviet Union since 1951," as the Swedish Press Agency pointed out—attended a meeting in Moscow of the Swedish-Soviet Joint Commission on economic, technical, and scientific cooperation.

There were two main items on the agenda: Swedish participation in the development of the raw materials-rich Timano-Pechora area east of the Urals, an area described as being "as big as all of Sweden." Swedish participation would encompass involvement in oil and gas, paper and pulp, and mineral development and involvement in everything "down to the last nail," according to Swedish industry minister Nils Aasling.

The second item under discussion was a Soviet offer to supply natural gas to Sweden via Finland. In return, the Soviets are seeking the help of Swedish industry in developing the natural gas fields and building the pipelines.

The Swedish press noted that a clause in the new 10-year trade agreement calls for "joint projects in third countries," and the newspaper *Sydsvenska Dagbladet* reported, "it has been hinted that this may be a reference to cooperation in building nuclear plants."

Swedish Industrialist Calls for 'Maximum Industrialization'

"The basis for global peace is the development of the entire developing sector. And here I am of course including literacy programs, higher education and medical and health care." Bengt Hokby, a leading spokesman for Swedish industry, made these comments in an interview featured in the Oct. 1980 issue of *Energi Och Utveckling* (*Energy and Development*), the publication of the FKU, a Swedish cothinker organization of the Fusion Energy Foundation.

Hokby is the president of HIAB-FOCO, one of the world's leading manufacturers of heavy hydraulic cranes. He is also the former chairman of the Swedish Association of Metalworking Industries and a board member of the Swedish Metal Trades Employers Association.

In the *Energi* interview, Hokby calls for the integration of Sweden into the European Community and the European Monetary System and the adoption of a national industrial policy based on "maximum industrialization" at home and the opening up of the vast markets in the Third World—a perspective that is now being discussed throughout Swedish business circles.

Hokby emphasizes the need to step up development credits to the Third World—using the vehicle of the EMS—to ensure the industrialization of those nations, markets for the advanced sector's products, and world peace. "There is no comparable alternative to the EMS," he concludes.

USDA Responds to African Famine:
Business As Usual

After reading in the Nov. 1980 Fusion about the emergency need for 3 million tons of U.S. grain to prevent 10 million Africans from starving to death, California readers Mr. and Mrs. Donald Nelson telegraphed President Carter urging him to take immediate action to send grain to Subsaharan Africa. They received a reply dated Oct. 31 from an official of the Foreign Agricultural Service of the U.S. Department of Agriculture explaining that the United States is carrying out its normal grain sales to Africa. Reprinted here is the text of the USDA reply:

Thank you for your cable of Oct. 17 urging release of 3 million tons of grain at parity prices from U.S. farmers for immediate shipment to Africa.

About 2 million tons of U.S. grain have been allocated for fiscal year 1981 for sale to African countries under the Public Law 480, Title I, program. Under Title I, the United States, through the Commodity Credit Corporation (CCC) finances the sale and exports of commodities, with the actual sales made by private U.S. suppliers to foreign importers, government agencies, or private trade entities. The commodities are then usually resold in the recipient countries (or used to build stocks), and the local currency proceeds are used by the recipient government or private trade entity (PTE) for the purposes specified in the sales agreement.

In addition, nearly 200,000 tons of grain are expected to be made available to several African countries during fiscal year 1981 under Title II of the Public Law 480 program. Title II encompasses all grants of agricultural commodities carried out by cooperating sponsors. These sponsors include friendly governments operating under bilateral agreements with the United States, nonprofit voluntary U.S. agencies such as CARE and CRS, international organizations such as UNICEF, and the World Food Program, a multilateral organization set up by the United Nations and the Food and Agriculture Organization (FAO). These grants support regular ongoing programs such as school feeding, maternal/child health programs, and food-for-work community development projects, as well as emergency disaster relief activities.

Glenn Samson for Donald J. Novotny
director, Grain and Feed Division, Commodity Programs

'Animal Rights' Advocates Target European Diet

European environmentalists celebrated a multinational victory in October when the agriculture ministers of the European Community nations agreed to place an across-the-board ban on the use of hormones in livestock raising. The decision, which has not yet been implemented, appears to go far beyond its U.S. precedent, the outlawing of use of the hormone DES (diethylstilbestrol) in livestock raising a year ago.

The EC action will cripple the growth of a capital-intensive livestock industry in Europe, making meat more costly and scarce in countries that do not yet come close to American nutrition standards. In fact, this is the explicit intention of one of the leading forces in the EC campaign, the Swiss-based "animal rights" movement, whose advocates have already succeeded in completely banning egg production by means of caged layers in Scandinavia, and are campaigning throughout Europe to ban the use of slatted floors in livestock production.

The flap in Europe began last summer when the media promoted a story concerning possible cancer-causing hormones in French veal exported to Italy as baby food. At the same time, Europe was flooded with stories of helpless calves being snatched from their mothers and raised inhumanely in an industrial fashion. Photos of calves tied in feed boxes filled the newspapers.

The Brussels-based Bureau of European Consumer Organizations and French consumer groups went into action, calling for a boycott of veal in early September, which caused a 50 percent drop in veal slaughter and sales within two weeks and rapidly spread to Britain.

On Sept. 23, weeks after Italy had banned the import of French veal, an Italian magistrate ordered a countrywide ban on the sale of veal, the staple meat of the Italian diet.

As in the case of the DES hoax in the United States, the facts of hormone use in livestock raising were distorted or ignored in the EC environmentalist campaign. DES—like many other hormone and antibiotic feed additives—has been used successfully for more than 20 years in the United States, its use guided by clear, scientifically based rules and regulations. These additives, by protecting the health of animals, are responsible for both a better quality of meat for consumption and more efficient and therefore cheaper production of animal protein. It is estimated, for instance, that DES has increased feed efficiency by 12 percent, and has saved about 7.7 billion pounds of feed a year in the United States.

The environmentalist propaganda in Europe emphasized that at least 80 percent of French veal is produced from cattle receiving hormone injections. This is true. And France produces fully half the veal consumed within the EC despite the fact that the country lacks an abundance of good grazing land—an accomplishment that results from the adoption of capital-intensive methods, including hormone additive use.

Obituary

M.A. Lavrentyev: 1900-1980

The Father of Siberian Science

Mikhail Alekseevich Lavrentyev, the father of Siberian science, died Oct. 15 at the age of 80. For more than 20 years, Lavrentyev led the scientific experiments that produced the outstanding record of Siberian science, technology, and economic development.

Lavrentyev was given the responsibility for planning and organizing the Siberian development effort by the Soviet Academy of Sciences in Moscow in 1957. At the time, the Soviet government adopted a policy statement to establish a Siberian branch of the Soviet Academy of Sciences in order to open up the vast Siberian territory—one-third of the entire Soviet Union—to raw material, industrial, and agricultural development.

For 35 years, beginning in 1935, Lavrentyev had directed a section at the Steklov Mathematical Institute of the Academy, where he became recognized as the head of the Soviet school of the theory of functions. He also did work in aerohydrodynamics.

After World War II Lavrentyev turned his attention to theoretical research in nonlinear waves, problems of instability, and space science. He obtained groundbreaking results in both theoretical and experimental work in shock waves from explosions.

As the founder, first settler, and permanent president of the Siberian branch of the Academy, Lavrentyev was responsible for 43 research institutes, but his major interest remained in wave theory. As the head of the Institute of Hydrodynamics, he continued his research in cumulative (directed) explosions. Under his guidance in 1973 a series of directed explosions moved 2.5 million tons of rock to form a dam to protect the Siberian city of Alma-Ata from impending mudslides.

Later, Andrei Deribas, one of his students, developed the method of explosion welding that proved to be the metal-forming technology that could withstand the severe Siberian winters. Directed explosions were also used to keep the frozen Siberian rivers navigable in the winter months.

These practical applications of explosive techniques required the most meticulus calculation of the hydrodynamic effect of the nonlinear waves produced by the blast, a field in which Lavrentyev pioneered.

In addition to making advances in hydrodynamics, Lavrentyev led the effort to create new cities, industries, and resources in Siberia. He leaves behind a legacy of the second largest branch of the Academy of Sciences where some of the most fundamental research in the Soviet Union is being done in hydrodynamics, plasma theory, and military research.

—*Marsha Freeman*

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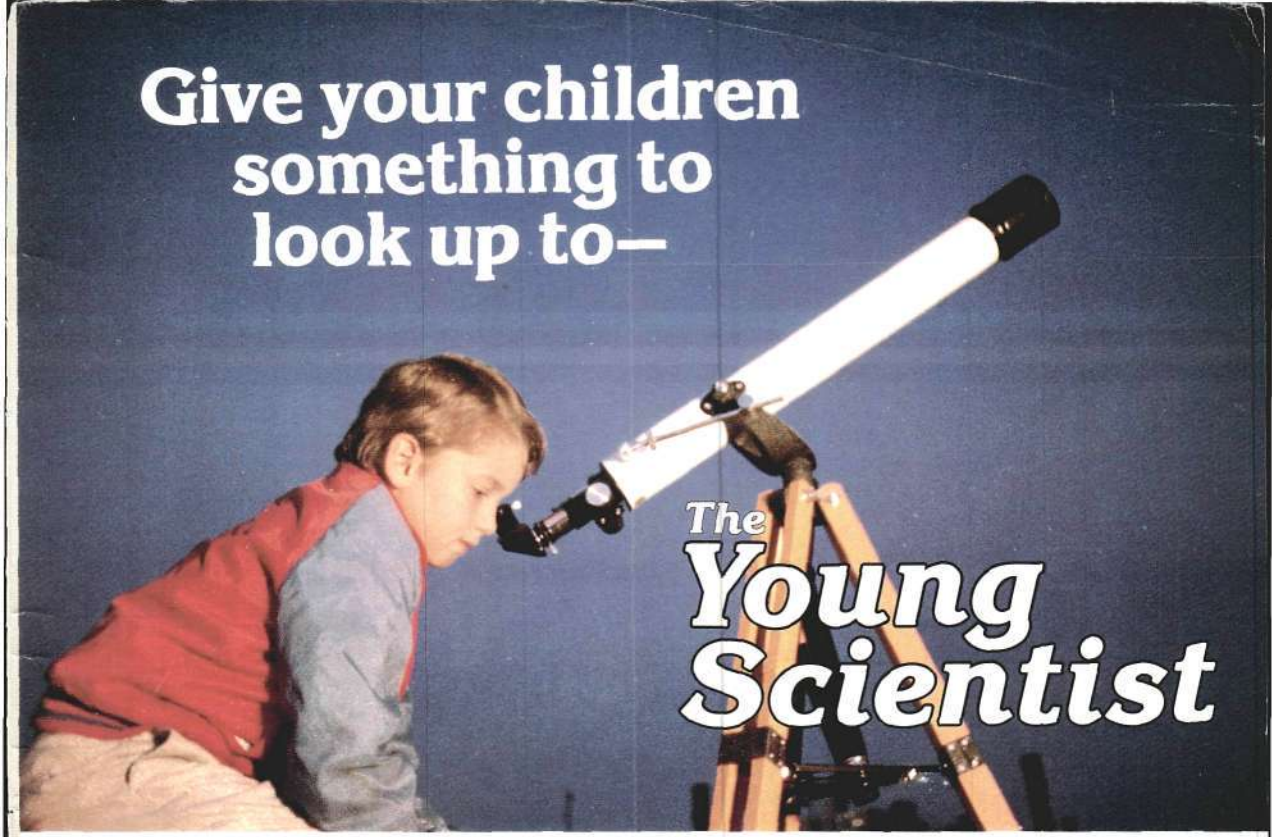

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Here's a sampling of what *The Young Scientist* covered in December:

- The tokamak: bringing the star power of fusion down to earth
- A tour through the Alabama Space and Rocket Center
- Experiments with magnetic fields and moving charges
- Trains without wheels
- An interview with Dr. Stephen Dean —how a fusion scientist got his start as a young man

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THE CHALLENGE OF THE SATURN RESULTS

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NASA

A dazzling view of Saturn and its myriad rings taken by Voyager 11 million miles away.

THE FEF AND THE FIRST AMENDMENT

While the majority of Americans cheer NASA on and support the development of nuclear power and advanced science, a tiny minority prefers drugs and austerity economics. Fusion Energy Foundation executive director Dr. Morris Levitt describes how this minority is using dirty tricks to force *Fusion* magazine out of the national airports and outlines what readers can do to change the situation.

The Fusion booth at the Houston airport.

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The cover: Front cover shows the magnetic field coil for use in Princeton's Tokamak Fusion Test Reactor in the process of winding at the East Pittsburgh, Pa. plant of the Westinghouse Electric Corp. Westinghouse is making 22 coils under a $5.5 million contract awarded by Ebasco Services, Inc. Photo courtesy of Westinghouse Electric Corp. Cover design by Christopher Sloan.