FUSION

MAGAZINE OF THE FUSION ENERGY FOUNDATION

July 1980

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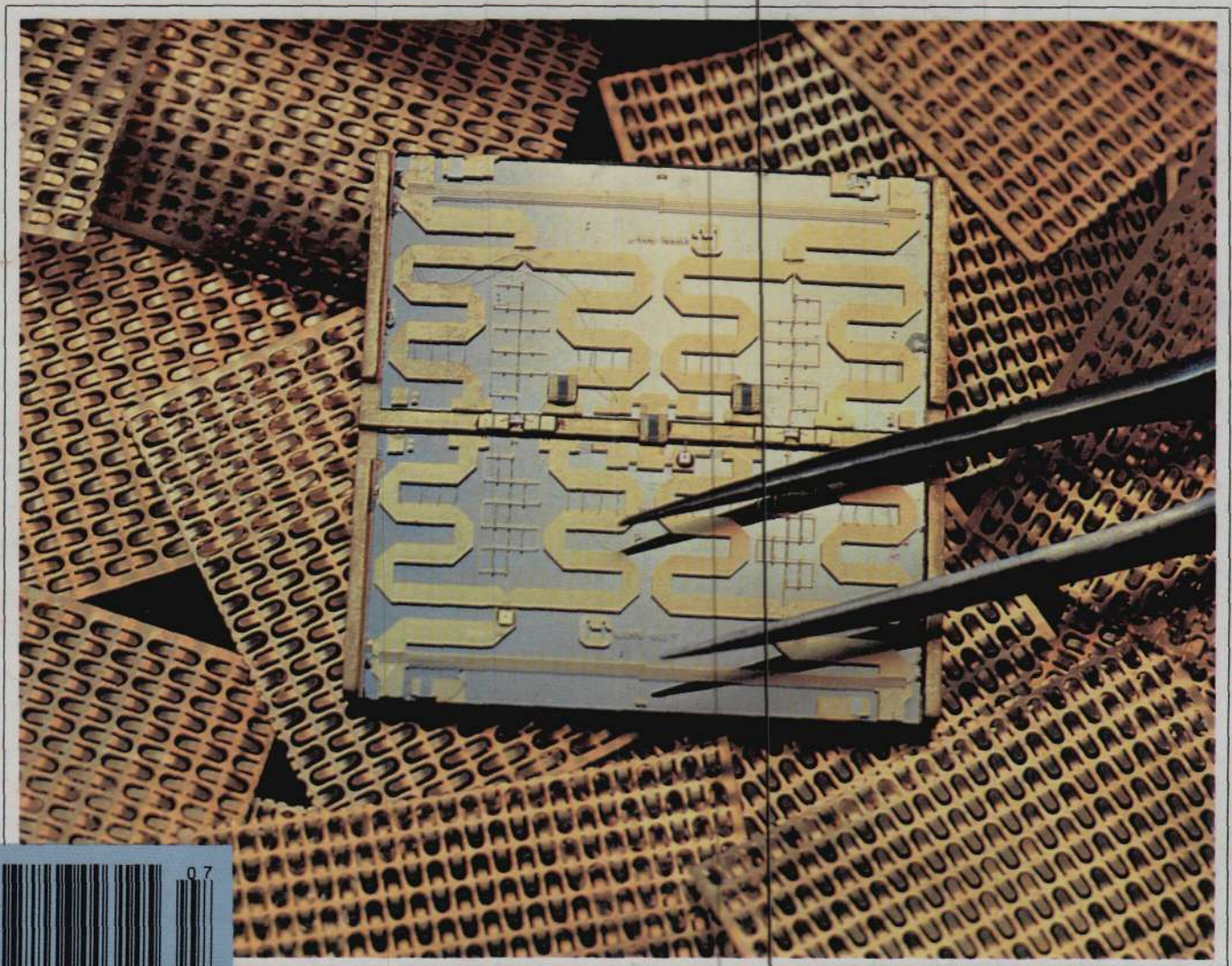
Special Feature
The Frontiers of Computer Science in the 1980s

Science and the Economy

It's Boom or Bust for Both



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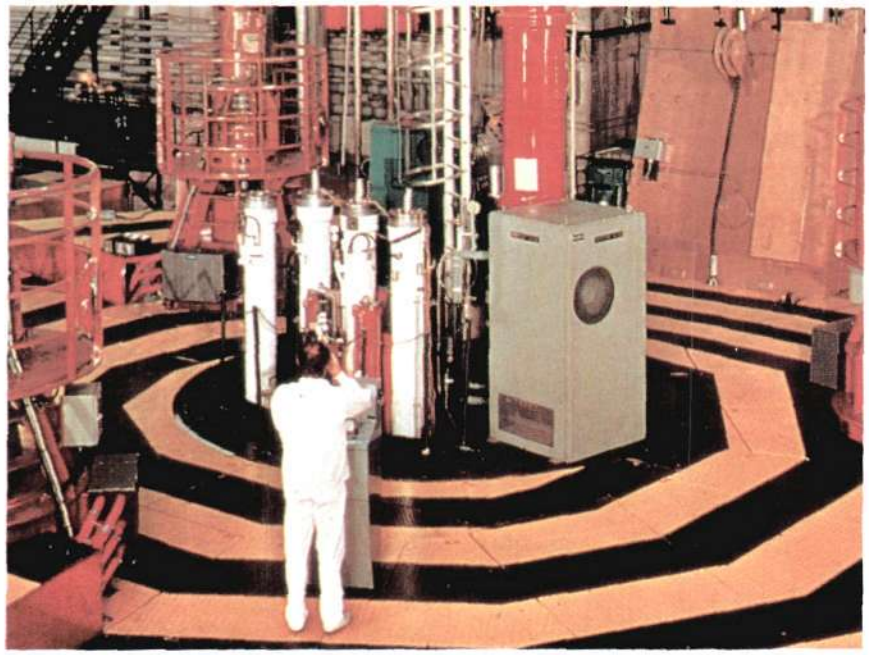
Coming in the next issue of

FUSION



France Takes the Nuclear Lead

France's bold program for nuclear development at home and abroad has centuries-old roots in the French tradition of state involvement in the promotion of science and industry. Next month's nuclear report reviews the scope of the current French program and its political history, including the story of how America lost an ally.

FUSION

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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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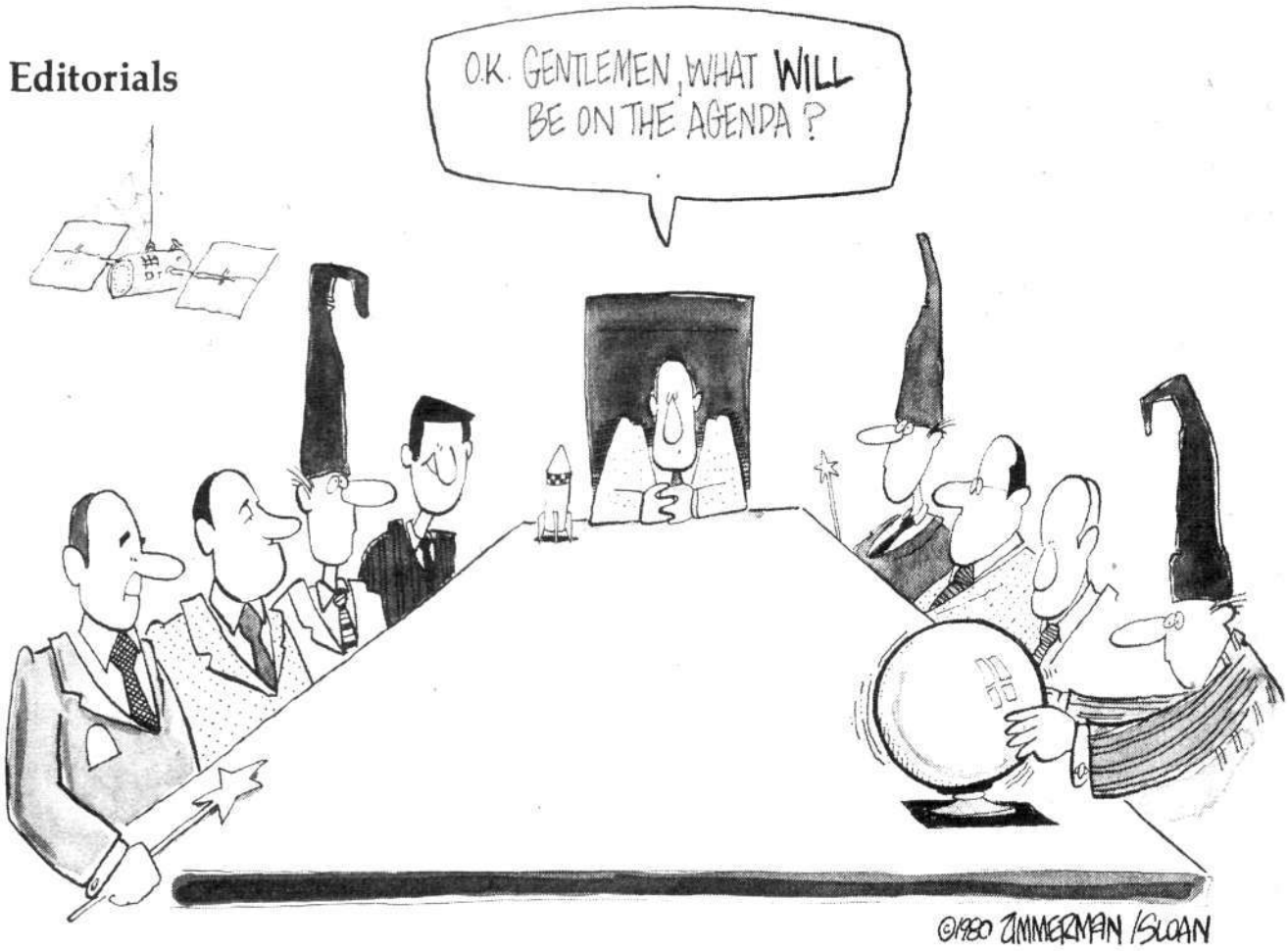
Notice to Subscribers

This issue, Vol. 3, No. 9, is dated July in order to meet the requirements of our new national newsstand distributor. Although there will not be an issue of *Fusion* dated June 1980, subscribers will receive 12 issues in this volume and no month will be skipped.

Features

News

Departments



Science Against Kookery

Back in October 1979 *Fusion* published one of its most widely discussed articles, a review of the New York Council on Foreign Relations' *1980s Project* that intends to bring on "controlled disintegration" of the U.S. and world economies. For many readers the article provided confirmation of the gut reaction that there was "something behind" the crazy energy and economic policies of the Carter administration.

We also stated editorially at that time that the deeper motivation for the attacks on science and industry was to bring on a New Dark Ages. Recent developments provide conclusive evidence of just how true that analysis is, and of the extent of the movement to destroy science and reason.

First, there is the objective situation. While Western Europe, particularly France, has been attempting to stabilize the world monetary and economic situation and improve East-West and North-South relations by expanded trade and technology transfer, the Carter administration's "incalculable" behavior (to use the term applied by many European governments) has now put the U.S. economy on the trajectory of *uncontrolled* disintegration. As we go to press, the disastrous consequences of 20 percent interest rates, nuclear shutdown, and foreign policy debacles are all too evident.

The Open Conspiracy

Second, there is new evidence of an open conspiracy to promote this disintegration. Amazingly, as the crisis deepens there are those who openly celebrate the "death of America"—a celebration that reveals the ultimate truth about the present situation: The United States is being destroyed by an open

conspiracy to bring on what the conspirators call a new "Aquarian Age" of kooks and mystics.

As reports in this issue document, the White House itself has increasingly become a mere instrumentality of the Club of Rome and similar feudalist groupings for the transformation to a new era of unbridled kookery. Already, it is claimed, 10 million former citizens are now active members of one or another variety of cultist activity. Every center of science and industry has been saturated with Aquarian ideology; even the U.S. military high command is having sensitivity sessions!

This madness will end only if enough Americans loudly and publicly say *"No!" to the New Dark Ages and demonstrate enough political muscle to back* it up. And we'll get this muscle by using the most vital weapon we have in the fight to preserve the nation and to save science—scientific economics, a discipline that actually grasps the processes by which humanity improves its productive powers and realizes its moral purpose.

This issue continues the discussion of the Riemann-LaRouche economic model, which the FEF staff has developed from this standpoint, and shows the model's relationship to other frontier areas of science as well as computing technology. These investigations not only are vital for technological and economic progress, but also help to illuminate how the world really works.

Negentropy

Contrary to kooks and miseducated scholars alike, the universe and humanity were not created in a "Big Bang," nor were they created by a series of unfathomable random mutations. The universe is characterized by the *negentropic* process of development of new qualities of organization of matter and energy. These are demonstrated in the self-organizing properties of plasmas as well as in the way man purposefully alters the thermohydrodynamics of the complex "heat engine" that is the global economy. There is no law of entropy governing the universe because laws, particles, or forms of energy are not fixed.

However, there is a lawful process of the nonlinear evolution of lawfulness. The universe is neither fixed nor lawless. Man in his full Reason is neither a clever talking beast nor a raving mystical psychotic. A human economy is not a manual-labor work camp, a kook's commune, nor a self-cannibalizing war machine.

As our Founding Fathers defined it, the American economy is the vehicle for the realization of productive innovations that emanate from the creative capacities of the human mind. Man guides the ongoing process of lawful creation *and, in that sense, is made in the image of his creator.*

In a nutshell, this view distinguishes a true scientific and religious outlook from pagan cultism. A moral science is our last, best hope against the enemies of progress who have declared war on the republic and on civilization itself.

Calendar

June

5-7
Seminar on Nuclear Energy
New Jersey Conference of Mayors
Boardwalk Regency Hotel,
Atlantic City, N.J.
Featured speaker June 5, Jon Gilbertson, director of Nuclear Engineering for the FEF

16-20
7th Int'l Conference on MHD Electrical Power Generation
UNESCO, IAEA
Cambridge, Mass.

23-26
3rd World Hydrogen Energy Conference
International Association for Hydrogen Energy
Hydrogen Energy System Society of Japan
Tokyo, Japan

July

1-10
8th Int'l Conference on Plasma Physics and Controlled Nuclear Fusion Research
IAEA
Brussels, Belgium

15-18
1980 Annual Conference on Nuclear and Space Radiation Effects
IEEE, DOD, NASA, Defense Nuclear Agency
Ithaca, New York

The Lightning Rod

My dear friends,

An epidemic of April Foolishness has broken out since the anniversary of the "media meltdown" at the Three Mile Island plant. Indeed, it is difficult to walk about without being assailed by some streetcorner soothsayer babbling that the cows, pigs, chickens, grass, drinking water—not to mention the entirety of the earth's atmosphere in the vicinity of central Pennsylvania—have all been abominably contaminated by radioactive waste from the offending nuclear facility. On the nightly news programs, we are informed that the local populace is in a four-alarm panic, rushing from one demonstration to the next, in a heartbreaking effort to convince the nation that nuclear energy is the work of the Devil and that nothing less than a mass exorcism of the Three Mile Island plant will suffice to remedy the situation.

A particularly nasty tale given prominence in the public press was a report that newborn infant deaths had soared by some 50 percent within a

Continued on page 4

Letters

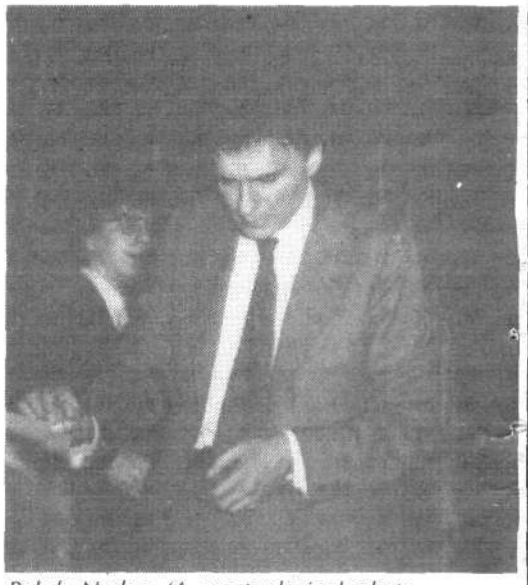
Speaking Up Against Nader

To the Editor:

Ralph Nader came to the University of Alabama in Huntsville April 3. His topic for the night was "Nuclear Energy" or, more precisely, the ending of nuclear power. Nader laid out a vague plan for passive solar heating, solar water heating, and the use of photovoltaic cells for the production of electricity. He never quoted a price for this conversion or told the audience what to do during an extended period of cloudy days.

Nader went to great lengths to point out the problems of nuclear waste, human error, and even the possibility of sabotage. But he failed to point out any flaws, general or specific, with the technology of producing power by nuclear fission.

Concerning radiation, Nader managed to bend the facts. He mentioned that a nuclear worker was allowed 5 rems a year exposure. But of a coal-fired plant that is putting out traces of radioactive elements and poisonous heavy metals he said, "We're always looking at low-level emission gradually. . . ."



Ralph Nader: 'A nontechnical obstacle to innovation,' April 3, 1980

Fortunately, as a *Fusion* reader I knew of the FEF and they helped me present the pronuclear side. On the local level I organized the whole thing,

LIGHTNING ROD

Continued from page 3

10-mile radius of the plant in the year since the TMI incident occurred. This fact was subsequently exposed as a gross mathematical fabrication. Although in absolute numbers more infant fatalities had been recorded, the infant death rate—the ratio of infant deaths to infant births—had marginally *decreased* by a statistically insignificant amount. The surveyors of this infanticide hoax, however, offered not the slightest hint of an apology when their lie was exposed, scientific accuracy being no concern of theirs.

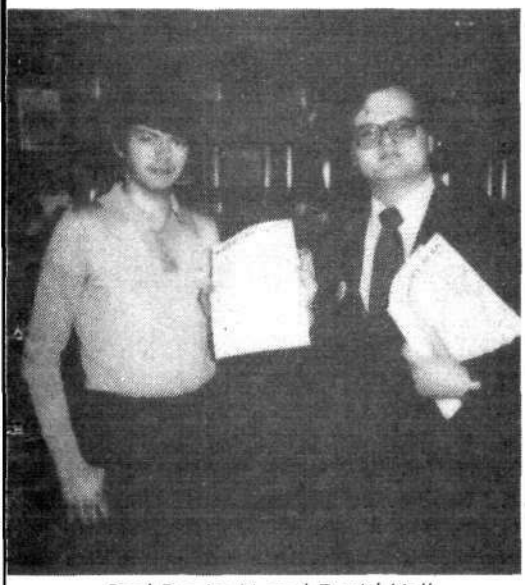
Fortunately, it appears that the people of Pennsylvania, although somewhat bewildered that their government has bestowed a hunting license against nuclear power on the ignorant, have not yet assented to the Alice-in-Wonderland logic of the environmentalists, by which conservation is equated with energy, science with superstition, and sense with nonsense. Far from departing in terrified flight, the population in the vicinity of TMI has actually increased in the past year.

A second, more personal bit of evidence to that effect was recently provided to me by a close relation, in the form of a letter written to her by another lady, who has resided in the Harrisburg area for more than a half-century. I have undertaken to reproduce the letter exactly, as giving a far better account of the mood of the people living around Three Mile Island than the preposterous farrago of frenzy portrayed in the press.

Middletown, Pa.
March 29, 1980

Happy Easter—Happy Spring,

It is so nice that it is both Easter and Springtime. I always dread the cold winter months; however I must



Paul Everitt (r) and David Hall
Photos by Paul Everitt

and the FEF supplied me with a leaflet on Nader's lies to pass out. My point is that even if you are by yourself you can do a lot and the FEF will help you as much as possible. Help the FEF with a contribution so we can all do more!

I would especially like to thank David Hall and Jennifer King who helped me get the pronuclear view expressed.

Paul Everitt
Huntsville, Ala.

The Unthinkable Cronkite

To the Editor:

. . . I am quite excited at the prospect that if we can survive the evil onslaught of the Council on Foreign Relations-Trilateral Commission worldwide policies, America will lead the world in a new golden age, where men will use their minds for the ultimate betterment of all mankind.

I have enclosed a copy of an article on Walter Cronkite taken from the *Parade* section of the *Chicago Sun-Times* March 23 . . . which I think you should excerpt for your readers to expose Cronkite.

Cronkite says: "We have got to start thinking the unthinkable. Is democracy possible when people can't get enough information to intelligently vote on their future. . . . And it just may be that total freedom of speech and press are not possible when technology has so compressed time and distance. . . . Technology has inundated us with facts about everything, and yet I'm not sure we're getting at the truth of anything. How viable is democracy as we know it in this kind of environment?"

James K. Olson
Hobart, Indiana

A 'Super Publication'

To the Editor:

I have just started reading *Fusion* magazine and I think it is a super publication.

I am a 14-year-old, and while other kids my age are reading movie magazines I find myself reading all types of scientific magazines. *Fusion* is by far one of, if not the best, scientific magazines I've read.

I think fusion power is one of the best energy alternatives this country has. It's a shame the government doesn't support research and further development of this field more than it does now.

I would like to research and possibly pursue a career in creating and producing forms of fusion energy for the benefit of all people. With *Fusion* magazine I can become informed in fusion technology and current fusion events.

Keep up the good work!

Ed Lloyd
Lakewood, Ohio

Joining the MHD Battle

To the Editor:

Marsha Freeman's article on MHD in the April issue is excellent. May I have five or six reprints to send to congressmen and senators to push the cause? I am appalled by the nonenergy activities of the Department of Energy and will try to join the battle on behalf of MHD, as I am currently doing for fusion and HR-6308.

W. Josiah Norton
Cooperstown, N.Y.

The Editor Replies

Reprints of the MHD article—and most *Fusion* features—are available from the FEF at $1.25 each postpaid, with reductions for bulk rates.

admit that for me the time since Christmas has literally flown by. It is always nice to see the earth awaken after the winter months. I always enjoy seeing the first patches of green grass and the early spring flowers—also the return of the summertime birds.

The 28th of March has been here and is gone. The "kooks against nukes" have had their day. The Middletown merchants celebrated the day by giving a fresh carnation to each customer. I did not go downtown as I felt that there would be the curiosity seekers as well as the TV cameras. Since I work four 10-hour days, Friday is a day off for me so I did not see any of the goings-on at the Capitol, and since I feel asleep before the 11:00 p.m. news and did not wake until it was over, I did not get to see it on TV.

The meetings in the area have been ridiculous. I have not attended any as I dislike violence; however I have never seen any of the people that appear on TV in Middletown. If they are residents, they certainly are not longtime residents. All the long-time residents, the people I have known all my life, feel the same as I feel. Met-Ed has served Middletown well for many, many years. If they cannot accept TMI, they should leave. We certainly did not ask them to come to Middletown— in other words, "Love it or Leave it."

Having passed on that message from my native state, I remain,

Yr. obt. svt.

Benj. Franklin

FEF INTERN PROGRAM

The Fusion Energy Foundation plans a summer intern program for undergraduate and graduate science and engineering students who would like to work with the foundation. Interested students should send a letter and resume to Dr. Morris Levitt, FEF, Suite 2404, 888 Seventh Avenue, New York, N.Y. 10019.

News Briefs

GANDHI SENDS GREETINGS TO FEF CONFERENCE

Indian Prime Minister Gandhi sent the following message to the conference on the Industrialization of India in Frankfurt, West Germany May 5-6, sponsored by the Fusion Energy Foundation and the *Executive Intelligence Review*.

"Since 1947 India has made considerable progress in science and technology. The world now recognizes the versatility and capability of our industries. Our aim is to make our country self-reliant. But we wish to ensure that development helps all sections of the people and does not create imbalances in society or in the ecology. It is appropriate to assess our progress now and to look into the future.

"My good wishes to the conference on India's industrial development being held by the European Fusion Foundation and the *Executive Intelligence Review*."

A report on the conference will appear in the next issue of Fusion.

FEMA—EMERGENCY GOVERNMENT IN THE WINGS?

Sometime during the first two weeks in April, a nuclear war was simulated in which a majority of the American population perished. The simulation was conducted by the publicity-shy but highly active crisis management agency known as the Federal Emergency Management Administration, which has completed a series of disaster rehearsals for taking government control in a crisis. A FEMA official characterized the nuclear exchange simulation as follows: "We simulated a nuclear exchange between the United States and the Soviet Union. Washington was destroyed. A large section of the government including 34 agencies and every department of the government was moved. We at FEMA coordinated the entire relocation. . . . We [also] simulated a 'limited' nuclear war in the Mideast, beginning with a regional conflict over the Persian Gulf. . . . We were testing the mandate our agency was given when it was established by presidential executive order last March."

As *Fusion* noted at the time, FEMA was put into action three days before its mandate on the eve of the Three Mile Island incident and was involved in managing that manufactured crisis from the top down. Its mandate grew out of a presidential review memo (PRM 32) that specifically noted that traditional democratic institutions will not be able to handle the crises of the 1980s. In brief, the mandate gives FEMA dictatorial control over every operating level of government—without interference from Congress, the courts, or even the Joint Chiefs of Staff—in the event of natural disaster, energy crisis, or war.

FEMA director is John Macy, whose career includes a stint at the Atomic Energy Commission in the late 1940s, presidency of the Public Broadcasting Corporation from 1969 to 1972, and consulting work for the Iranian government until his FEMA appointment this year.

A full report on FEMA and its activities will appear in the next issue of Fusion.

Isaac Asimov

DOES YOUR CONGRESSMAN HARUSPICATE?

The Aquarian Conspiracy (see Books, this issue) has captured at least 125 congressmen for zero growth through a group called the Clearinghouse for the Future, started by the Club of Rome, which regularly infuses Aquarian mystic ideas into Congress. Clearinghouse director Ann Cheatham, a Club of Rome member, schedules monthly sessions for the Hill where Congressmen can engage in futurism and activities like "haruspicating with science fiction" with futurists like Isaac Asimov. (Haruspicating is the name given to the activity of Roman sages who predicted the future by looking at the entrails of sacrificial animals.) In a recent session Asimov told the congressmen, "If science fiction is the literature of escape, it escapes to reality."

How successful have these brainwashing sessions been? North Carolina Congressman Charles Rose, a main Clearinghouse booster, put it this way: "It is impossible to measure what has happened to the more than 125 members of the House and Senate who have attended the Clearinghouse monthly dinners, but surely we are not the same as we were before we heard them."

LOSS OF FLUID TESTS PRODUCE NO FUEL DAMAGE

Recent visual examinations of an irradiated nuclear fuel module at the EG&G test facility in Idaho have confirmed that no fuel damage occurred during the first series of tests run late last year in which coolant fluid was deliberately removed from a nuclear reactor during power operation. Researchers at the scientific consulting firm had concluded that this was probably the case on the basis of operations and other data, but no one was sure until EG&G's specially designed remote periscope and closed circuit TV equipment was submerged in the fuel storage canal of the test facility's recently upgraded "hot shop."

The tests are part of the Loss of Fluid Test (LOFT) experiments conducted by the Department of Energy's program at the Idaho National Engineering Laboratory. The LOFT tests are designed to demonstrate that an emergency core cooling system can operate effectively to prevent core overheating and fuel rod damage in a reactor that had undergone a loss-of-coolant accident.

PRODUCERS SAY VOLCKER CREDIT POLICY WILL DESTROY AGRICULTURE

A delegation of farm producer representatives including spokesmen for the major farm organizations, visited Federal Reserve Board Chairman Paul Volcker April 10 to tell him that the administration's high interest rate and tight money policies were strangling the farm sector.

Although Volcker's policies were defended by Agriculture Secretary Bergland and Agriculture chief economist Hjort, who insisted that credit restraint is not being imposed on small business and agriculture, the farm representatives presented facts that suggest otherwise. Fully 20 percent of America's farm producers may be forced out of business this year, according to information coming into the offices of the American Agriculture Movement, represented at the Volcker meeting by California producer Ed Osborne.

TEACHING THE DEATH AND EXTINCTION OF MAN

The Phi Delta Kappa Educational Foundation is circulating a "steady-state" educational curriculum for primary and secondary students designed to get students and teachers to think only in terms of a "steady-state" economy, one that has a "declining state of growth." Titled "Alternatives to Growth: Education for a Stable Society," the curriculum states: "The steady-state school will reconsider the idea of progress. Technological improvement will not be thought central to progress. . . . To aspire to be a captain of industry or businessman expanding an industrial empire will be thoroughly discouraged as we now condemn aspirations to be an outlaw. Whatever is left of the business entrepreneur as an exemplar of American ideology will quickly disappear."

The basic theory of the curriculum is "quite simple," according to the proposed curriculum: "The longer life we want for our species, the sooner we must effect a cessation of growth. . . . Acceptance of a rational attitude about death and extinction will be a prominent feature of steady-state schools. The steady-state student will understand that each person begins to die at the instant of birth. . . . The students will clearly comprehend that homo sapiens will become extinct. . . . Infanticide is a preventative check on population."

The foundation, started in 1966, credits the development of its curriculum ideas to Kenneth Boulding, Nicholas Georgescu-Roegen, Thomas Malthus, Rachel Carson, Dennis Meadows, and the Club of Rome. The authors of the document are Robert Bjork of the George Peabody College for Teachers in Georgia and Stewart Fraser of the Educational Testing Service in Princeton, N.J.

FEF SLIDE SHOW TEACHES STUDENTS ABOUT GROWTH, TECHNOLOGY

"I've never seen anything like it," the astonished science coordinator of a New York City elementary school said of his students' enthusiastic response to the Fusion Energy Foundation's nuclear energy slide show April 11. Dr. Steven

Continued on page 8

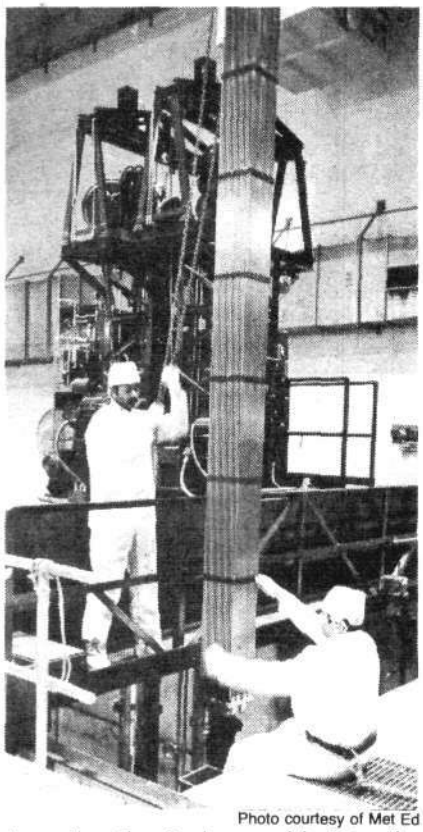


Photo courtesy of Met Ed

Lowering the fuel assembly into the fuel rod at Three Mile Island

News Briefs

Continued from page 7

Bardwell, FEF director of plasma physics, informed the 450 fourth and fifth graders at Bronx Public School 24 of the advanced technology solution to the zero-growth theories they have been learning. The school's only science magazine is on solar power.

Dr. Steven Bardwell

Bardwell caught the attention of his young audience with a slide of a starving child and explained that technological progress is necessary to eliminate worldwide problems of starvation and disease. He then described the technologies of nuclear and fusion power, developing the idea of energy density to show that nuclear energy is essential to a sound economic policy. In the fusion age, Bardwell said, when water is fuel, drinking a glass of the stuff will be like drinking the energy equilvalent of 50 gallons of gasoline. "What will the conservationists say when that time comes?" he asked.

Bardwell also identified the real benefits of the "gimmicks" presented in popular science fiction—lasers, for example—to educate the students to a conception of useful, advanced scientific technologies which they as scientists may someday help develop.

After Bardwell concluded the 25-minute slide show, dozens of hands shot up, and the children's questions made clear that they were excited by the rare opportunity to learn about advanced science. The discussion ranged from the practical considerations of developing fusion power to theoretical matters, such as the reason for the tokamak's donut shape and how a laser beam works. A 10-year-old girl summed it up after the class when she told Bardwell: "Fusion seems like it's real good. But we better get moving. If we wait too long to develop it, it might be too late."

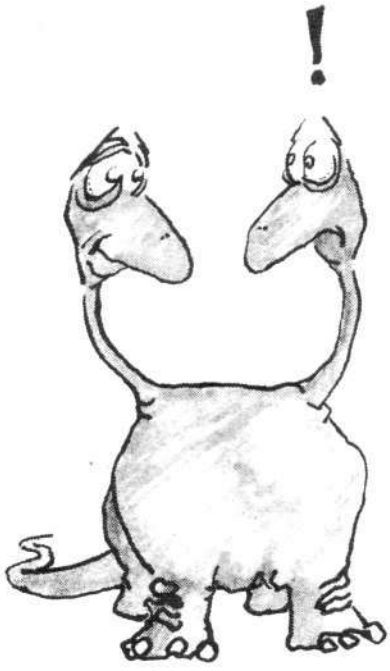
The FEF is developing a slide show on fusion for sale and rental. Interested readers should contact the FEF.

BARDWELL KEYNOTES NAACP SCHOLARSHIP DINNER

Dr. Steven Bardwell, associate editor of *Fusion* and director of plasma physics for the FEF, was the keynote speaker at the annual scholarship dinner of the Flint, Mich. National Association for the Advancement of Colored People April 10. "With the awarding of this scholarship and its aggressive support of nuclear energy, the NAACP has chosen sides in a war, an epistemological war whose stakes are the survival of the human race," Bardwell told the 120 participants.

Bardwell stressed that the NAACP had to enter the fight armed with a complete understanding of the humanist, scientific method. Using the example of the "new math," he stressed that the enemies of progress—like the intellectual founders of the new math, Bertrand Russell and Jean Piaget—understand very clearly that the fundamental question is one of how man's mind works. "We cannot be fooled by delusions of practicality and convenience into compromising on issues like nuclear energy or science education, or we will lose." Bardwell said.

A representative from the mayor's office presented Bardwell with a key to the city of Flint.



LOUSEWORT LAURELS: ANOTHER TWO-TIME WINNER

Lousewort Laurels this month go to S. David Freeman, chairman of the Tennessee Valley Authority who won his first lousewort award a year ago for his distribution of 120,000 wood-burning stoves to Tennessee Valley residents. "Nuclear power is expensive, not cheap, as nuclear proponents previously claimed," the head of the nation's largest nuclear construction program told a Knoxville, Tenn. meeting of the American Nuclear Society April 8. "Low-risk nuclear power is quite expensive, as compared to today's rates. Anyone who favors safe nuclear power must favor rate increases. The two are Siamese twins, and anyone who says otherwise is either uninformed or deliberately misleading the public. . . ."

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Viewpoint

Regulating the Environmentalist 'Big Brothers'

by James F. McAvoy

Coal and nuclear power will have a future in America only if we act immediately to bring the federal bureaucracy under control.

The Orwellian federal bureaucracy has come to be dominated by a small group of big brothers who feel that regulation, and plenty of it, is the best way to keep individual Americans, and of course, "big, bad business," walking the straight and narrow road to Utopia.

In their Utopia we wouldn't burn coal or use nuclear power, two sources of energy whose increased development, they've already effectively blocked. No, in their Utopia we would get back to the earth, listen to the birds, and let the sun warm our bodies. Sun-warmed bodies—I'd have a difficult time selling that to my family, let alone the American public in the dead of winter, unless we all move to Florida. Actually, they already know they can't sell it, so they've tried to force their goals down our throats with an endless array of regulation. No longer are they content to control industry alone, now they're taking on the role of social architect as well.

But, in the process of bringing about this so-called social reform, the no-growth, status-quo Washington bureaucrats have pushed inflation to an all-time high and interest rates to 19 percent. Gasoline prices will probably hit $2 a gallon by summer's end, if not before, and air fares are literally sky rocketing, leaving even the simple dream of a family vacation on perilous ground.

Excessive environmental regulations in particular, contribute significant fuel to the fires of inflation. Beyond a shadow of a doubt they are a significant cause for this country's energy crisis, which, in turn, has left the economy in a shambles.

We can't even talk about coal and nuclear energy until we deal with powerful, unelected, professional environmentalists who've succeeded in taking the reins of power from the president himself to make decisions that affect not only the environment, but energy and the economy as well. But dealing with these people is nearly impossible. How can you deal with people who believe they're in sole possession of morality and ethics? How do you deal with people who've decided that regulatory agencies are somehow independent of the executive, legislative, and judicial branches of government?

Where once the Congress created the laws, the Chief Executive enforced them, and the Judiciary passed judgment when necessary, today regulatory agencies do all three.

Ever since the federal government forcibly entered into partnership with American industry, we've seen business stumble.

The Utopian Plan

Examples abound: the steel industry, the auto industry, the rubber industry, the coal industry, the nuclear industry—they're all floundering, and coercive Utopians rejoice, it's all going according to plan.

The plan you ask? Coercive Utopians have a plan to bring the system tumbling down. How? Stop growth. Stop growth by blocking energy development. Stop growth by blocking the development of new industry. Stop growth by subjecting water and land use to delaying tactics.

All this reviewing, evaluating, and court wrangling has led to our predicament today. And, I can assure you, you won't want to see what 10 more years of it will do to the economy, for when you stop, not control wisely,

but *stop* the development of new industry, power plants, water projects, and land development, the effect is not readily visible. However, 5 to 15 years down the road, as Dr. H. Peter Metzger of the Public Service Co. of Colorado has said, "there will be an economic cataclysm in store that will make the Great Depression look like a tea party."

Do you think I'm being too hard on those who would destroy the social and economic order of this country in the name of clean air and water? Then listen to John R. Quarles, former deputy administrator of the U.S. Environmental Protection Agency (USEPA) who said, "recent amendments to the Clean Air Act provide that in any area where the air quality standards have not been fully attained (that means most cities) no new industrial plant can be built after July 1, 1979 unless the state has adopted and USEPA has approved, an air pollution control plan which will assure full compliance by the end of 1982.

"This provision, like a loose cannon on a pitching deck, threatens a path of destruction. The new law allows no leeway. If the plan is not finished and approved—no matter why, the sanctions apply automatically.

"If a state agency lacks adequate manpower; if a governor opposed one part of the program; if EPA rejects a plan for technical or procedural defects; if anyone ties up the new plan in litigation; or if for any other reason the deadline is missed; then federal law will prohibit construction of new plants with unforgiving finality.

"The use of this radical sanction reflects a desperate gamble, a hope that the threat of economic calamity will bludgeon states and localities into adopting whatever measures are needed to achieve the air quality standards, even though the time to develop plans is inadequate and in a few instances, such measures go beyond all bounds of reason."

As director of environmental protection for the state of Ohio, I couldn't be in a better position to see just how true Quarles's words are. USEPA, often hiding behind the names of clean air and clean water, puritanically opposes trade-offs and compromise, labeling them as "unethical." So you see, the future of coal and nuclear power remains, at best, gloomy. Despite the gains we've made in cleaning up our air and water, we've essentially been told it's not good enough.

Speak Up

We in Ohio refuse to be coerced and cowed by a small group of coercive Utopians who are hell-bent on pursuing a zero-pollution, no-growth policy. We believe we must heed the words of the National Academy of Sciences, which reported that "coal and nuclear power are the only practical, large-scale energy sources available to supply our needs into the next century."

If we want our wishes to prevail, we must let our voices be heard. Unless we speak up, coercive Utopians will speak louder. They'll discredit conventional means to meet energy demands with scare tactics and denounce them as morally unacceptable degradations of the environment. In the ensuing chaos caused by this "no-pollution, no-growth" sentiment, guess who'll get the blame for massive unemployment and social disorder? You guessed it, the corporations, capitalism, and representative democracy.

What can we do to prevent such a scenario from developing completely?

First, demand that regulatory agencies be cut down to size.

Second, educate yourself about the ways of Washington politics and see for yourself who's running your life.

Third, if you are for the use of coal and nuclear power, say so.

James F. McAvoy is Director of Environmental Protection for the state of Ohio. His viewpoint is adapted from a speech presented at the Ohio Engineers Public Affairs Forum in Columbus, March 26, 1980. A graduate engineer, McAvoy was involved in the design, testing, and operation of Navy nuclear power plants before entering public service in 1973.

Notice

Fusion magazine has entered into a consent decree to pay for the use of a photograph, taken by Dan McCoy, of the cleaning of a solar collector appearing on page 37 of the July 1979 edition of *Fusion* which was used inadvertently without authority or attribution.

Special Report

The Club of Rome Plan:

Most Americans, had they attended the March 16-18 conference of the U.S. association for the Club of Rome in Bethesda, Maryland, would have come away form the proceedings in stunned disbelief. In line with the zero-growth efforts of the parent organization, the Club of Rome International, the focus of conference discussion was a campaign to compel Americans to "adapt" to the "death of the American dream of material and technological progress."

In Club of Rome parlance, the process of adaptation is "The Great Transition." Club of Rome methods, outlined in horrific detail throughout the conference proceedings, are the same ones employed by ruling oligarchies since the time of the pharoahs. They intend to spread *cults*, in religious, satanic, environmentalist, and death-worshipping varieties, in order to give the population "the means to cope" with the miseries and social chaos that will follow an American economic catastrophe.

The conference went substantially beyond the limits-to-growth propaganda for which the Club of Rome organization is already internationally notorious. Organized around the theme "The Human Side of the Energy Transition," speakers and participants were drawn from a broad spectrum, including Episcopalian and Jesuit theologians, solar energy advocates, environmentalist collectives, consumer-action groups, radical women's groups, political pollsters expert in American susceptibilities, and self-professed specialists in "death and dying."

This last group provided the featured participants. The most persistent reference point of the gathering was the death-cult idea of Elizabeth Kubler-Ross, leader of the "Death with Dignity" and Hospice movements, who has reported that she communicates frequently with the dead. The application to Americans *en masse* of Kubler-Ross's prescriptions for helping individuals cope with the grief of a dying way of life was the Club of Rome's specific interest.

Speaker Larry Kagan of the prestigious Yankelovich, Skelly and White polling agency put it this way: "There is social bereavement associated with the end of decades of booming industrial growth, the end of the days of America being the steelmaker and automaker of the world. As we move

'Goodbye More—Hello Less'

This excerpt is from "Goodby More—Hello Less," an official conference document at the Club of Rome's Bethesda conference authored by David Dodson Gray, an Episcopalian priest.

"We have not thought much about going down (not up), having less (not more), going slower (not faster), aging (not growing up), being (not achieving). In the past, transition has been something individuals went through alone, but a look back at the recent decade tells us that already our symbols and fantasies were turning to transition themes. The striking series of disaster films (*The Poseidon Adventure, Earthquake, Towering Inferno, Airport*, etc.) constituted a cultural anticipation of loss. Gerontology was a lively new field of study. . . . Grief seminars and seminars on death and dying were on the agendas of church conferences and popular courses in colleges. Meditation movements abounded.

"Transition carries one to acceptance and we can prepare ourselves for it through symbols and fantasies which help. . . .

"In the transition, what is central is what happens to the morale of individuals, of institutions, and of our culture as a whole. Kübler-Ross writes of the importance of respecting and preserving 'a thread of hope' throughout the grieving process. We need hope to find our way out of the maze, to pull ourselves through difficult tunnel-like transitions. We need hope to sustain us until we can again more clearly see our meaning and our way.

"We soothed social confict, in our growth phase, with the expectation that more growth would mean more for all. That hope no longer is plausible in the transition. A new hope, a new expectation, must be shaped apart from the opiate of growth. . . .

Within the Church, pastors must attempt to locate public moods and behaviors upon the landscape of the human spirit and point out the potential for coping with loss. Our goals and values matter even more now as we begin to think the heretofore unthinkable—about life after growth.

Killing the American Dream

out of the industrial phase of society and into the information phase, the hope is that we can help people adapt to this new reality, just as Kubler-Ross helps people cope with dying."

What Is the Club of Rome?

The Club of Rome was set up by families of the European "black nobility" and the British aristocracy in the early 1960s, who convened 100 financiers and others under the chairmanship of Italian banker Aurelio Peccei. Its purpose is to promote the ideas of the 18th-century zero-growther Parson Thomas Malthus of the British East India Company. Malthus proposed that the human race inevitably produces more people than the earth produces food, that nonfood-producing industry is unproductive, and that genocide and other population-reduction measures ought to be the central policy of governments.

The Club of Rome organization now plays a central role in a network of Malthusian organizations (controlled by the same medievalist families that founded the Club) engaged in a global cult-building campaign like that outlined for the USA at the March meeting. For example, current Club of Rome activities are centered around the forthcoming "Third Development Decade" conference of the United Nations Organization. The agenda and policy papers for this conference were all produced through the "Project on Futures" of the United Nations Institute for Training and Research (UNITAR), whose director is Ervin Laszlo, a Club of Rome policymaker since its inception. Laszlo's UNITAR, in turn, provided the principal policy input into the *1980s Project* studies of the New York Council on Foreign Relations.

Club of Rome Participants: 'Death Is In'

"When you have violent, brutal kind of death, human beings have the ability to shed the physical body, temporarily most of the time, but permanently when the body is killed. When a child is murdered or raped, they instantly have an out-of-body experience so that they watch the scene of the crime from a distance without pain or anxiety."

—Elizabeth Kubler-Ross in the keynote address to the Fifth Annual Conference on Death and Dying, at the St. Francis Center, Washington, D.C., March 20, 1980

"Death is in. There is a doom boom in the United States. We are restoring the ownership over death to the American population.... There will be a national conference on death and dying to expand the death-education process all over the country."

—Rev. William Wendt, in an interview St. Francis Center, Washington, D.C., March 22, 1980

"Americans' commitment to material progress is a combination of the Judeo-Christian ethic of man having dominion over nature with the American *macho*."

—Elizabeth Dodson Gray in an interview, March 14, 1980

The outcome of *1980s Project* studies was the proposal to realize Club of Rome-UNITAR goals of a new world order based on environmentalism by bringing about the "controlled disintegration" of the U.S. and other industrial economies, and by subordinating nation-states to the rule of "one world," supranational institutions. The Club of Rome now proposes to help Americans adapt to the consequences of these policies by joining cults. (See *Fusion*, Oct. 1979 for the details of the *1980s Project*.)

Among the principal institutions collaborating with the Club of Rome at the March 16-18 conference was the Interreligious Peace Colloquium, a project of the Jesuits with Episcopalian participation. The Colloquium was founded at a 1975 conference in Bellagio, Italy, one of whose sponsors was current U.S. Secretary of State Cyrus Vance. At the time, Vance was serving as a coordinator of the *1980s Project* studies, and together with the Club of Rome's Daniel Yankelovich, the pollster, was establishing "The

'The End of Science'

"There is a process developing here similar to what Khomeini did in Iran. The only difference is that Islamic fundamentalism is a reaction against the introduction of science and modernization, while the emerging American fundamentalism is a response to the end of science. . . . I am particularly interested in the charismatic movement. . . . We are transforming the way people understand the *Book of Genesis* injunction for man to have dominion over nature. From now on, man can only have stewardship over nature—to be a part of it, not rule over it."

—Jeremy Rifkin, Fellow, Institute for Policy Studies, in an interview, March 24, 1980

President's Commission Backing Club of Rome Policy?

The President's Commission for a National Agenda for the 1980s released an information packet recently, "Agenda for the 1980s," that expresses the Club of Rome theme of "transition" to America's "life after growth." Here are brief excerpts:

- "The economic base of society is shifting from basic heavy manufacturing to information, communications, and electronics."
- "The decline of confidence in government. . . has led to a shift to single issue, special interest, participatory politics. . . . A growing movement, anticipatory democracy, has citizens of the local, state and regional level actively participating in forecasting possible futures. . . ."
- "The following are vital sources of information: The Club of Rome, the Council on Foreign Relations, the Institute for World Order, the MIT Systems Dynamics Project, the United Nations Institute for Training and Research (UNITAR). . . ."
- Leading futurists recommended by the commission are: Lester Brown of Worldwatch Institute; science fiction writer Isaac Asimov, Jay Forrester and Dennis Meadows, authors of the Club of Rome's *Limits to Growth;* Ivan Illich; Herman Kahn; Ervin Laszlo of UNITAR; Aurelio Peccei, Club of Rome founder; the Audubon Society's Russell Peterson; and Alvin Toffler, author of the antiscience books *Future Shock* and *The Third Wave*.

Peccei: 'The Nuclear Hard Drug'

"I am more pessimistic and radical than my scientist friends in judging the nuclear solution. . . . I am, however, ready to argue that what is not reliable, secure, and clean enough is human society itself. I have devoted many pages to describing its state of disorder, its incapacity to govern itself, to act rationally and humanely and to ease the tensions which tear it apart; and hence I cannot believe that in its present state it can go nuclear. I cannot imagine that this same society will be in a condition, within a couple of decades, to safely host and protect several thousand huge nuclear power stations. . . . Those who are today inebriated by just small doses of the nuclear hard drug, as I have called it, and are pushing the programs to disseminate it in the body of society, are in effect condemning their successors to live entirely by it tomorrow."

— Aurelio Peccei in his autobiographical book, *The Human Quality*, 1977

Public Agenda Foundation" whose objective is to promote the Club of Rome "definitions of the issues facing Americans."

A cursory glance at the membership roster of any of these organizations shows a heavy overlap with the Trilateral Commission, a Council on Foreign Relations spin-off; the Bilderberg Society, an elite organization of the British and European medievalist families with selected American members; and the U.S.-based Aspen Institute.

Feudalist Goals

Club of Rome chairman Aurelio Peccei is not subtle about the organization's aims. At a press conference during the late 1970s, he lauded the cannibalism to which stranded mountain climbers resorted—an example to be followed by whole populations in the face of scarce resources, he stated. Similarly in the early 1970s, the Club of Rome sponsored the *Limits to Growth* computer-applications project of MIT professors Dennis Meadows and Jay Forrester. The Meadows-Forrester method was to program a zero-growth axiom into the model and then conclude that zero growth was necessary as a circular consequence of the axiom. Asked at a press conference if he was just a "neo-Malthusian" fraud, Meadows retorted: "I'm *not* a neo-Malthusian. I'm a *Malthusian*!"

In the mid-1970s, using the vehicle of Ervin Laszlo's UNITAR, in particular, the Club of Rome extended its efforts to the developing sector and even Eastern Europe, where Laszlo's "systems analysis" methods temporarily won adherents. Two relevant reports were produced, one the 1976 *Reshaping the International Order* since known as the club's *RIO Report*, and Laszlo's 1977 *Goals for Mankind*. The substance of both was an emphasis on "appropriate technologies" (like sticks for plows and cow dung for fertilizer) in the Third World nations and supranational control of economic policy making and advanced technologies.

In conferences based on these reports in Algiers and elsewhere, Peccei sought with some success to twist Third World aspirations for economic development into "demands" for "more equal distribution" of already

existing wealth, undermining growth in the advanced sector and ensuring no growth in the developing sector.

The attempt to coopt Third World policy planners led to a change in the Club of Rome's verbiage. Dropping "zero growth," which most developing nations' leaders immediately recognize as insane, the Club, UNITAR, and allied agencies like the Aspen Institute, introduced the terms "sustainable growth," "limited growth," "managed growth," "organic growth," and others. However, no matter which term is employed, the meaning is still "zero growth."

Similarly, the Club of Rome recently announced it would place more emphasis on the "informational aspect" or the "learning aspect" as opposed to the "economic aspect" of its program. What these terms mean was spelled out at the Bethesda Conference.

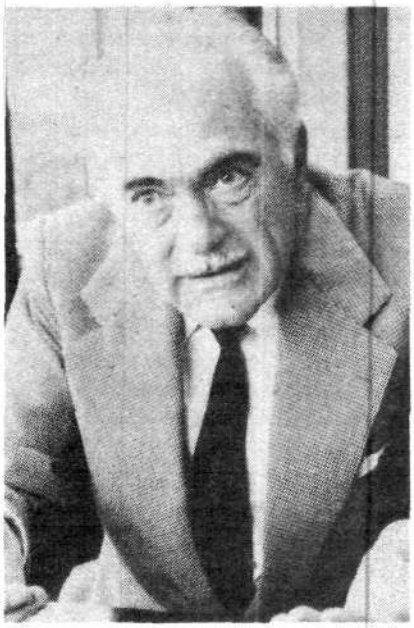
Selling the Cults

The Club of Rome established its U.S. Association in the 1976-77 period, with the cooperation of a handful of institutions like the Woodlands Conference in Houston, Texas, a spinoff of the Aspen Institute, whose sponsors are oil-man George P. Mitchell and the Mitchell Energy and Development Corporation. The Woodlands Conference is currently funding research efforts into the best methods for selling Club of Rome cults and ideas to Americans.

Highly elaborate profiling of American attitudes have been undertaken to locate those susceptibilities that will allow them to put the country through "The Great Transition." The basic tenet of the recent conference, in fact, was that the past decade's battering of the U.S. population by inflation, oil supply scares, drugs, and the rock-and-roll counterculture has already weakened the U.S. commitment to the idea of progress. Americans, reported the profilers, have come a certain distance, and are now in a "transition" to "new values."

The targeting strategies outlined by the conference to complete "The Great Transition" can be broken down as follows:

Death-cultism. Elizabeth Kubler-Ross's celebration of death must be adapted to broader social issues, with



Club of Rome head Peccei

the goal of compelling Americans now enraged at economic breakdown to turn those feelings *inward* toward a *stoic* acceptance of "fate" and increasing fascination and obsession with dying and themes of death. To this end, national conferences are to be held on death and dying, and a "death-education process" is to be launched in schools, churches, and other institutions nationally.

Women's "Liberation" Cultism. In the official conference prospectus, one of the main themes was that of "new opportunities for participation and leadership by women . . . drawing on the theory that, from a psychological and emotional viewpoint, women's perceptions and abilities are particularly well suited to coping with an age of transition in which there will be few neat, simple, or immediate solutions." Several conference panels focused on how women's sense of intellectual inferiority—science, technology, and development are associated with "men"—can be exploited. As one conference organizer put it, "women's groups, in particular as they merge into consumer action groups, will be a principal institution through which we will seek to concretize the Club of Rome's ideas in this society."

Fundamentalist cultism. "Church institutions will be vital in communicating the Club of Rome's ideas," say conference spokesmen. What must be undermined is the Book-of-Genesis injunction to mankind—"dominion over nature." The Judeo-Christian ethic "of man having dominion over nature is wrong," said one participant. Another speaker, Roy Anderson of All-State Insurance, a funder of the U.S. Club of Rome organization, delivered a bitter attack on doctors for being "overly concerned with curing people," and then warmly praised "the religion of the American Indians" as an alternative to the "notion of dominion in the Judeo-Christian heritage." The Club of Rome objective is to pit religious fundamentalist cults against Americans' reverence for the power of science.

Environmentalist cultism. Episcopalian priest David Dodson Gray, whose wife Elizabeth Dodson Gray also addressed the conference, told conference participants: "Peccei is a man with great vision. He thinks that now is the time to bring the Club of Rome into the institutions and pores of American society. He thinks the anti-nuclear movement will help implement the Club of Rome's ideas on a mass scale. He sees in this movement a way of allying environmentalists with workers by capitalizing on workers' growing fears of industrially caused disease and death."

Gray proposed that a "green death cult" be created, merging Kubler-Ross with environmentalism: "Many union people are now aware that the workplace is very hazardous for them, not just by bone-crushing accidents, but by long-term exposure in the workplace to chemicals or to ordinary materials like asbestos or vinyl fluoride. Out of this awareness is being built a coalition between labor and environmental people over those issues that involve the health of the work environment. Workers feel that disease and death should not be among the occupational hazards, and an alliance with them is being built out of the antinuclear movement. The nuclear issue is being used by the environmental activists to reach out into working neighborhoods, and a new phenomenon is developing."

—Mark Burdman

McCormack Fusion Bill Faces Economic Fight

When the funding authorization for the fusion legislation sponsored by Congressman Mike McCormack (D-Wash.) goes before the House Science and Technology Committee April 23, it faces a fight on whether an austerity economy can afford to develop fusion —the energy source that could help put the economy back on its feet.

The first battle in this schizophrenic fight occurred in the Subcommittee on Energy Research and Production, which McCormack chairs. McCormack had proposed that the subcommittee authorize a $45.9 million add-on to the fiscal year 1981 authorization for magnetic fusion. Although his recommendation passed by voice vote, all of the Republicans and one Democrat on the subcommittee did not vote for it—even though they support the development of fusion.

Instead, they supported an amendment introduced by ranking Republican John Wydler of New York to add on only $25 million to the Department of Energy 1981 budget. The reasoning according to one of this minority: "We don't want the appropriations committee to laugh. . . . This is the year of the tight budget, so we certainly don't want to appear like spendthrifts, fueling inflation by increasing government spending."

The irony of this position, as Congressman McCormack and other more thoughtful members of Congress have pointed out, is that scientifically vectored government spending for a program whose goal is cheap, inexhaustible energy and which provides highly skilled jobs for scientists and engineers, contributes to the increased productivity of the economy, not to inflation.

What the Add-on Is for

One of McCormack's major concerns is that the fiscal year 1981 budget make the commitment to build a fusion engineering test facility at the earliest possible date. For that reason the McCormack add-on breaks out a new budget line for the Fusion Engineering Test Facility, designated project 81-MF-1, and authorizes $4 million for the new line item. During fiscal year 1981, this funding is for the evaluation and selection of a site for the test facility and the initiation of what is termed "Title I Engineering" under contract with an architect/engineering firm.

The current Department of Energy fusion timetable would not even make the decision to build an engineering test facility until the mid-1980s, and the scientific community has stated that such procrastination would unnecessarily add a decade to the program timetable. The intention of Congressman McCormack's "Apollo" program for fusion is to construct a test facility by the mid-1980s and go on to demonstrate commercial feasibility before the end of the century.

The add-on also specifies $6.5 million in the project and planning area to upgrade the test facility conceptual design work underway at Oak Ridge National Laboratory.

The development and technology division in the fusion program received the single-largest increase of $22 million, to accelerate the crucial re-

search needed to bring fusion into the engineering phase. The rest of the $45.9 million includes $8 million for magnetic systems work, $8 million for plasma engineering, $2 million for fusion systems engineering, and $4 million to the capital expenditures budget. Two million dollars were also added for the Tokamak Fusion Test Facility at Princeton, which will demonstrate energy breakeven by 1983.

Another important decision implemented through the add-ons was congressional budget approval to alter the design of the Mirror Fusion Test Facility now under construction at the Lawrence Livermore Laboratory to the more efficient tandem mirror design. The MFTF will receive $3 million more for operating expenses and $6 million more for construction changes.

The subcommittee also chose to save the highly successful Elmo Bumpy Torus program at Oak Ridge National Laboratory. The hatchet fell on the EBT when President Carter announced his round of budget cuts in March. The subcommittee restored the $7.5 million cut by Carter, thus adding its approval to the next stage of the project, which has already been ok'd by the DOE fusion office and DOE scientific advisory committees.

This next proof-of-principle machine, the EBT-P, has been released to the public for proposals for construction. As a "hybrid" combination of the mirror and tokamak conceptual designs, the EBT will play an important physics and engineering role in the fusion program.

The Real Issue

The McCormack fusion bill has more than 150 cosponsors in the House, although it has not yet been introduced in the Senate. The most familiar excuse among Senators for not sponsoring is: "This isn't the year to propose a $20 billion fusion program; maybe next year."

The issue is whether the bill's sponsors will fight for the fusion legislation, on the basis that it is the real way to cure inflation—like the NASA space program, which revitalized American industry in the 1960s and built whole new industries, creating hundreds of thousands of highly skilled, productive jobs.

FEF Reprimands Fiscal Conservatives

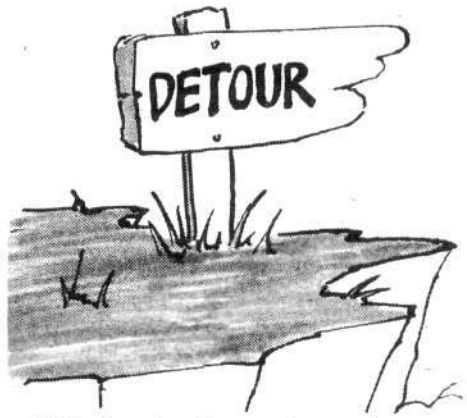
In an open letter April 15, Fusion Energy Foundation executive director Dr. Morris Levitt told the six Republicans and one Democrat who did not vote for Congressman Mike McCormack's $45.9 million add-on to the fiscal year 1981 magnetic fusion authorization that their behavior would "undermine Congressman McCormack's broader initiative to launch an Apollo-style fusion program." The $45.9 million add-on vote in the House Subcommittee on Energy Research and Production was passed April 2.

"By your inexcusable action you have helped to jeopardize the one research program that offers any real solution to our long-term energy and resources needs," Levitt wrote.

Addressing Congressman John Wydler (R-NY), the ranking minority member of McCormack's subcommittee and leader of the six subcommittee Republicans, Levitt said: "You have disregarded the support for Congressman McCormack's initiatives by House Minority Leader Rhodes and the letter of Dec. 6, 1979 from Senate Minority Leader Howard Baker to . . .

An Interview

Sidetracking Pronuclear Legislators



This interview, made available to Fusion *by a freelance reporter, demonstrates how congressmen who are genuinely for the development of nuclear and fusion energy get sidetracked on issues of ideology, a vulnerability that stems from a failure to discuss the real economics of fusion and fission.*

The person interviewed is Michael Helmantoler, communications specialist for the minority members of the House Committee on Science and Technology. Helmantoler, as can be seen in the interview, uses austerity ideology to sidetrack congressmen.

Question: Congressman McCormack has introduced a bill to put $500 million into fusion research. What is he doing with the bill at this point?

It's been signed by a hundred or so members.

Question: How does the subcommittee feel about it?

Well, the minority members, minority member Wydler [John Wydler, R-N.Y.] signed it as kind of a personal favor to McCormack, but he didn't favor putting all that money into fusion when he realized that it was really coming out of the cuts the DOE made in fission.

Question: Is that actually what the bill is doing?

That's the way it was explained to me by a member of the staff. There is only so much of a pie that DOE gets and to increase the fusion budget would take it out of the fission budget. Wydler didn't want to scrap fission, which is a now thing, for fusion, which may or may not get here in time.

Question: I'm interested in the way the political thing shapes up.

Well, are you familiar with the Fusion Energy Foundation?

Wydler in which Baker states: ... now is the time to decide that our children will not live in a world of peril because energy is running out. I urge that you and our Republican colleagues on the Science and Technology Committee support whatever measures are appropriate, so that we may proceed with the utmost responsible speed toward the goal which we have set for 1995.' "

Irrational Policy

Levitt also pointed out the irrationality of congressional decisions on energy policy: " ... You voted to cut down funding for the most important and positive program now before the Congress just as it is at its critical take-off point, while economically disastrous programs like synthetic coal production sail through with full funding. As long as you tolerate or support the Volcker credit measures or the equally destructive policies of fiscal conservatism and deregulation instead of fighting to restore the dollar and our industry through measures that ensure capital formation for production and export, you will not be capable of making constructive judgments on energy policy."

Congressional reaction to the open letter was immediate. One congressman's staff was so upset that such a straightforward critique of the congressman's actions was aired in public that he termed the letter a "threat" to the congressman.

Question: Yes, I know they are backing McCormack's bill heavily.

Are you familiar with the story in *National Review* on the FEF about a year ago? [The *National Review* story was a series of slanders on the FEF, written by an individual the FBI characterized as a pathological liar and whose subsequent journalistic work includes a piece for *New York* magazine on New York City whorehouses.] Well, we kind of feel that way too [about the FEF]. There are a lot of people backing fusion—Princeton University and a lot of other legitimate groups—and I don't think the FEF has much credibility up here because of the things that were pointed out in the *National Review* story. ...

I'd say all the [subcommittee] members are profusion, but they're not fusion freaks, and I think everybody's committed to moving up the day when fusion can be more commercially available sooner [sic]. But they're not looking for any kind of Apollo-level pork-barrel.

Question: We do have to look at the budget overall. ...

I'm new to the Hill, but it seems to me that if you are going to get any kind of a program through, you've got to come up with some absolutely astounding numbers to get people's attention and then people start whacking away at it and it finally gets down to something that's fairly reasonable. ... You should talk to Jack Dugan [the minority staff's fusion specialist]. He's a big reader of *National Review*. ...

Question: This thing about the FEF. ...

There are a lot of people who are cautious of involvement with that group because of the way they go about things. They're a little spooky. They move a little fast. People who sell magazines in the airport concern congressmen. They've got the right idea. I have had lot of people tell me the stories in their magazine are the best technical stories on fusion, so they have some credibility. ...

Question: What were you doing before you came to the Hill?

I was in public broadcasting and telecommunications. ... I had no energy background at all. I knew about the antinukes, and figured they came out of the 1960s antiwar groups. I was more of a conservative Republican than the "March on Congress" crowd.

Question: That's funny because most of the Public Broadcasting Service people are liberals.

Yes, I tramped with those people for 10 years, mainly out in the stations. The stations are not that liberal; it's the people in New York. I've tried both ideologies and since coming to the Hill, I feel more comfortable with *National Review* than even with *Time* magazine. ...

LASL Director Backs McCormack Fusion Bill

In a personal letter to Senator Pete Domenici (R-NM) Feb. 29, the director of the Los Alamos Scientific Laboratory in New Mexico, Dr. Donald Kerr, affirmed his support for the Apollo-style fusion bill (HR 6308) introduced into Congress by Mike McCormack (D-Wash). Domenici is a member of the Senate Energy Committee.

The McCormack bill has not yet been introduced in the Senate and scientists in the fusion community have been involved in finding a Senate sponsor.

Excerpts from the Kerr letter follow:

Congressman McCormack has introduced a bill in the House which would significantly increase funding for the development of magnetic fusion into a commercially attractive source of energy. This bill would enable the country to pursue this development on a high priority basis and establish as a national goal the construction and successful operation of a magnetic fusion electric generating demonstration plant before the end of this century. In the estimation of experts from the national laboratories, industry, government, and the universities this goal could be achieved on this time scale, and this would provide the country with the basis for commercializing this energy source. The country could then look back at this historic legislation and recognize it as an act of political vision on the part of the Congress.

My colleagues and I at the Los Alamos Scientific Laboratory believe the proposed step is a wise one, justified by impressive technical achievements during the past several years, and urgently required by the political, economic, and social problems with which the energy crises threatens the United States. Our belief is based on the long term Los Alamos involvement with the nuclear fusion process ....

The Lab and I stand ready to provide you and your staff with additional information about the status of the national fusion program and our own contribution to it.

The DOE's Earth Day

The most disturbing thing about the DOE's participation in the zero-growth environmentalist celebration of Earth Day April 1980 is not that the department spent more than $100,000 to bankroll Earth Day activities nor that the DOE even funded some of the antinuclear groups that plan an Earth Day sit-in at department headquarters to protest the DOE's "pronuclear" policies.

Most disturbing is the fact that 10 years after Earth Day 1970, one of the chief organizers of the original Earth Day, zero-growther Denis Hayes, is now the head of the DOE's Solar Energy Research Institute in Golden, Colorado; for this fact epitomizes how zero-growth and antiscience have become institutionalized as government policy in what used to be the world's leading scientific and technological nation.

The DOE top officialdom however, is pleased with the situation. DOE Secretary Charles Duncan told all employees in a department memo that Earth Day "will be both a celebration of the achievements already made and an opportunity to push forward to new environmental and conservation goals for the 1980s."

Dennis Hayes was even more sanguine: "Our efforts which began on April 22 ten years ago have helped alleviate the environmental and societal problems that plagued our society. Earth Day is being organized to give hope. Many of the easy victories are now behind us and the second environmental decade promises to be even more challenging."

The "first environment decade" kicked off by Earth Day 1970 was put together by the admirer of primitive societies, Margaret Mead, and was bankrolled by Robert O. Anderson, director of the Aspen Institute and member of the Club of Rome. This year's Earth Day 80 will be a celebration of how far the environmentalists have pushed the destruction of the nuclear industry and all advanced technology.

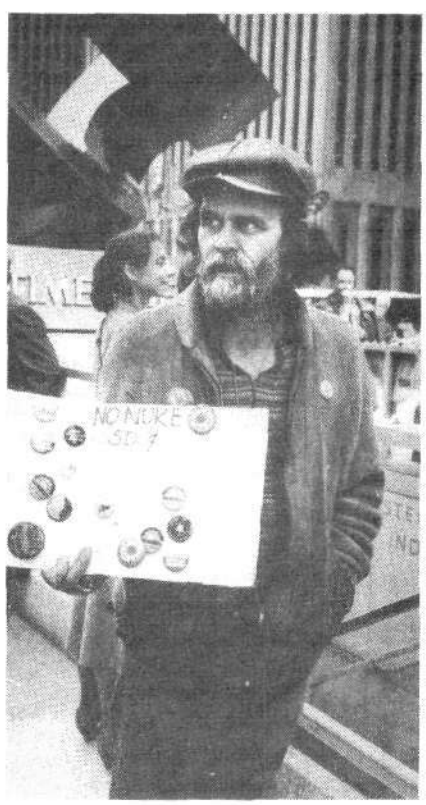
Photos by Stuart Lewis/NSIPS

The Earth Day celebration in New York City. Above: Mirrors at right can heat the kettle of water in only 40 minutes. Below: One of the DOE's Earth Day "achievements"?

The DOE has made available $2,000 through each of its 10 regional offices under its assistant secretaries for the environment and for fossil fuels, and the DOE's education office is making further small grants available. In all more than $140,000 will be spent on Earth Day by the DOE.

DOE grants for the celebrations include exhibits on solar energy, conservation, "renewable fuels" such as alcohol—and some antinuclear propaganda. Asked whether any of the community groups getting DOE funds for the Earth Day activities would be going to Washington four days later to stage a civil disobedience demonstration at the DOE against nuclear power, one DOE spokesman said: "It wouldn't surprise me."

The Coalition for a Nonnuclear world, the umbrella group sponsoring the sit-in, includes groups that were recipients of DOE grants.



U.S. Coal Conversion Plan Spells Economic Disaster

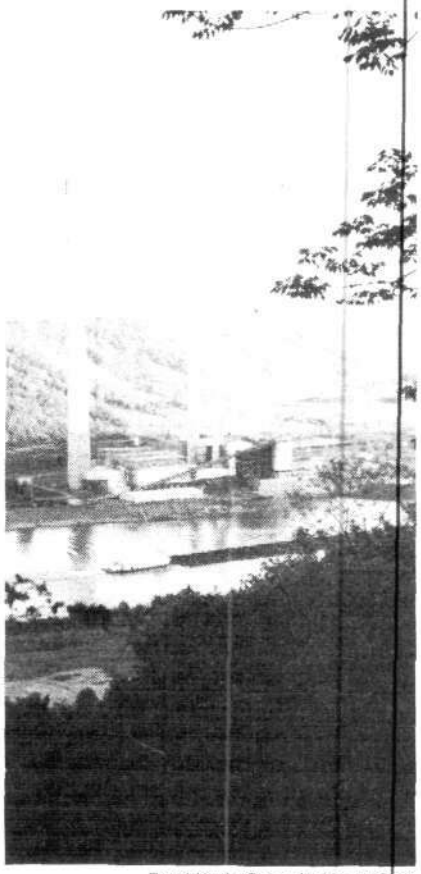
President Carter has added a sweetener to the administration's three-year crusade to induce the nation's electric utilities to convert to coal: He proposed March 6 that the federal government kick in $10 billion over the next 10 years to help the utilities cut oil consumption.

The new administration proposal also reduced the coal-conversion goal. In July 1979, the president had proposed cutting the utilities' oil consumption in half by 1990 to 1.5 million barrels per day; now the goal is to cut the utilities' oil consumption to 2 million barrels per day. Currently, the nation's utilities burn about 3 million barrels of oil per day out of a total oil consumption of 17 million barrels per day.

Talk of utility conversion to coal began after the 1973 oil embargo when the Federal Energy Administration issued voluntary conversion orders, mainly to utilities in the Northeast. When not one utility had voluntarily converted to coal, the orders became mandatory; but since then the orders have been tied up in legal challenges.

Why have the utilities resisted conversion to coal? The utility industry, the National Coal Association, and the boiler equipment manufacturers who would have to supply the conversion equipment stated their answers plainly in 1977: Oil-to-coal conversion would waste billions of dollars that the utilities need in order to supply cheap, reliable power; it would adversely affect the reliability of the electric grid system; it would actually waste energy in terms of the BTUs needed per kilowatt hours produced; and it would put an unreasonable strain on the transport system and the electric equipment manufacturers.

In any case, the utilities had their own, well-conceived plan for phasing out oil-burning capacity—building more nuclear power plants.



President's Commission on Coal

Coal-fired generating plant in West Virginia

The Conversion Plan

The president's latest offer consists of federal grants to the utilities in two stages. From 1980 to 1985, phase one would mandate the conversion of 107 power plants, mainly in New England, with federal grants totaling $3.6 billion and a goal of saving 400,000 barrels of oil per day. Phase two would offer $6 billion for power plants mainly in the South and California, in order to save another 600,000 barrels of oil per day.

The total program would require the transportation of approximately 72 million tons of coal, mostly into the New England region—a task which even the Department of Energy has admitted would strain the railroads and increase freight rates.

Equally disastrous are the expected environmental effects. Reportedly the Environmental Protection Agency fought with the DOE for eight months on the consequences of burning the coal, particularly in the New York-New Jersey region. (It is now illegal to burn coal in New York City.)

The EPA has estimated that the administration's conversion program would increase sulfur emissions in New England by as much as 25 percent, also increasing the phenomenon of acid rain. The combination of water in the atmosphere with sulfides in the air produced from burning coal is known to adversely affect the acid balance of bodies of water when it rains, and the so-called acid rain has rendered lakes and rivers in upper New York State and Canada sterile.

Economic Disaster

Immediately disastrous for the utility industry and the population of New England will be the financial effect of coal conversion. A recent study by the Engineering Societies Commission on Energy, "Regional Conversion to Coal," puts it bluntly: "Because of its physical characteristics, simple conversion to coal of a utility steam boiler unit designed for oil or gas is not feasible. Boiler replacement or preboiler coal liquefaction or gasifications would be required. . . ."

The American Boiler Manufacturers Association made a similar evaluation in 1977: "If the unit was not intitially designed for future coal-firing . . . conversion of an industrial or utility boiler is virtually impossible and totally impractical, both as relates to economic feasibility and boiler capacity, which can be reduced as much as 60 percent . . . . This situation really means boiler replacement."

The National Coal Association report added the obvious question: Why spend billions of dollars to rebuild old oil-burning plants to burn coal, when you could build new, modern plants with higher capacities at a lower cost?

The administration has never come up with an answer.

In 1977, the Edison Electric Institute estimated that the coal conversion plan would cost the electric utilities and, therefore, their customers more than $50 billion. This is no exaggeration, as the case of the Long Island Lighting Company in New York shows. For the last 10 years, Lilco has planned to phase out its oil-burning power plants and replace them with nuclear capacity. Lilco estimated that its two planned nuclear units at Jamesport, N.Y. alone would replace 20 million barrels of oil per year.

Now Lilco has been ordered to convert 10 power plants to coal in the first phase of the DOE program, which the utility estimates will cost $3.2 billion. In other words, Lilco alone would need nearly one-third of all the money being offered in federal grants just to convert 10 plants. The costs of conversion "are shocking to us," Matthew C. Cordero, Lilco vice president for engineering, remarked in the *Engineering News Record* March 13.

The cost of conversion (or in many cases rebuilding the entire boiler, putting in coal handling, transport, and storage facilities, and installing environmental pollution control devices—all of which require the expenditure of a lot of energy) can vary significantly depending upon whether the plant burned coal in the past. However, it is clear that the administration's program would require more than $30 billion for the 1980-1985 phase alone.

This $30 billion is more than the total capital expenditure of the entire utility industry in 1980. Therefore, over the next five years of phase one, more than 20 percent of the utility industry's capital investment will have to go for coal conversion, while the president's offer would pick up less than one-fifth of the total cost.

And where will the rest of the money come from?—increases in consumer electricity bills. Considering that it can take more than six months to make the conversion to coal, consumers will also take the chance of foregoing a reliable electric power supply while the units are taken out of service.

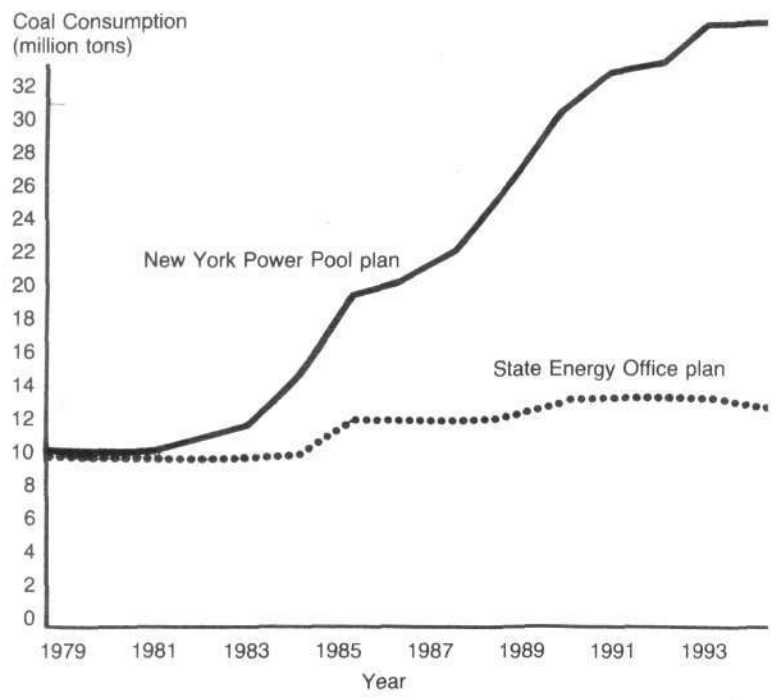
—*Marsha Freeman*

New York State: Case Study in Planned Shrinkage

In August 1979, under the signatures of Governor Hugh Carey and Energy Commissioner James LaRocca, the newly established New York State Energy Office (SEO) published an "Energy Master Plan" designed to make New York energy "self-sufficient" on the basis of the most backward and costly energy technologies available. If the official plan is implemented, New York will change dramatically, from the populous and productive industrial state it is today into a rural landscape dotted with legalized gambling centers.

The plan specifies the elimination of any new nuclear plants, an across-the-board conversion of oil-fired plants to coal in the immediate term, and the use of solar, wood, biomass, and "cottage-level" hydroelectric projects as the primary sources of energy for households and industry. Most incredible, the plan specifies: "Such renewables as wood and solar, as substitutes for conventional fuels, make better use of the state's indigenous resources . . . . Wood is abundantly available in New York. . . ."

Specifically, the plan intends a sharp reduction in net energy consumption—7 percent in 1980—pushing New York down to an average 0.9 percent annual rate of "primary energy growth"



PROJECTED COAL CONSUMPTION FOR ELECTRICITY GENERATION FOR NEW YORK STATE (1979-1994)

Where the New York Power Pool Plan calls for a fourfold increase in nuclear power resources, the State Energy Office Master Plan projection specifies a fixed nuclear energy base and baseload additions based primarily on conversion from oil to coal, cottage-level hydroelectric projects, and "resource recovery"—for example, depleting the state's forest lands.

over the 1978-94 period and gutting the most advanced economic sectors. The plan, in fact, identifies the state's 10 most capital-intensive industries, specifically the energy sector itself, as primary "targets for conservation."

Using the lies of the zero-growth advocates, the plan states as if it were fact: "Conservation and solar technologies per megawatt equivalent of generating capacity have lower costs and higher employment and earnings than the added new generating capacity." (For the facts, see the Inappropriate Technology section, this issue.)

Modern Feudalism

There is nothing "indigenous" about the Master Plan itself. It was devised from the top down as part of a regional plan called the Energy Corporation of the Northeast (ENCONO), an agency with bond-floating powers that is scheduled to have veto-control over the planning, funding, and supervision of energy programs in all northeastern states. (This is by agreement at the last several meetings of the Conference of Northeast Governors.)

The link with ENCONO identifies the third leading feature of the plan: Its implementation and enforcement will be conducted through a structure of the type that characterized Mussolini's "corporatism." ENCONO policy is to impose "regional autonomy" on the energy-base of the Northeast, forcing contraction in productive economic activity and population levels by subordinating the regional economy to whatever energy supply is available indigenously.

In the Master Plan's own words: "ENCONO will be the agency to plan, expedite, and finance projects to reduce regional energy costs and increase energy supplies. With ENCONO as the funding mechanism, the Northeast and New York state specifically, would develop its own sources of energy. . . . Since none of the three major fuels used for electric generation (coal, nuclear, oil) are either substantially produced or processed within New York, their employment and earnings impacts within the state are assumed to be negligible. . . ."

The primary public spokesman for the ENCONO policy is Felix Rohatyn, a general partner at Lazard Freres, the U.S. subsidiary of Lazard Brothers investment bank in London. Not coincidentally, Rohatyn and his circle are high-profile advocates of "controlled disintegration" of the industrial economies of the Western nations. The definitive formulation of this policy was issued by the New York Council on Foreign Relations' *1980s Project* in a series of publications. (See *Fusion*, Oct. 1979 for details.) Rohatyn, specifically, is the chief architect of New York's Municipal Assistance Corporation, "Big MAC," whose debt-pyramiding, service-cutting policy for New York City is the financial aspect of what Rohatyn circles term "planned shrinkage."

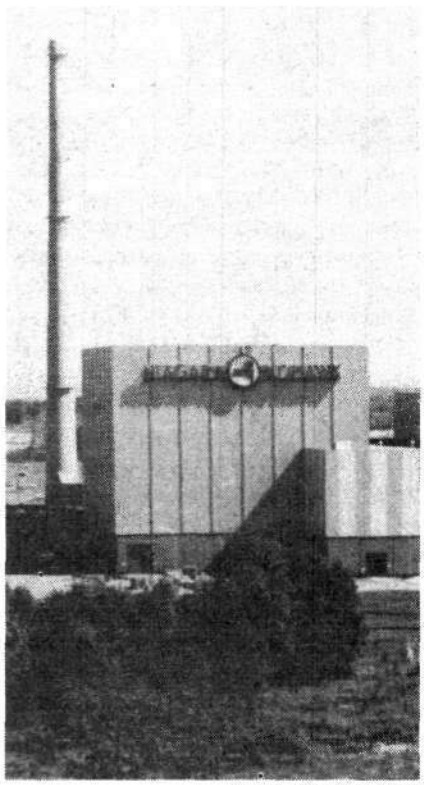
Under the shrinkage policy, New York City's current population is to be cut in half (a proposal made openly by the "controlled disintegration" faction) and the municipal economy shifted to services and recreational entertainments typified by legalized gambling, prostitution, and drugs. New York is not the only state slated to shrink. ENCONO and its New York Master

COMPARISON OF THE NEW YORK STATE ELECTRIC PLANS THROUGH 1995
(Megawatts)

	New York Power Pool Plan	State Energy Office
Oil-to-coal conversions	*0*	5,982
Baseload additions		
Nuclear[1]	9,050	1,900
Coal[2]	850	2,050
RDF/Coal	700	700
Oil[3]	850	850
Pumped-storage	1,000	1,000
Small hydro	213	725
Resource recovery	32	298
Cogeneration	0	224
Imports	800	800

1. 1,900 MW already under construction.
2. Includes Somerset, 850 MW.
3. Oswego 6, already under construction.

The differences between these two New York state plans is primarily a result of the NYPP's emphasis on increased use of safe, clean nuclear power resources. The State Energy Office's proposal, on the contrary, calls for massive conversion of oil burning plants to coal-burning plants and the related use of wood-burning technology—even more polluting than coal. The State Energy Office proposes no new nuclear power resources at all through 1994.



Niagara Mohawk Corp.
New York's Niagara Mohawk Nuclear Plant near Oswego

Plan are just one of several national models now afoot; California under Governor Jerry Brown and the Tennessee Valley Authority under S. David Freeman are other models underway.

It is not an accident of selection that New York under Governor Hugh Carey has produced the first plan within the ENCONO region. The Sodom-and-Gomorrah aspect of both regional and urban "planned shrinkage" touches upon the seamier side of the New York governor's rise to high office. Carey, in fact, announced his support for "legalized gambling" during the 1978 gubernatorial election campaign, only days after he received several tens of thousands in campaign contributions from the Canadian Bronfman brothers (Seagrams whiskey). The Bronfmans, who are allied to the Rohatyn circles, reportedly got into the black market during Prohibition and have since then become tied to related organized crime activities including drug running and the current drive for "legalized gambling" throughout the United States.[1]

Such sponsorship permits the New York State Energy Master Plan to talk of "economic growth" under ENCONO, despite the plan's conspicuous designs to destroy the state's productive industrial base. The economic model used to create the plan is "linked to the Wharton Long Term Annual and Industrial Model," which sees economic growth not in industrial production but in increased cash flows through services and entertainments like prostitution, gambling, and drugs. "There is no fixed relationship between energy and economic growth in a period of significant energy price, public policy, and institutional change," the report declares.

In fact, in the Wharton-linked forecasting model developed for the New York energy planners by Charles Rivers Associates, the industrial impact of the plan was deliberately left out. "The office [State Energy Office] concentrated combined staff and consultant resources on developing residential and commercial models," the report says.

Can It Be Stopped?

The 1,000-page report has been carefully kept from the public.[2] The traditional, broad-based institutions formerly responsible for New York energy-policy planning—the New York Power Authority and the New York Power Pool, a utilities industry group—are usurped by the Master Plan, as is the New York State Legislature. All that the Master Plan requires to be implemented is the approval of the same State Energy Office that wrote the plan and a five-member Energy Planning Board that Governor Carey created by executive fiat. If the plan is approved, energy policy is removed from the elected representatives of the people and handed to ENCONO.

The prerogatives of these agencies and constitutional government itself are not the only issue. Both the New York Power Authority and the Power Pool have submitted policy recommendations to the governor's Planning Board that are sharply opposed to those of the ENCONO-oriented Energy Master Plan.

For example, the New York Power Pool's proposals for electricity generation through 1995 (see figure and table) reject the oil-to-coal conversion that is the immediate feature of the Master Plan; the power pool also wants significant increases in nuclear power, which the Master Plan rejects altogether, using the antinuclear hysteria after Three Mile Island as an excuse.

The New York Power Authority, an even more influential body than the Power Pool, advocates a more expansive nuclear program, and is currently at loggerheads with the governor's Planning Board over that agency's refusal to even grant it site permission for a *coal* plant. Despite tremendous political and financial pressures, the Power Authority, which was established in 1931 "for the purpose of improving commerce and navigation on the St. Lawrence River," has not lost its commitment to real economic growth.

—Mary Gilbertson

Notes

1. The Bronfmans' connections to the drug trade is documented in the bestselling book *Dope, Inc.* by David Goldman, Constandinos Kalimtgtis, and Jeffrey Steinberg (New York: Campaigner Publications, 1978).
2. The State Energy Office refused to let the author look at the plan, saying that it was available in public libraries. A check of New York's major libraries, however, revealed that the report was not there.

Gov. Stalls TMI Cleanup

Pennsylvania Governor Dick Thornburgh has stalled the venting of krypton gas from the damaged Three Mile Island containment building by requesting yet another opinion on the situation, this one by the Union of Concerned Scientists, an avowedly antinuclear group.

Three previous evaluations—the first by Metropolitan Edison, the plant operator; the second by the Nuclear Regulatory Commission; and the third by the governor's own independent Blue Ribbon Committee—all recommended venting the radioactive krypton gas as quickly as possible. These three groups also were in complete agreement that the safety problems associated with controlled venting are minimal and that there would be no danger to the public.

The governor has offered to reimburse the Union of Concerned Scientists (UCS) for the costs incurred in their study out of the special governor's fund, and he has asked the Nuclear Regulatory Commission to cooperate with the antinuclear group by delaying its decision on venting another four to six weeks until the UCS study is completed.

In a letter to NRC Chairman John Ahearne April 13, Thornburgh wrote: "Please be assured that my request to UCS in no way represents a judgment, on my part, regarding the venting proposal. If a broad consensus is possible on this difficult question, however, I believe it would be in the public interest for all parties to work together in a good-faith effort to reach one. . . . Your support and assistance in this regard would be deeply appreciated, not only by me, but by the people living in the area surrounding Three Mile Island."

The NRC has agreed to Thornburgh's request and has set up an information exchange with the UCS.

Continued on page 67

Three Mile Island And the Sabotage Question

1 Utilities Tackle Lies on TMI, Punt on Sabotage Question

After a year of outrageous media lies on the Three Mile Island nuclear plant incident, the utilities industry has begun to show the first signs of a fight. At a Washington, D.C. press conference March 25 sponsored by the Nuclear Oversight Committee, a group formed by regional electric utility presidents, committee members told the press precisely why the Three Mile Island incident could never have become a "disaster"—and why it would be a disaster for the nation not to go nuclear.

"Energy developments in the year since the TMI accident have proved that the greatest risk related to nuclear power is the risk of facing the future without it," stated Floyd Lewis in his opening remarks. Lewis, the chairman of Middle South Utilities Company headquartered in New Orleans, is the chairman of the Nuclear Oversight Committee.

"The compelling evidence of the past 12 months," Lewis said, "demonstrates not only that nuclear power is adequately safe, but also that it is absolutely necessary."

Lewis's remarks were backed up by a months-long committee study of TMI delivered to President Carter titled "A Report to the President and the American People—One Year After Three Mile Island." Compared with previous industry studies, the committee's report at least attacks head-on the anti-nuclear policy of the Carter administration: "The national energy direction—whether by deliberate policy or drift—has taken us farther away from domestic energy adequacy rather than closer to it. We must remove the roadblocks to the development of domestic energy supply," the report states.

No Meltdown Possible

Speaking for the Nuclear Safety Analysis Center, a subgroup of the Nuclear Oversight Committee connected to the Electric Power Research Institute, Dr. Edwin Zebroski specified rigorously why the Three Mile Island incident could not possibly have become a catastrophe, as the press and some of the official reports have continued to insist. (The Analysis Center, set up by the industry after TMI, has the capability of simulating and studying any type of malfunction or accident in a nuclear plant.)

The official Nuclear Regulatory Commission investigation, known as the Rogovin Report, for example, concluded that if the pressure relief valve at TMI had been left open for another 30 to 60 minutes, a core meltdown would have occurred.

Such "assertions of a narrowly averted catastrophe at TMI have no foundation," Zebroski said. "Even if the operators at TMI had continued to misread the condition of the core for several more hours and melting had begun, the addition of water at any subsequent point would have stopped the accident."

Zebroski based his statement on the results of a newly released study by the Electric Power Research Institute that show that when a plant operator adds water to the core, any melting in progress stops—or, as was the case at

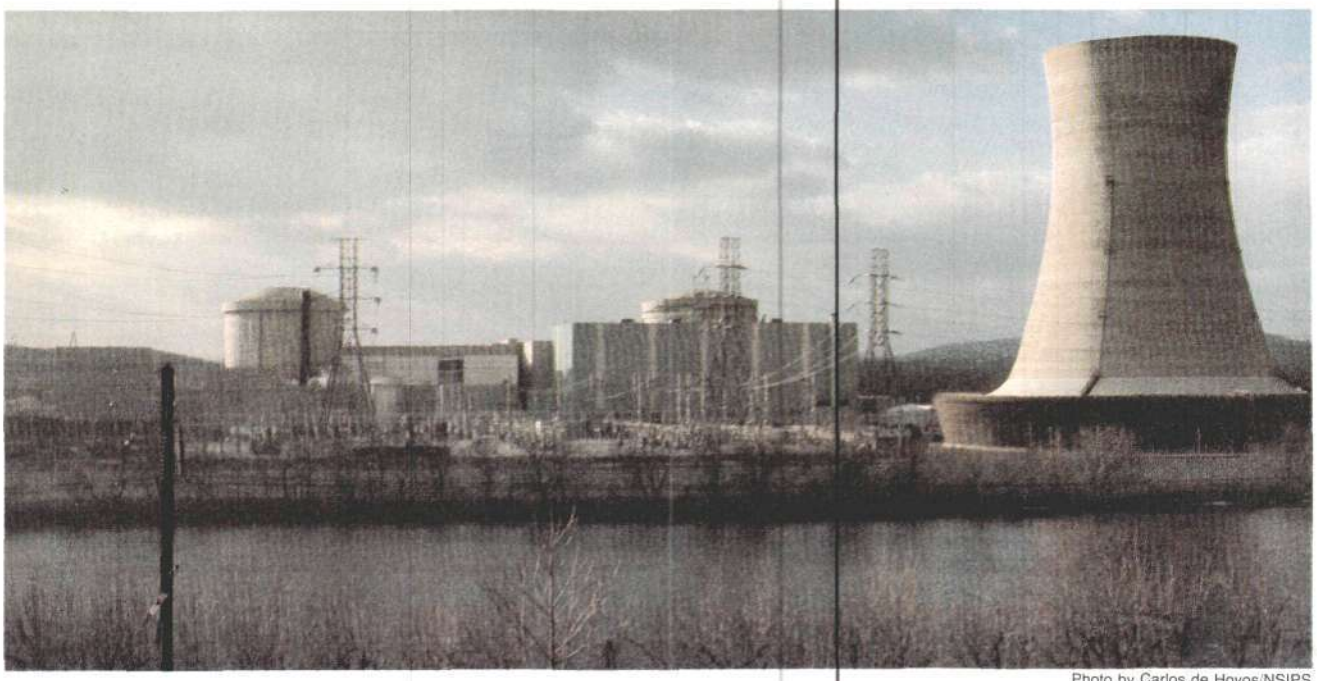


Photo by Carlos de Hoyos/NSIPS

Three Mile Island: "The larger issue remains the well-documented connection between the bottom levels of the antinuclear movement and the top level controllers of the Carter administration's antinuclear policy."

TMI, is prevented. Furthermore, the EPRI investigation concluded that taking into account the known conditions at TMI and the normal reliability of the several back-up sources of water, no damage would have occurred to the containment building—even if the accident had gone on unchecked for many hours beyond the point of meltdown.

In other words, there is no "China Syndrome."

Nuclear Is Even Safer

The actual results of the TMI incident and the subsequent investigations have proven that nuclear reactors are even safer than they were originally thought to be in earlier studies such as the Rasmussen Report. Combining this fact with the improvements that have already been made in the safety of existing and future reactors based on lessons learned from TMI, there is no reason whatsoever, as the Nuclear Oversight Committee pointed out, that the United States should not immediately recommit itself to a vigorous expansion of nuclear power—long recognized as the most economical resource available.

Certainly one of the best proofs of this, as reported by the EPRI and the Nuclear Oversight Committee, is that since the incident at TMI, the rest of the world has decided to go full steam ahead with nuclear power development.

For example, the Soviet Union's planned nuclear capacity has increased 35 percent over the past year; France plans to start up one new reactor every two months for the next five years; and Britain will have more than 50 percent of its electricity supplied by nuclear by the early 1990s (see section 3 for more details).

The Question of Sabotage

The utility report nonetheless contains a crucial flaw. The most glaring omission in the documents and information presented by the Nuclear Oversight Committee is its failure to deal with the question of potential sabotage at Three Mile Island and the issues of plant security that it raises. For example, the Fusion Energy Foundation has pointed out that no one has yet discovered who closed the emergency feedwater block valves prior to the March 28 incident and why—was it an act of sabotage or negligence? (See Section 2 for a rundown of TMI reports on the sabotage question.)

Four different investigations, the Nuclear Regulatory Commission, the Kemeny Commission, the Rogovin Report, and now even the Nuclear Oversight Committee have concluded that the fact that these valves were not known to be closed misled the operators and further confused them during the early stages of the incident.

For example, the EPRI-Nuclear Safety Analysis Center report, "Analysis of Three Mile Island Unit 2 Accident," specifically states: "The second condition [that is, the closed emergency feedwater block valves] resulted in a temporary unavailability of auxiliary feedwater for a period of almost 8 minutes at the beginning of the accident. This factor was not a significant, direct contributor to the damage of the core during the accident. However, it was a key factor in terms of additional problems for the operators, and it may have contributed to the failure of the operators to recognize the course of the event and to take the actions which would have resulted in a controlled shutdown of the plant" [Appendix TH, page 25].

This report and the others mentioned, then make an about-face and say that it did not matter, since the outcome would have been the same.

They assume, as an easy way out, that the operators' actions would have been identical whether or not they were being confused by the unique set of control room readings caused by the combination of these closed valves and the stuck-open pressure relief valve in the reactor itself—an assumption that simply does not hold up and was not backed up by any of the investigations.

Two Other Cases

As has been acknowledged by the NRC since the TMI incident, similar, but also crucially different, events had happened at least twice, once at the Davis-Besse (Ohio) plant in 1977 and at the Oconee (South Carolina) plant in 1975. In both cases, the electromagnetic relief valve stuck open for a period of time with water eventually being dumped on the floor of the reactor containment building. However, in both cases, the operators discovered the malfunction within 20 minutes and closed the block valve in the pressurizer line thus ending the event and recovering full control.

The difference between these events and TMI, aside from lower power level in the former cases, was that the emergency feedwater system did not fail; it came on as designed because the valves were open.

This fact seems to beg the obvious question. Isn't it the case then that the closed emergency feedwater system valves made it more difficult for the operators to figure out what happened, by significantly changing the initial conditions and later readings and in fact, was a major contributor to making this incident more severe than the previous two?

Cover-up Continues

The necessity for a full investigation is underscored by continuing coverups of the sabotage question. On a morning interview show, "What's Happening America" on WOR-TV in New York City March 25, a former TMI plant operator admitted tampering with plant records.

Subsequent investigations by the Fusion Energy Foundation indicated that WOR-TV played the interview to imply that the former plant operator, Hal Hartman, had admitted sabotaging the

2 What the TMI Reports Said About Sabotage

Title
Analysis of the Three Mile Island-Unit 2 Accident

Date
March 1980

Sponsor
Electric Power Research Institute/ Nuclear Safety Analysis Center

Approach to Sabotage Evidence
The possibility is not entertained, nor are its implications for personnel-screening, plant security, or equipment accessibility.

Specific Findings
From the standpoint of judging the safety of nuclear technology, the chain of events constituting the accident could have continued unchecked for many hours without threatening the integrity of the containment building— a nuclear plant's "bottom line" safety device. This directly contradicts one of the hypothetical scare scenarios put forth *in the Rogovin Report.*

Other Noteworthy Conclusions
Nuclear reactors are much safer than previously believed. No meltdown danger ever existed at TMI Unit 2, because even in a worst-case scenario, there was ample time to take a variety of measures certain to have prevented such a development.

Title
Investigation into the March 28, 1979 Three Mile Island Accident by the Office of Inspection and Enforcement

Date
August 1979

Sponsor
Nuclear Regulatory Commission

Approach to Sabotage Evidence
The principal question confronting investigators—how the emergency feedwater systems were put out of service—is acknowledged only as a "mystery." Conclusions drawn are exclusively concerned with what occurred *after* the accident's chain of events were set in motion.

Specific Findings
Operator error and equipment failure caused pressure, temperature, and pressurizer-level conditions of a nature that further confused operators, prolonging and deepening initial difficulties.

Other Noteworthy Conclusions
Of six possible initiating causes for the incident, NRC investigators explicitly disproved four, and a fifth was implicity discounted by weighty testimonial evidence. The sixth, "sabotage or criminal negligence," was discussed only with great circumspection.

Title
Report of the President's Commission on the Accident at Three Mile Island—The Need for Change: The Legacy of TMI (known as The Kemeny Commission Report)

Date
October 1979

Sponsor
President Carter

Approach to Sabotage Evidence
The commissioners include a passing reference to "intentionality" as a "remote possibility."

Specific Findings
The evidence compiled and findings developed parallel those of the NRC report, that equipment failure and human error combined to produce in-plant difficulties; no significant danger to the public was ever actually threatened. The greatest damage was to "the mental lives" of the area's population.[1]

Other Noteworthy Conclusions
Despite lack of supporting evidence, the commissioners dotted the report and its conclusions with an antinuclear bias. The following is a typical statement: "The analysis of this particular accident raises the serious question of whether all electric utilities have the necessary technical expertise *and managerial capabilities for administering such a dangerous high-technology plant* [emphasis added]."

Note

1. The Kemeny commissioners themselves added greatly to the "mental distress" of the population by the calculated manner in which they released their findings to the public. A private vote among the 13 panelists came out on the side of a "moratorium on all nuclear construction." Although not included in the report, whose evidence would not bear the burden of such a recommendation, the vote's outcome was deliberately leaked to the press by the commission at the time they released the report, thus providing news media with a way of coloring all coverage of the report in antinuclear shades.

plant in collusion with supervisors. The charge, although picked up by the national media, appears to be a publicity stunt by the television show's host, Ira Rosen. In the first place, a close reading of the TV show transcript shows that the tampering or "sabotage" referred to is simply the alleged falsifying of irrelevant records of water flow in the reactor.

Second, Rosen is currently coauthoring an antinuclear book about TMI along with his close associate Michael Gray, scriptwriter for the movie "The China Syndrome," and the interview was aired at the height of the recent antinuclear activity to shut down TMI permanently.

What the Hartman interview demonstrates, however, is that there were among the TMI staff the type of unstable, manipulable individuals necessary for carrying out an inside sabotage operation. For example, a utility spokesman stated that Hartman was fired for drinking on the job, and in the interview Hartman complains that he was unjustly accused of being "psychotic" by the plant psychologist, who recommended that Hartman not be allowed into any security area because of symptoms of hypertension.

Case Closed—But Unsolved

The question posed by the Hartman case is why, if it was known that there were such individuals on the TMI staff, was there not an all-out criminal investigation to determine if one or more such individuals were responsible for sabotage?

The FEF's investigation of the Hartman case revealed some interesting answers. First, it was confirmed that five different official investigations looked into the possibility of sabotage—and all of them stopped short of getting at the real story. The utility itself and the Nuclear Regulatory Commission, both looked into the sabotage possibility, the former immediately after the incident, and the latter during May and June through the NRC Office of Inspection and Enforcement.

The Kemeny Commission also considered sabotage, and in June wrote a letter to FBI chief Webster requesting that his agency pursue the investigation.

Title
Three Mile Island: A Report to the Commissioners and to the Public (known as the Rogovin Report)

Date
January 1980

Sponsor
Commissioned by the Nuclear Regulatory Commission, carried out by the law firm of Rogovin, Stern and Huge

Approach to Sabotage Evidence
This investigation, which reexamined much of the evidence compiled in the NRC report, explored some new ground. It referenced the NRC discussion of "sabotage or criminal negligence" as an unexplored possibility.

Specific Findings
The public was never actually in any danger, but had events continued as they were—even one-half hour more—very great danger of radiation leakage, meltdown, and other disasters would have resulted. (It should be noted that this conclusion was not based on the facts established in the technical part of the report.)

Other Noteworthy Conclusions
This report is "schizophrenic." Its recommendations, penned by environmentalist lawyer Mitchell Rogovin, bear no relationship to the technical part of the report, which was authored by scientists and engineers. The technical report emphasizes that reported dangers were fabrications of news media or the product of state and federal officials' unruly imagination. Rogovin's recommendations, on the other hand, feature radical measures to counteract the "great dangers" the incident revealed, including "the closing down of existing plants" that cannot meet extremely rigid licensing requirements tied to "evacuation planning."

Title
The Harrisburg Hoax: The Gilbertson Report on Sabotage at Three Mile Island

Date
March 1980

Sponsor
Fusion Energy Foundation

Approach to Sabotage Evidence
The chain of events constituting the incident could not have occurred without sabotage of some form by one or more plant operators—a conclusion with a probability of *1 million to 1* and supported by empirical evidence that several reported "mechanical" failures, in fact, were caused manually.

Specific Findings
Improbable mechanical failures occurring in series intersected unusual operator errors to make initial routine problems into an "accident": Two failures of independent emergency feedwater block valve systems were, first, followed by operator actions contrary to routine for such a case, and then, by a pressure relief valve failure, and yet another (fourth) manual backup valve failure; finally, as high pressure injection pumps were automatically correcting the situation, operators turned them off. The two emergency feedwater block valves were found not to have failed; they were closed by some unknown person(s) either by negligence or, more likely, by an act of sabotage.

Other Noteworthy Conclusions
Despite bizarre mechanical failures and consistently incorrect operator actions, there was never any danger to public or plant personnel. Reported threats of "core meltdown," "hydrogen bubble explosion," and "radiation leakage" were the imaginary products of the Nuclear Regulatory Commission's "unscientific and inflammatory reports. . . that were counter to the actual facts; and the national press and media, which operated like a Goebbels propaganda machine. . . convincing the population of things that were not true."

Title
Nuclear Power Plant Safety After Three Mile Island

Date
March 1980

Sponsor
Committee on Science and Technology, U.S. House of Representatives, 96th Congress

Approach to Sabotage Evidence
The subject is not discussed nor is the question of plant security raised. The report implies that the closure of the two emergency feedwater block valves is the result of an inadvertent act by some plant employee(s).

Specific Findings
Althought it may not have been apparent to the public at the time of the accident, a disaster was never imminent. Even if the reactor had lost all cooling and all the fuel had melted (an unlikely event given the circumstances), a sufficient margin of safety remained to make it very unlikely that the release of radioactive materials to the environment would have been substantially larger than what occurred.

Other Noteworthy Conclusions
The committee hearings showed that despite the serious nature of the accident at Three Mile Island, a significant safety margin was built into the system protecting the public from serious harm. It remains true that not a single death can be directly attributed to the release of radioactivity from operating civilian nuclear power plants. In addition, nothing happened at TMI that indicates a need to modify the technical assessments that show that the likelihood of a nuclear disaster is extremely remote.

Webster's reply was that the FBI had already done so, and as far as the bureau was concerned, all leads had been exhausted; the case was closed. The Kemeny Commission, and subsequently the Rogovin Commission, therefore, simply relied upon the NRC's investigation and did nothing further of their own.

According to a former top staff member of the Kemeny Commission, the FBI investigated only the most obvious malcontents and former employees at the plant. (This may not have included Hartman, who is now under investigation by the NRC.) None of these people could be positively connected to the two closed valves. Since there were three different locations within the plant where someone could have had access to closing these valves, it was concluded that nearly 500 people would have to be investigated in order to find out the culprit.

According to reports, the FBI then decided that this was too large an effort and at that point stopped the investigation of sabotage.

Industry Error

Instead of investing the necessary resources to find out who shut the valves off and why, the investigators have simply lumped all the causes of the incident together under the category of "operator error." The conclusion drawn is that either the valves must have been left closed from two days earlier when they had been tested —even though the operators who did the test have sworn they reopened them and were checked off by supervisors—or someone "accidentally" closed them at some other time.

As the FEF noted in its recommendations to the industry, no nuclear plant will be safe from shutdown until the sabotage question is settled. In addition, the selection process for all operating or maintenance personnel, as well as security forces, should be thoroughly upgraded (*Fusion*, April 1980, pages 20-22).

Even then, the larger issue remains the well-documented connection between the bottom levels of the antinuclear movement and the top level controllers of the Carter administration's antinuclear policy.

—Jon Gilbertson and Morris Levitt

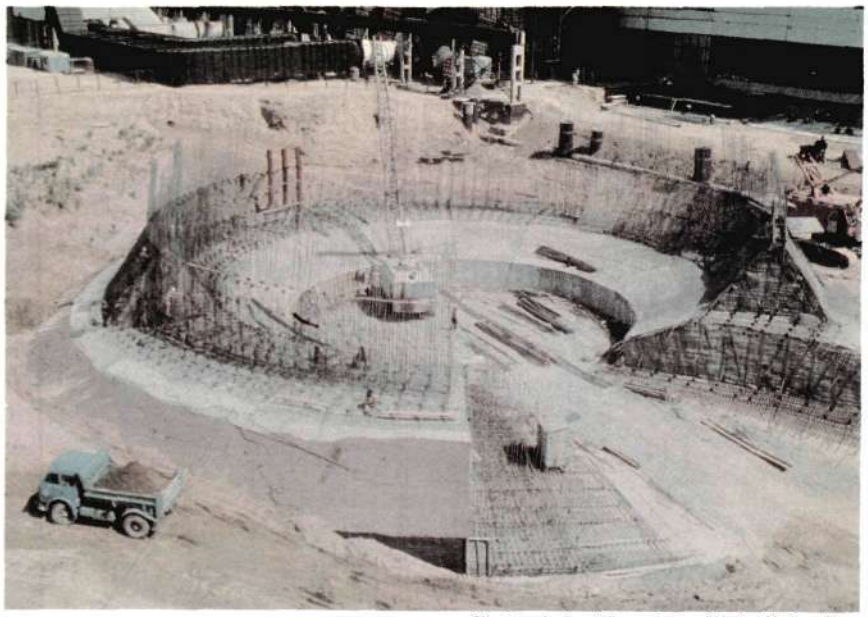


Photo by A. Gorokrik, courtesy of United Nations/Tass

Nuclear construction is booming in the East bloc. Here a cooling tower under construction at the Syr-Darya Power Station in the Soviet Union.

3 After TMI: The World Goes Nuclear

This evaluation of the international reactions to Three Mile Island appeared in the March 1980 report "Analysis of TMI Unit 2 Accident" issued by the Electric Power Research Institute. Most sobering for Americans is the glaringly obvious fact that while TMI has been used as an excuse to shut down U.S. nuclear power, other nations are maintaining and even increasing their commitment to nuclear energy. The Soviet bloc, for example, has upped the planned amount of power to be supplied by nuclear by one-third since TMI.

* * *

How have other countries with nuclear electricity programs reacted to the Three Mile Island accident?

Specifically, a number sent scientists, engineers, physicians, journalists, and government investigators by the hundreds to visit not only the stricken reactor, but also U.S. nuclear equipment suppliers, technical experts, and regulatory agencies. These professionals were sent to look, listen and read, to interpret Three Mile Island as a lesson to be learned and applied to nuclear programs. The main point is that their countries are maintaining—and, in some cases, expanding—commitments to nuclear energy as a major source of future electricity generation.

Of course, as in the United States, a few Western governments have been faced with sophisticated demonstrations opposing the proenergy, pronuclear programs, but energy officials in most countries are steering through such political diversions and concentrating on securing their energy supplies as firmly as possible. Their decision to rely on nuclear is based on reality: nuclear's economic advantages, its minimal impact on the environment, its good health and safety record, its contribution in reducing oil imports, and its commercial viability compared with renewable energy sources.

Sustained reliance on nuclear is also borne out by virtually all objective energy studies, including this year's U.S. National Academy of Sciences report and the International Nuclear Fuel

Cycle Evaluation (INFCE) report. The academy report urges the use of nuclear as a major source of electricity for the next several decades. The INFCE study, prompted by the United States and involving some 60 nations, extends endorsement of nuclear to approval of the fast-breeder reactor as the next logical step in the energy programs of major industrial nations.

The Nuclear Energy Line-up

Right now, there are 42 countries outside the United States with nuclear electricity programs. These embrace total commitments of nearly 600 reactors, nearly 450,000 electrical megawatts (MWe), and are growing every month. Most popular are U.S.-type reactors, including the pressurized water reactor, similar to the Three Mile Island station. U.S.-type reactors account for about two-thirds of all non-U.S. plant commitments. Two more such reactors were ordered last year, after the TMI accident, by South Korea. Also significant is the promotion of energy conservation by advancing the commercial use of nuclear-fuel reclamation through chemical reprocessing and development of the fuel-efficient fast breeder reactor. These last activities have been severely restricted in the United States under the Carter administration.

In 1978, about 6 percent of the world's electricity came from nuclear plants, according to the International Atomic Energy Agency—an impressive portion considering the relatively short commercial life of the technology. With about 130,000 nuclear MWe to be in operation this year and many more plants scheduled to come on line every year thereafter, this share will be growing dramatically.

A meaningful picture of nuclear's place in the world energy supply outside the United States can be seen in certain details:

France

France may have the most vigorous program at the moment. Accepting a virtual absence of domestic oil and coal, the country has expanded its nuclear commitment to a total of 65,000 MWe, with more to come. French officials plan to start up a new nuclear plant, on the average, about every two months for the next five years. The nation is also reprocessing spent fuel and has a waste-management program. Its breeder program was expanded a few weeks ago and now projects four large semicommercial units.

Japan

Japan has the largest nuclear program outside the United States, with commitments for 78,000 MWe to be on line by 2000, plus domestic fuel reprocessing, waste management, and a commercialized breeder.

Soviet Bloc

An overall total of 120,000 nuclear megawatts is on the books for the Union of Soviet Socialist Republics and countries commercially linked to it: Eastern Europe, Cuba, Finland, and Libya. This marks an increase of more than a third for these countries in about 18 months. Soviet reactor-manufacturing facilities are being expanded rapidly to keep up with demands. The Soviet Union is also specifying secondary reactor containment for certain plants there, a safety feature common in the United States but previously considered redundant in the Soviet Union. Its program includes development of the breeder; a 600-MWe sodium-cooled fast reactor, in the Urals, recently went critical.

"Sustained reliance on nuclear is also borne out by virtually all objective energy studies. . . ."

The Americas

Brazil and Argentina, largely with West German reactor manufacturing agreements, dominate programs in South America. In the rest of the Americas, Mexico—with rich oil resources—is nevertheless turning to nuclear for future electricity stations, a program that will add seven reactors to the two (1,300 MWe) now being built. Canada's well-established program is rounded off with fuel-reprocessing and waste-management demonstration units.

West Germany

The Federal Republic of Germany, harrassed by a highly vocal minority opposition, nevertheless forges ahead, including the breeder, fuel reprocessing, and waste management.

Italy

Italy's program has been slowed for various reasons, although a substantial commitment is intact. Revitalization looks imminent, following the recent agreement between Finmeccanica and Fiat to expedite construction schedules, especially for five twin-unit nuclear plants with 10,000-MWe capacity. The country already has more than 1,400 nuclear megawatts on line producing electricity and is building plants totalling 2,000 additional megawatts.

United Kingdom

The present goverment of the United Kingdom is firm in support of nuclear electricity. One new station a year is to be ordered between 1982 and 1992, while the UK breeder, fuel-reprocessing, and waste-management programs proceed. However until now, the British have not used U.S.-type reactors. This apparently will be changed when the next order is placed; it's to be for a U.S.-type pressurized water reactor.

Sweden

Sweden, a country so often cited as ideal in efficient use of energy and conservation successes, receives about 25 percent of its electricity from six operating nuclear plants (about 3,600 MWe). Six more plants (about 6,000 MWe) are being built there....

India

In the Far East, India is prominent—with a nuclear program expected to provide about 6 percent of its electricity by the end of the century—mostly for a fairly new fuel-reprocessing and waste-management project and its construction of a demonstration fast breeder reactor.

4 East and West Agree: Nuclear Is the Answer

India

Indira Gandhi
Prime Minister

We must have our eyes and ears open to developments in the nuclear field and be in touch with the latest technology. . . . We remain committed to the use of atomic energy for peaceful purposes. . . .

—Speech to the Indian Parliament, New Delhi, March 13

Dr. Homi Sethna
Chairman, Atomic Energy Commission

Public acceptance of nuclear power is not an issue in India because the no-growth philosophy and the curbing of consumption which is being advocated by industrialized Western countries has no relevance to our socioeconomic conditions. Our need is not curbing consumption, but increasing production for survival. . . . For this purpose, India requires a range of nuclear technologies and a string of nuclear power plants.

—Speech to an Indian scientific group, March 1980

France

Valery Giscard d'Estaing
President

Why nuclear electricity? At the present time there is no other readily available technology. There won't be for 10 or probably 30 years. Moreover, it is an investment that pays off highly since the higher oil price means that 1 kilowatt-hour produced in a nuclear plant will cost about 13 or 14 centimes whereas the kilowatt-hour produced from oil will cost on the order of 24 to 25 centimes. So there is a very significant difference in price. Lastly nuclear electricity enables France to be more independent from the energy viewpoint; that is, so nobody can tell us what to do. . . .

—Statements made in an interview Jan. 18 on Radio Europe No. 1.

Soviet Union

Aleksei Kosygin
Premier

In the current Five Year Plan, the Soviet Union is supplying to the nations of the Council on Mutual Economic Assistance almost 370 million tons of oil, 46 million tons of petroleum products, 88 billion cubic meters of gas, and 64 billion kilowatt-hours of electricity. In the next Five Year Plan, these supplies of fuel and energy resources are slated to grow overall by 20 percent. . . .

We must. . . approach our problems of production and consumption of fuel, energy, and raw materials from the standpoint of technological progress.

The development of atomic power is foremost in providing for the energy needs of the CMEA countries. Our joint program for building nuclear power plants will give a growth in capacity equal to over one-third of the present capacity of electricity generation in the European members of the CMEA plus Cuba. . . .

—Statements made during the June 26-29, 1979 summit of the Council on Mutual Economic Assistance

West Germany

Helmut Schmidt
Chancellor

France will then produce 50 percent of its electricity from nuclear energy—six years from today. The East bloc plans to expand its nuclear energy production from 33,000 megawatts to 140,000 within 10 years. In Dublin a few days ago, the president of the European Commission, Mr. Jenkins, said the Commission saw no possibility at all in overcoming the threats to their energy resources and the economic dangers of the future without considerable exploitation of nuclear energy.

I cannot imagine that all these governments in East and West are wrong.

—Statement to the Dec. 4, 1979 Social Democratic Party convention

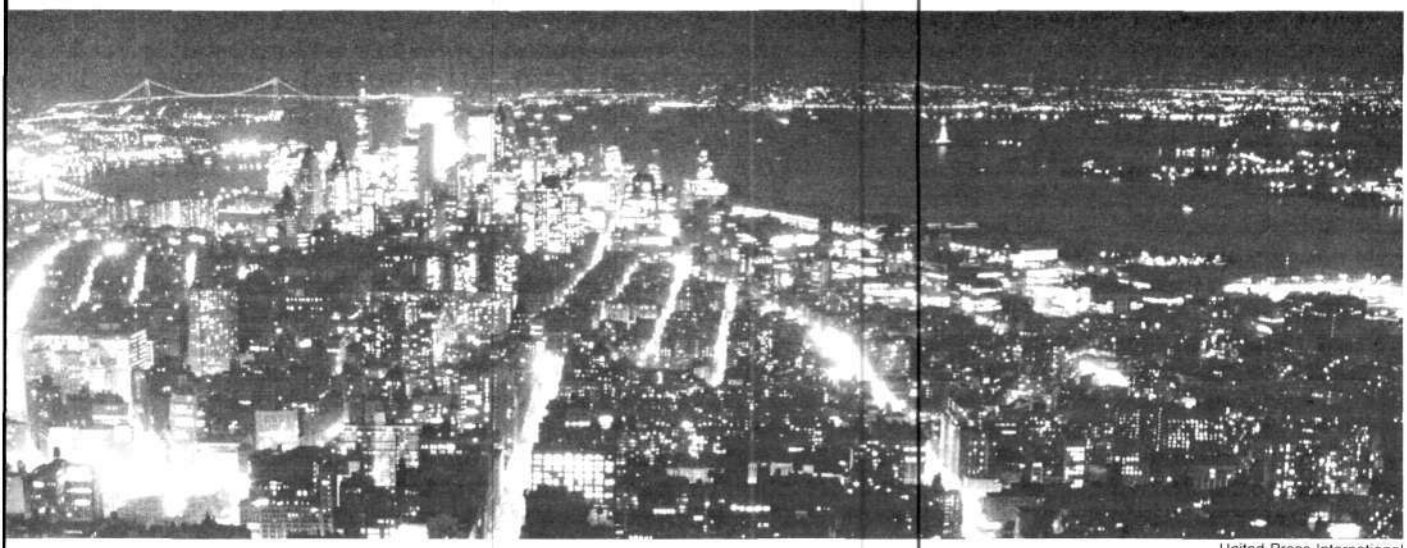
5 When Will the Lights Go Out?

The Impending Collapse of the U.S. Electric Grid

Not once in the history of this nation have people had to suffer extended power shortages because of an inadequate electric power supply—not even in wartime. Yet sober estimates by the National Electric Reliability Council (NERC), as well as studies by industry organizations, show that the United States is facing an "inevitable shortfall of electric-generating capacity."

This shortfall is not in the distant future. NERC estimates that it will hit as early as this year or, at the latest, in the mid-1980s.

The cause? Extraordinary delays in bringing new generating capacity on line because of environmentalist interference and a growing maze of governmental regulation. And it's bound to get worse. What the environmentalists hail as a return to a "simpler



United Press International

lifestyle" and what the Carter administration dictates as fiscal necessity—the end of reliable, adequate electric power—will mean lowered standards of living for the population and a backseat for the nation as an industrial power.

The ability of the U.S. economy to grow has been directly dependent on the shift from burning fossil fuels to the production of universally usable electric power. Although total energy consumption growth has averaged under 3 percent per year since 1920, the rate of growth in consumption of electricity has averaged 6.6 percent per year over the same period, with rates as high as 8 percent per year during the decade of the 1960s.

Nuclear energy has been the pacing technology for this rate of growth of electric power since the 1960s. As electric power replaced the direct burning of fossil fuels, nuclear power has replaced the use of these finite fuels, producing electricity in a cheaper, more efficient process. Between 1968 and 1976, fossil fuel plants went from a capacity of 233 gigawatts to 415 gigawatts—a 78 percent increase over eight years. In the same period, nuclear capacity went from 2.8 gigawatts to 42.9 gigawatts—*a 15-fold increase*.

Early Death of U.S. Nuclear Power

In the early 1970s, just when the oil embargo had made it clear that nuclear power was critical for the economy's health, environmental interference and regulation-gone-wild began to strangle the U.S. utilities.

For example, in 1968 a utility applying for a construction permit to build a nuclear plant was required to answer about 120 questions for the government. Ten years later, the number of regulatory questions to be answered jumped to more than 700. (Industry estimates indicate that if the government had encouraged the development of standardized plants instead of proliferating regulations, the questions would number about 200 and licensing delays would be substantially cut.)

In the early 1970s, to take another example, the 700-megawatt H.B. Robinson nuclear plant in South Carolina took 54 months to be brought into operation from the date of announcement to fuel loading. Latest estimates from the utilities indicate that now this process has stretched out to a *17-year* lead time.

Given the unstable economic situation and the pressure coming from the Carter administration, some of the utilities have almost given up.

What this means for the growth rate of nuclear power can be seen in Table 1, which summarizes the state of nuclear orders and cancellations in the last 10 years. Since orders remained healthy until 1974, it might be assumed that problems would not seriously arise until the mid-1980s when the falloff in orders from the mid-1970s would begin to hit. However, during 1979, eight reactors that were perfectly ready to go did not get operating licenses from the Nuclear Regulatory Commission—a direct result of the hysteria created around Three Mile Island.

Because only 13 plants have been ordered since 1975 while 53 plants have been canceled, it is clear that many units scheduled for operation in the early to mid-1980s will not be built.

The most insidious result in terms of the nation's energy future is that the federal government has encouraged these cancellations by forecasting that the demand for nuclear-generated electric power will be going down, not up—a case of self-fulfilling prophecy. Specifically, as Table 2 indicates, the government has accepted as fact the environmentalist verdict that the public will not tolerate more nuclear power. And looking at the numbers in the table, which serve as a critical guideline for the industry, no

"Both public and private utilities are encountering serious difficulties in bringing into service planned new generation and transmission capacity....This situation could conceivably lead to shortages implying blackouts and brownouts or managed power curtailments to consumers."

—Department of Energy National Power Grid Study, Sept. 1978

utility executive in his right mind could believe that there will be a growing U.S. nuclear industry by the end of the century.

How It Happened

Load forecasting by the utilities has never been an exact science. In the 1960s, for example, the industry found itself caught short because the Apollo space program so quickly brought whole new high-technology industries into existence that were energy-intensive.

The shortage situation now, however, is very different. The only thing that kept electric power shortages from taking place in the 1970s was the *forced slowdown* in real economic growth and the conservation in energy use practiced by individual consumers who could not afford to continue using as much power—both a result of deliberate government policy.

NERC projected that given this situation, problems in providing adequate service are still inevitable and that the situation is getting worse daily. During the year 1978, for instance, 55 gigawatts of nuclear capacity experienced some amount of delay, with an average of one year per unit. Licensing procedures alone for nuclear utilities can now take up to six years—the time needed to complete the entire project a few years ago.

Even if load growth over the next decade is only 50 percent of the historical trend of a 10-year doubling time, the capacity needed to meet this lowered demand is not likely to be completed on time. Of the 250 gigawatts now projected to begin operating by 1988, 107 gigawatts are supposed to be nuclear. Most of the coal capacity of 125 gigawatts is under construction, but according to NERC's 1978 annual report, published in August 1979, only 60 percent of the planned nuclear capacity for service during 1984-1988 is under construction.

"The implementation of the coal and nuclear programs forecasted by the utilities face serious obstacles. It is highly probable that the completion of many of these units will be delayed—in some cases for at least three years. Also, there are likely to be outright cancellation of some projects," the NERC report states. "The likelihood of delays in the completions of the projected generating capacity program raises serious concerns regarding the adequacy of bulk power supply in the United States during the next 10 years....

"The overriding concerns of NERC at this time are the discernible and disturbing trends which point to a future bulk power supply system which will be unable to maintain an adequate and reliable electric power supply for the United States—a requirement which NERC believes is essential to maintain a viable economy and to provide for the well-being of society."

Computer Industry on 'Redline'

Not surprisingly, the computer industry, one of the most energy intensive in the United States, is extremely worried about the predicted shortfall in electrical energy, "the lifeblood of the computer." As a Jan. 1980 study of the Computer and Business Equipment Manufacturers Association (CBEMA) on "Electrical Energy in the '80s" put it, "any shortfall of the anticipated magnitude would affect the growth rate of CBEMA-represented businesses by 50 percent."

Current installed computer capacity in the United States represents an investment of more than $50 billion, with a continued growth of 12 to 14 percent forecasted, according to the report. "Since every major industry and business is now computerized, the business and economic climate of the United States is dependent on the reliable operation of these equipments. Some businesses, such as airlines, essentially are helpless if their computer system network is nonfunctional."

Table 1
U.S. NUCLEAR PLANT ORDERS AND CANCELLATIONS SINCE 1970

Year	Orders	Cancellations
1970	14	0
1971	21	0
1972	38	6
1973	38	0
1974	34	9
1975	4	10
1976	3	5
1977	4	10
1978	2	11
1979	0	11
1980 (first quarter)	0	6

Source: Department of Energy

Table 2
U.S. GOVERNMENT NUCLEAR CAPACITY FORECASTS

Year of Forecast	Commercial Operation by Year 2000 (in gigawatts)
1972	1,200
1974	850–1,400
1975	625–1,250
1977	380–440
1978	380
1979 (July)	235–500

Sources: Atomic Energy Commission, Energy Research and Development Administration, Department of Energy

The report explains that the "redline" or reserve margin for the electrical utilities is that level of reserve below which brownouts are likely to occur. Until the mid-1970s, the redline capacity reserve was considered to be 15 percent. After that the redline was placed at 20 percent because economies of scale had made larger power-generating units the favored option for new capacity.

At the time of the 15 percent redline, the average utility capacity was 850 megawatts. Today that average is 1,000 megawatts. Consequently, when a unit is taken out of service for maintenance or becomes unavailable, the percentage reduction in the entire system is greater.

In 1978, General Electric asked Data Resources, Inc. to do an analysis of the impact if no nuclear plants were added between 1981-1985 and only half of the president's coal targets were met. The analysis indicated that the nation's reserve margin would drop to about 13 percent under those circumstances—way below the redline according to CBEMA.

The report also projects that electrical energy shortages can be expected by 1985, with some regional shortages likely by 1983. And if the weather is worse than projected, some regional shortages could appear as early as the 1981-1983 time period. All of these projections start with the assumption that load growth will be half its historical rate.

The computer and electronics industries represented by CBEMA consume less than 1 percent of total energy in the United States. And as they are the first to point out, the really electricity-intensive industries such as aluminum and other specialty metals will be hit much harder. For example, the aluminum industry has been forced to do research and development into new energy sources on its own because it has already experienced shortfalls in electric power availability.

Power Economics

The effect on the total economy of a slowdown in electrical power can be seen by looking at the electric power supply industry itself, the most capital-intensive industry in the U.S. economy. The Department of Energy's Sept. 1979 National Power Grid Study noted that the electric utility industry required one-fifth of all national construction expenditures and one-third

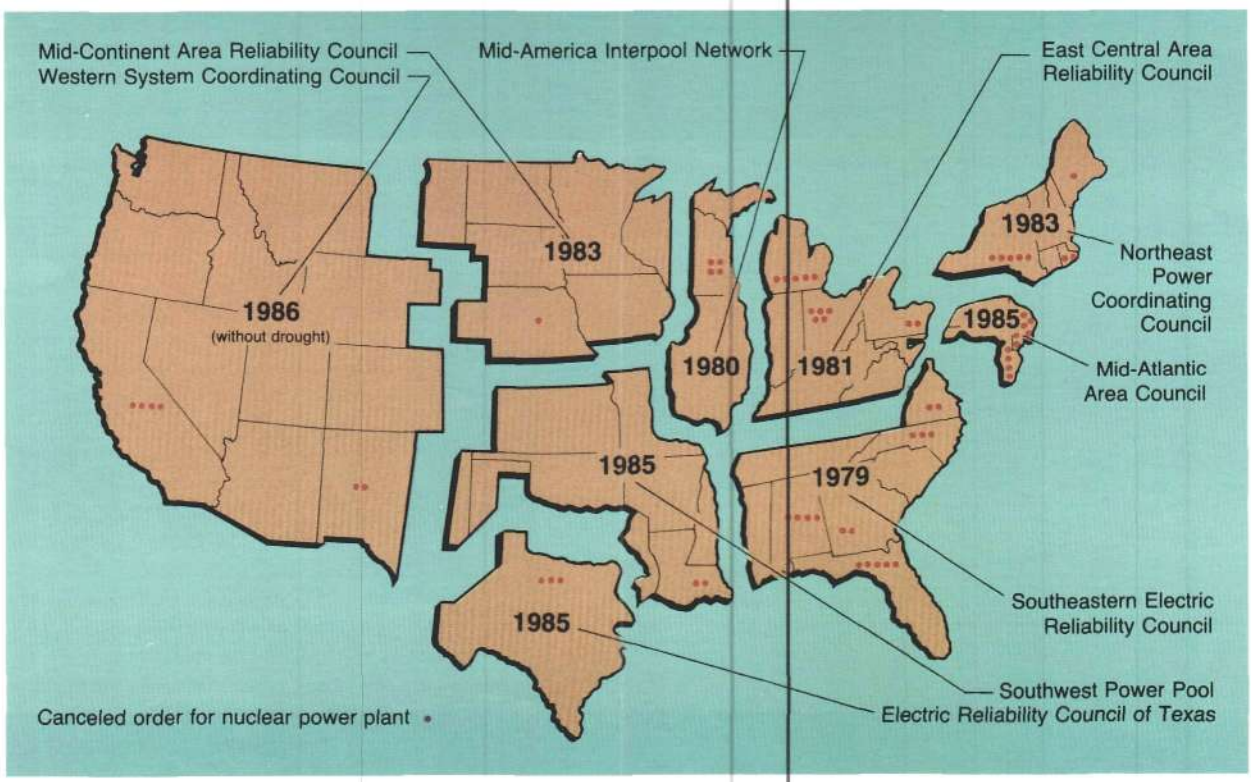


Figure 1

NUCLEAR PLANT CANCELLATIONS AND YEAR OF FORECAST DEFICIT IN ELECTRICITY SUPPLY

The nuclear plant cancellations shown here by state are for 1972 through the first quarter of 1980. The total megawatts of these canceled plants is 67,906, according to the Atomic Industrial Forum.

The National Electric Reliability Council compiled the regional estimates of forecast deficits in electricity supply for their 1977 annual report. The Southeast Electric Reliability Council, which includes the TVA, had predicted shortages by 1979. These shortages were avoided only because peak load demand over the year had increased 4.7 percent and not the expected 5.2.

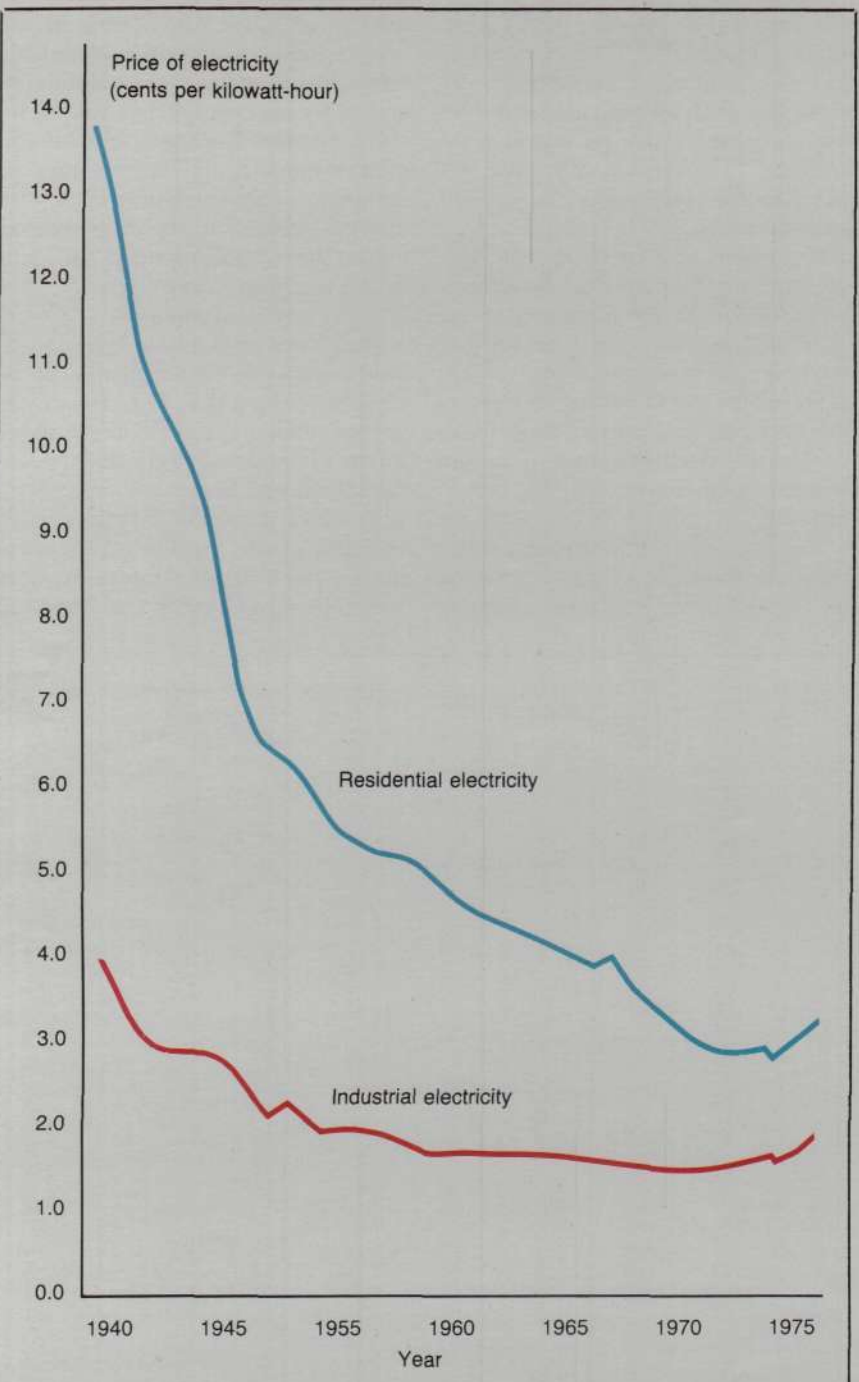


Figure 2
ELECTRICITY PRICES FOR RESIDENTIAL AND INDUSTRIAL CUSTOMERS—1940-1975 (in 1975 dollars)

Both industrial and residential users have experienced dramatic decreases over the past 35 years in the cost of delivered electric power, although the rate changes for industry vary less because of the economy of bulk use. The quadrupling of fossil fuel prices in 1974 reversed this trend for the first time.

Source: M.H. Ross and R.H. Williams, "Energy and Economic Growth," a report prepared for the Subcommittee on Energy of the Joint Economic Committee of Congress, 1977.

of all long-term financing. As credit availability shrinks and rates of construction and expansion decline, a slowdown in this industry alone will greatly affect the nation's employment picture.

To get an even closer picture of what a decline in power availability means, let's suppose that by some miracle you could keep U.S. industry going despite a lack of reliable and adequate electrical power. The situation would make astounding labor demands on the economy. *No worker using muscle power alone can produce the energy represented by 1 kilowatt of electricity.* In 1974, a factory worker used on average almost 48,000 kilowatt hours of electricity—the energy equivalent of 715 men. This ability of industry to substitute technology for human labor was dependent on one primary parameter—an exponentially decreasing cost of delivered electric power.

Figure 2 shows this trend for residential electric power from 1940 until 1974, when primary energy costs quadrupled. The trend is similar for industrial power users, but industry has had a lower per-kilowatt-hour rate because of bulk use. This decrease in cost of delivered power is simply a function of improvements in technology and in economies of scale.

The transition from fossil fuels to nuclear continued the downward price trend. Even today, with 12 to 14 years for nuclear power plant completion and millions of dollars incurred by utilities in legal fees to defeat environmental interference, nuclear is still cheaper than oil, the energy it replaces.

For example, Virginia Electric and Power Company announced in March 1980 that although the North Anna nuclear unit 2 will add $46 million to the rate base, fuel savings estimated to be $78 million will result in a 3 percent rate decrease for the company's customers.

What will life be like without reliable, available affordable electric power? Imagine the United States as a developing sector nation—with manual labor the rule, little advanced technology for industry or agriculture—and a life expectancy of 25 years less than the current U.S. life expectancy.

—Marsha Freeman

Most High Voltage Spark Gap Materials Die Young.

Not so with spark gaps and electrodes fabricated from POCO graphite. POCO graphite offers extreme high strength at high temperatures, plus high sublimation energy per unit volume ($107 kj/cm^3$).

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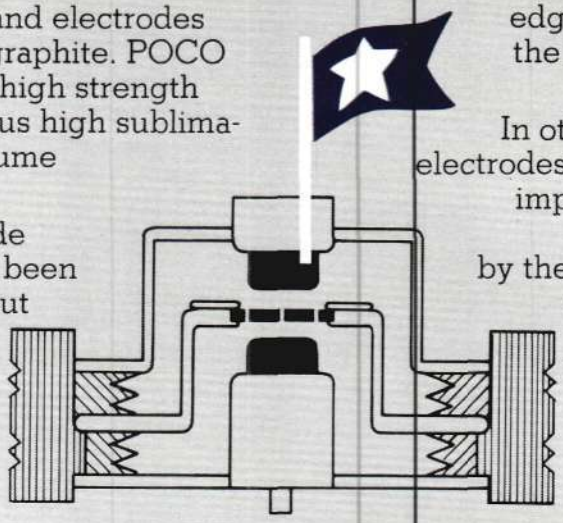

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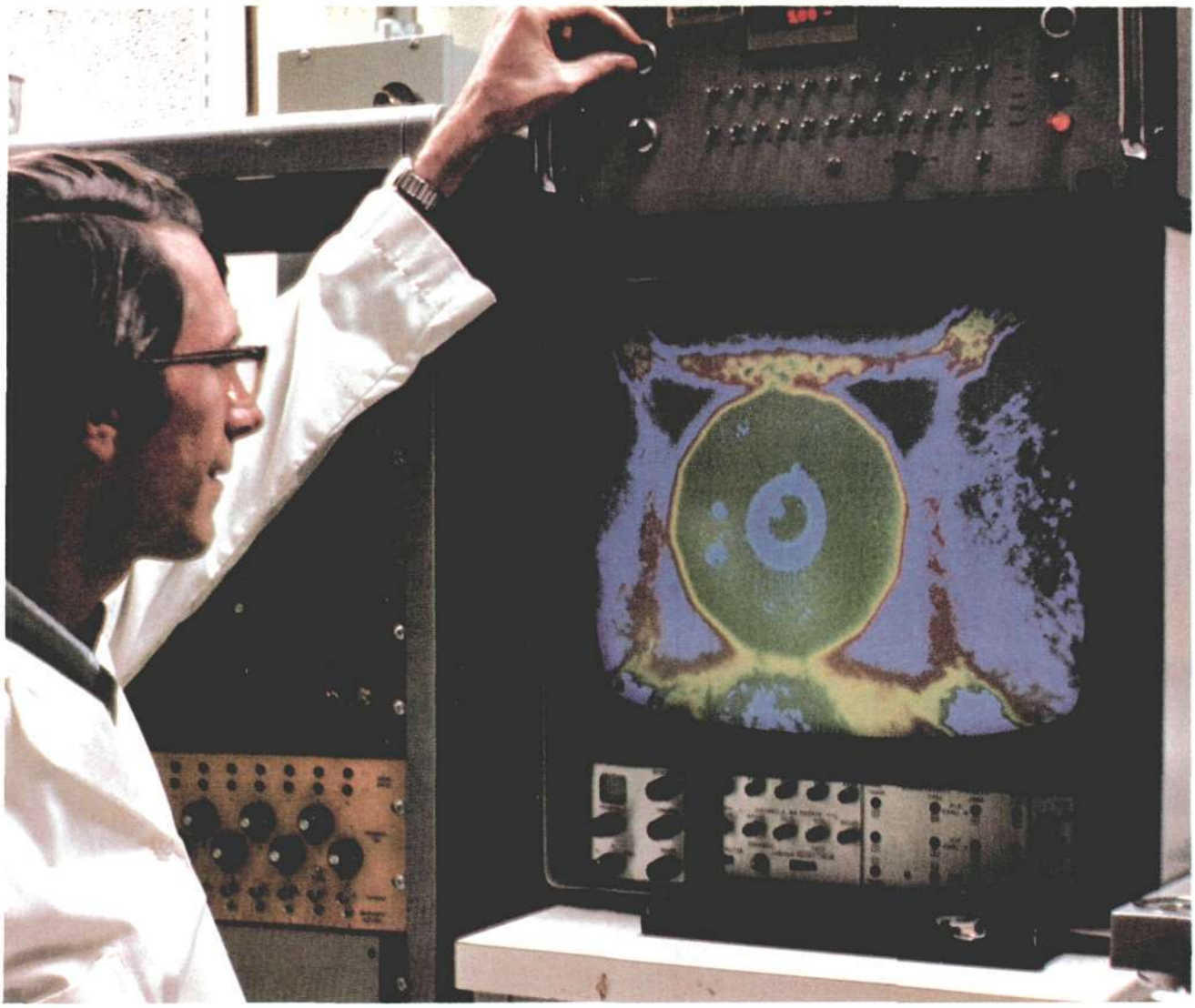


Photo courtesy of IBM

"Computers are inherently linear machines; they carry out a fixed set of instructions with unvarying regularity. To what extent can they model systems whose essence is qualitative change, change in the laws governing the system being studied?" Here an IBM researcher studies a magnetic "bubble," a technology under development that has the potential for storing large amounts of data. The bubble, magnified 3,000 times, is moving in a garnet crystal.

Breakthroughs in the 1980s

The Frontiers of Computer Science

by Dr. Steven Bardwell

JOHN VON NEUMANN, the father of the modern electronic computer, had a very specific problem motivating his design of the first computer—the description in numerical terms of fluid motion.

Subsequent plans for both the hardware (electronic circuits) and software (programming instructions) were based on analysis of the sort of fluid motion problem confronted in meteorology: finding the techniques that can be used to solve the highly nonlinear, partial differential equations that describe continuum systems (see Figure 1).

This problem still forms the basis for the design of the most advanced scientific computers. Seymour Cray, considered to be the most innovative American computer designer today, describes his thinking on the design of a new computer in terms very similar to von Neumann: The most important guide for the computer scientist, Cray says, is provided by the problems of fluid flow, and the most productive insights are provided by actual fluid flow.

The unique combination of physics and mathematics behind the Navier-Stokes equation for continuum media (Figure 2) defines its solution as the frontier of computer science, both in hardware and software. This family of nonlinear partial differential equations has several interrelated properties that distinguish it from other, complex equations:

First, they are nonlinear. Nonlinearity, in a formal sense, refers to the *lack* of the more familiar property of linearity. In a linear system—a piano string, for example—any scalar multiple of a solution (a characteristic vibration of a piano string) is also a solution: Approximately the same tone can be played at any volume. A nonlinear system, on the other hand, does not have solutions that are independent of its amplitude. This creates the possibility for highly distorted wave forms, localized, self-sustaining disturbances with particlelike properties (called solitons), and similar behavior contrary to (linear) common sense.

Second, they have many-length scales. The mathematical and physical systems that inform our intuition possess the remarkable characteristic of a single "wavelength" or dominant length scale. On the contrary, nonlinear partial differential equations, like the Navier-Stokes equations, have solutions that couple energy at all length scales.

Fluid turbulence, which seems to be described by the Navier-Stokes equation, requires the treatment of length scales spanning three orders of magnitude for its description in numerical terms—as opposed to a linear system that needs only a handful of discrete lengths (namely, the fundamental wavelength and several harmonics) for its description. This property makes nonlinear partial differential equations especially rich, and their solution especially difficult.

Third, partial differential equations have irreducible dimensionality. Simple linear systems like a piano string can usually be reduced to a set of problems, each of which has lower dimensionality. A piano string can be quite accurately dealt with as a one-dimensional system, and even three-dimensional *linear* systems can usually be dealt with as a superposition of lower dimensional solutions. This is usually not the case for nonlinear partial differential equations; they are inherently three-dimensional in the case of the Navier-Stokes equation and its relatives. This is most strikingly shown by the qualitatively new phenomena that appear when the two-dimensional and three-dimensional solutions are compared.

In fluid turbulence, for example, the Navier-Stokes equations have totally different properties in two and three dimensions. In two dimensions, a fluid amplifies energy in the longest wavelengths, spontaneously forming large

vortex-motion; in three dimensions, the direction of energy flow is opposite, going from large to small scales.

These three properties of nonlinear partial differential equations make their solutions not only the most challenging aspect of numerical computation, but also the most important. It is clear that since the real world shares these three properties, its mathematical description will demand being able to handle nonlinear, many-scaled, three-dimensional problems.

This empirical applicability in the widest sense has made nonlinear partial differential equations the touchstone for the most advanced computer development. In von Neumann's original conception, which is still dominant today, the specific problem was to design a machine that could perform the repetitive prescriptions for calculation (an algorithm) that "solved" the equations generated by a physical model of a continuum system. Von Neumann's prescription, however, defines a unique kind of a solution. In classical mathematics, a solution to a differential equation is a function satisfying the equation for a continuum of points. That is, the solution is not a number; it is a rule for generating numbers—a function relating the variables and the solution.

However, a computer solution is not a function; it is one specific set of numbers, calculated at a discrete set of values of the variables, that very closely approximates a solution (see Figure 1). The computer-generated solution is not continuous, not exact, and not available for all values of the variable. The aim of the computer solution is then severalfold: to achieve as accurate as possible solution in a reasonable amount of time; to choose a range for the solution that encompasses the interesting phenomena; and to have sufficient resolution to catch the small-scale behavior of the solution. It turns out that the frontiers of computer science are almost totally defined by the inability to achieve one or more of these objectives in the solution to the Navier–Stokes equation in some important problem.

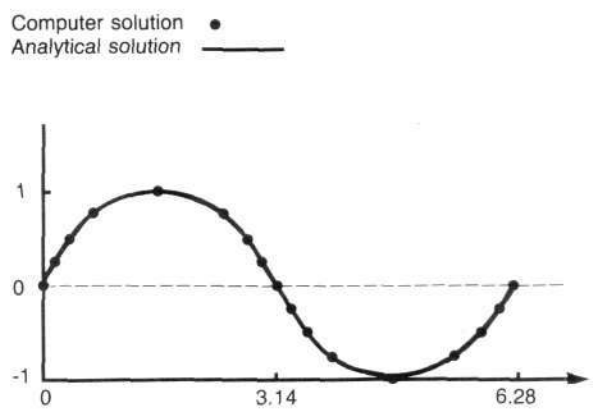


Figure 1
COMPUTER SOLUTION TO A DIFFERENTIAL EQUATION
The dots show the computer-generated approximation to the solution of the differential equation (here linear) describing a vibrating piano string. The solid line is a graph of the analytical (as opposed to numerical) solution given by classical mathematics. Note that the computer solution has limited resolution. Clearly, if the dots were spaced farther than the units apart, we would not see the function. Also, the solution is given only for a finite range of x.

Plasma Physics

The most advanced scientific computer now operational, the CRAY-1, was first installed at several plasma physics laboratories in the United States. This machine was immediately put to work solving equations used to describe the behavior of the plasma, the extremely high temperature, electrically charged gas that is the working fluid of nuclear fusion experiments. The CRAY attacked one of the most complicated sets of computer codes, called LASNEX, at Lawrence Livermore and Los Alamos Scientific laboratories. This set of hundreds of equations is used to model the highly compressed plasmas formed in the course of laser fusion experiments when the fusion fuel is bombarded with intense laser light.

LASNEX and the related plasma physics simulation codes at other fusion laboratories define an important aspect of the frontier of computer science. They are prime examples of equations that cannot be solved in their full generality on present-day computers; that is, the equations

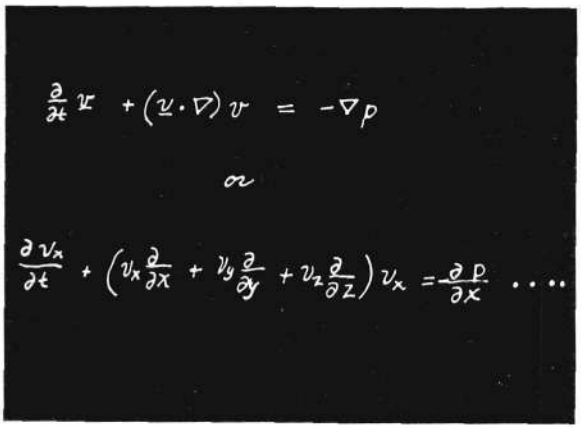


Figure 2
A SIMPLE FORM OF THE NAVIER-STOKES EQUATION
The Navier-Stokes equation, shown here for a nonviscous fluid, is a nonlinear partial differential equation that describes continuum systems in many contexts. Its nonlinearity comes from the second term, which involves a product of velocities (v). *Since the velocity enters twice in this term, it does not scale like the rest of equation, in proportion to* v. *Hence, it is a nonlinear equation. The occurrence of variation in four dimensions simultaneously* (t, x, y, *and* z) *makes the equation a partial differential equation.*

are known to contain interesting physics that cannot be reached because of insufficiencies even in machines as sophisticated as the CRAY-1.

On the most obvious level, present-day machines are too slow to solve the equations. Even though these machines can perform billions of operations per second, the number of equations (in the hundreds) and the large number of variables in a code like LASNEX, make standard simulations take many hours of computer time. As a result, drastic approximations must be made in the model equations to accomodate them to the practicalities of present-day computers. LASNEX, for example, is largely two-dimensional, ignoring most three-dimensional dependence in the equations because the resulting system of equations would be many orders of magnitude beyond the capability of any existing computer. Similarly, only approximations to the actual transport properties, energy population dynamics, and bulk (hydrodynamic) motion can be included in the system of equations.

These problems are serious enough, but more far reaching is a problem often lost in the gray area between hardware and software. By its very nature, a computer solution to a set of equations will only produce an answer known beforehand in its general outlines. That is, the resolution in both time and space in a plasma simulation must be set beforehand; the computer can produce a solution that shows only phenomena that occur on this time and space scale. Very often, phenomena on larger and smaller scales are obscured or totally invisible.

Similarly, the area of parameter space accessible in a computer solution must also be set beforehand. If the experimentally relevant parameters are known only approximately, essential physical phenomena are frequently lost in a computer solution.

A remarkable study by a scientist at Los Alamos using a global parameter analysis showed several areas where the much more complicated LASNEX code seemed to miss whole areas of parameter space in its local optimization approach.[1] Even more striking, a large study comparing codes like LASNEX with experimental evidence from the huge compressed plasma that occurs in a hydrogen bomb showed that the computer solutions consistently failed to show the qualitative phase changes that dominate the later stages of plasma behavior.[2] In other words, the computer solutions, precisely because they are computer solutions, cannot at present deal with unexpected, qualitative changes in a system. Unfortunately, like all nonlinear systems, a plasma is characterized by this sort of phase change.

There have been two general approaches to this problem. The first is to develop global, qualitative solutions to simpler equations that can illuminate larger areas of parameter space, either analytically or numerically. These are then used as qualitative guides to set the resolution and relevant physical phenomena for a larger model. Most productive in this regard, is the development of new algorithms that use the physical definition of important length scales and interactions to isolate the relevant mathematics.

Second, of course, is the brute-force approach of building bigger, faster computers. This approach has yielded a

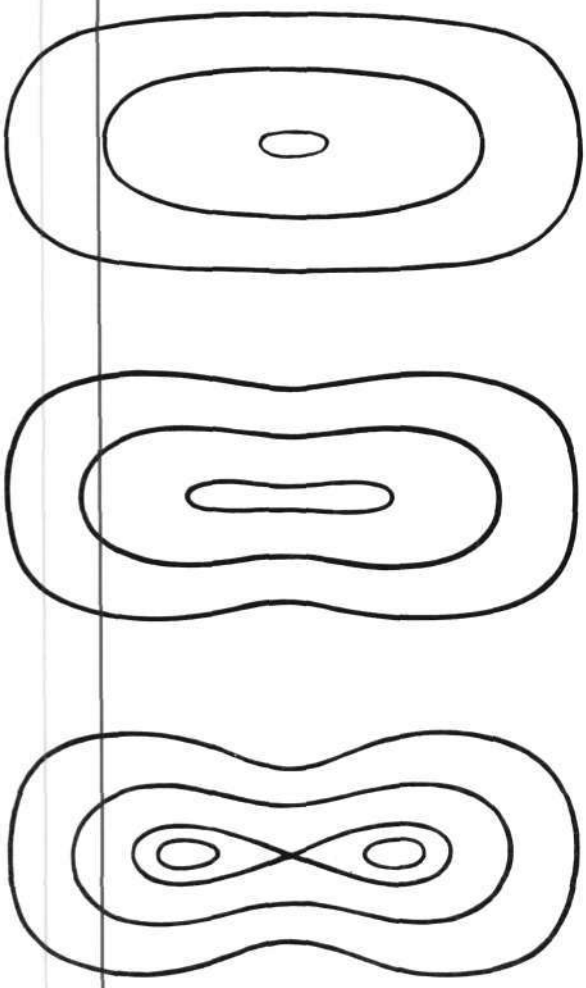


Figure 3
COMPUTER SOLUTIONS GENERATED BY THE GRAD-HOGAN METHOD

One of the most powerful algorithms developed for the solution of nonlinear equations in plasma physics is that of H. Grad and T. Hogan. They reduced the usual equations for a magnetized plasma in dimension, simplified the time scales by analytical means, and then developed a powerful numerical method for calculating the evolution of complex magnetic fields in these plasmas. The Grad-Hogan method can follow the evolution of these magnetic fields through singular changes in their geometry as shown in the above solution for a singular current layer in a plasma. Here the magnetic field changes to form islands or loops, a process called islation.

Source: H. Grad et al, "Classical Plasma Diffusion," New York: Courant Institute of Mathematical Sciences, New York University (undated manuscript)

many-thousand-fold increase in the complexity of systems that can be solved on a computer, but it has not changed the more fundamental shortcoming of present-day computers: Truly global, qualitative, "geometrical" analysis is impossible on a computer.

Climatology

Von Neumann's original work on computer design was largely a result of his studies of climate modeling and weather prediction. In the early 1950s, von Neumann proposed that electronic switching had developed to an advanced enough stage so that the dream of the school of so-called scientific meteorology—numerical solution of the hydrodynamical equations describing the atmosphere—was within reach. He led a team at Princeton University in the development of the first large electronic computer, specifically for the solution of these meteorological equations.

In the ensuing 25 years, the numerical solution of the same basic model of climate formation and short-weather forecasting has provided a second frontier in computer science. A number of new scientific computing machines have been evaluated by their performance on the large climate models used at the National Center for Atmospheric Science in Boulder, Colorado, the National Weather Bureau in Washington, D.C., and the climate-modeling group at Princeton University.

These large weather models have repeatedly run up against the same problem of speed and storage capacity that occurred in plasma simulations. However, the weather problem has always had an essential simplicity lacking in the plasma physics; namely, that the underlying equations were entirely hydrodynamic and thermodynamic; electromagnetic and nuclear phenomena could be ignored in the formation of the earth's weather.

In the early 1960s, this simplicity led to the proof of a striking theorem: E.N. Lorenz of the Massachusetts Institute of Technology proved that given these hydrodynamical equations and a perfect computer, numerical solutions of the equations were incapable, in principle, of predicting the weather more than 14 days in advance! Lorenz's reasoning proceeded in the following way. Like all nonlinear partial differential equations, the weather equations couple energy at all wavelengths. Therefore, motion at the smallest scales affects the atmosphere even at the largest distances. Thus, if starting conditions for the equations are specified and the computer then marches these forward in time, the accuracy will be limited by the resolution of the initial observations.

Lorenz calculated that if one had weather stations measuring the temperature, pressure, and wind velocity on a grid all over the earth at 50-mile intervals, the weather could be predicted about a week in advance; after that, the situation is rapidly worse. To predict the weather two weeks in advance, one would have to know the flap of every seagull's wing.

Clearly there is something wrong here. Like all nonlinear systems, the weather seems to possess a special kind of causality. It is certainly lawful, since the change of season and dominant weather patterns are obvious even to the casual observer. But, there is a nondeterminist quality to this lawfulness. Something more than just the initial conditions in the system must be specified if the long-time behavior of the system is to be described. As in the case of the problems plasma physics has presented to computer science, it is unclear if the challenge posed by meteorology is in the realm of hardware or software. Would it be sufficient to develop new algorithms that deal with a new model of the weather, overcoming with a new conceptual attack the dead-end of a Newtonian fluid approach to weather? This is certainly an important approach.[3] Could a new kind of computer be developed that directly models nonlinear equations, through, perhaps, a digital-analogue system reproducing the sort of nondeterminist causality of the weather? Again, an intriguing possibility.

Something is clearly necessary. Even the most advanced computers today cannot solve the full set of weather equations in less than real time; that is, tomorrow's weather happens before the computer has calculated its forecast.

Economics and Industrial Planning

Von Neumann was the inspiration for the application of numerical methods to economic modeling and industrial planning, as well as the author of the first research in econometrics.[4]

Von Neumann's basic idea was to formulate a set of equations, either algebraic or differential, that described economic behavior as a function of time and then to use a computer to solve these equations. His original work in 1938 did not rely on numerical computation, but did prove a number of interesting topological and geometric facts about an economic model not worthy of the elegant mathematics. Nevertheless, his idea was rapidly taken up by economists of Cambridge University, producing the modern-day school of econometrics.

Unfortunately, the powerful mathematical and computing tools are being used to solve models that have at best a tenuous (and usually a deleterious) relation to a functioning economy. Although it is true that current economic models have taxed modern computers to their limits, the determining factor in the colossal mistakes made by economists in the 1960s and 1970s is not the fault of the computer; it is the fault of the models and modelers.[5]

There are two new pieces of research, however, that show in a striking way the potential for economics to push the frontier of computer science forward. Basically, this is because economics, if it is to be successful, must account for the properties of economic systems that resemble those of nonlinear partial differential equations; namely, directed evolution (progress), self-organizing behavior, and complex geometric phenomena.

First, a surprising and beautiful application of the essential geometrical nature of the solution of systems of algebraic equations that arise in econometrics was recently discovered by a Soviet mathematician, L. Khachian. This algorithm, described in the following article, uses global geometric methods to solve these equations, instead of the classical local method. Although it is still unclear whether the algorithm in its present form will be better than known methods, it opens up a whole new method for finding numerical solutions to econometric problems.

However, it is not enough to have a new algorithm, no matter how elegant, to solve the old equations. A new kind of economic model is necessary, one that from the start throws out the equilibrium assumptions of conventional econometrics. A new econometric model, the Riemann-LaRouche model under development by the author and Uwe Parpart, attempts to solve exactly this problem. The new model formulates a set of equations, elaborated into a set of nonlinear partial differential equations that closely resemble fluid equations, that can describe the inherently evolutionary, qualitatively changing behavior of an economy.[6] This new approach, coupled with new algorithms for solving the unusual kinds of underdetermined systems of partial differential equations in the model, opens a new frontier of computer science.

Some Critical Questions

Confronted with similar problems in the application of computers to plasma physics, meteorology, and economics, computer scientists and mathematicians have formulated a series of unanswered questions on the fundamental nature of computers in mathematical physics. These questions, distilled from 20 years' experience in the numerical solution to nonlinear partial differential equations, must be tackled if progress is to be made in the computer solution to continuum systems:

Computer "existence" proofs. In analytical mathematics, often the most difficult part of the solution to a given problem is the establishment of the existence of that solution. Does a numerical solution constitute an existence proof? That is, is it possible that the conditions under which a computer "solution" exists are significantly different from the conditions under which an analytical solution exists? If this question could be answered in the negative, then computers immediately would become an extremely powerful tool for the analysis of now unapproachable problems in continuum mechanics.

Foremost among these is the question concerning the accessibility of certain states. It is easy to show, for example, that most nonlinear partial differential equations have equilibrium solutions, but there is good evidence that these equilibrium states are not accessible from any interesting initial condition. A computer proof of the existence or nonexistence of these independent solutions would be a major advance.

The continuum on a computer. By their very nature, present-day computers can represent only a small number (a finite number) of rational numbers. By no stretch of the imagination does a computer deal with the number line or the continuum. Yet, the computer can perform significant mathematical tasks on this very limited set of numbers. It is unclear what limitations we have placed on the solutions to complex problems by examining them on such a restricted set of numbers. Do any significant physical effects fall between the "holes" in the number line left by the computer? For example, there are many important physical effects that depend on properties of integers or of exact rational numbers (technically, a set of measure zero). Under what conditions will a computer "see" these effects? Can we rigorously explain the connection between mathematics in a continuum and mathematics on a finite set of rational numbers?

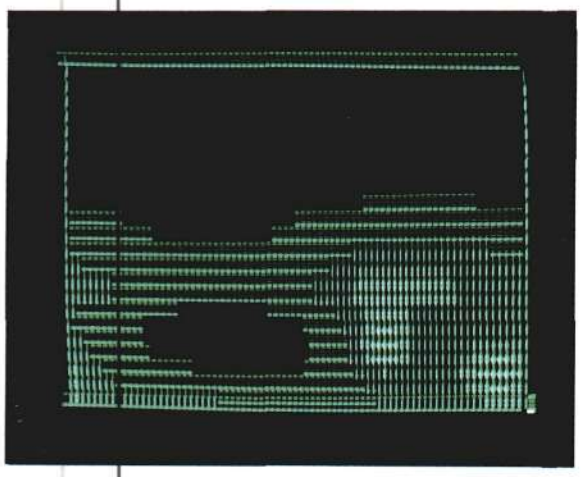


Figure 4
GLOBAL CLIMATE SIMULATION

One approach to the problem of climate simulation has been to use analytical methods to extract the dominant physics and energy relations out of the hugely complicated nonlinear equations describing the weather as a whole, to find a single, long time scale, and to solve the equations for this simpler but truer set of equations. In a research project of the Fusion Energy Foundation, the essential hydrodynamics of the earth's atmosphere are hypothesized as the result of the interaction of quasi-geostrophic vortices. As shown above in the computer graphic, the circulation of the atmosphere is approximated by a set of such vortices and then the dynamics of the atmosphere are determined by the interaction of these "elementary particles."

Qualitative change. Finally, and most important, is the question of the computer's ability to find solutions involving a qualitative change in the system. Computers are inherently linear machines; they carry out a fixed (and finite) set of instructions with unvarying regularity. To what extent can they model systems (like economic systems) whose essence is qualitative change, change in the laws governing the system being studied?

Steven Bardwell, associate editor of Fusion *magazine, is the director of plasma physics research for the Fusion Energy Foundation.*

Notes

1. R. C. Kirkpatrick, "An Overview of Design Space for Small Fusion Targets," American Physical Society Meeting, Atlanta, Georgia, Nov. 1977. See also *Fusion* Oct. 1978.
2. This secret evaluation has never been declassified.
3. The Fusion Energy Foundation is engaged in ongoing research along these lines.
4. J. von Neumann, "A Model of General Economic Equilibrium," *The Review of Economic Studies*, 1946, p. 1.
5. See V. Berg, "A Critical Review of Economic Modeling," *Fusion*, May 1980.
6. S. Bardwell and U. Parpart, "Economics Becomes a Science," *Fusion*, July 1979.

The Soviet Ellipsoid Method In Linear Programming

By P.F. Pickel and R. McLaughlin

Editor's note: The importance of finding the appropriate geometrical framework for solving nonlinear problems is true in almost every important physical case. Even for linear, though complex, problems there is a deep relationship between geometric and analytic properties. That point is beautifully illustrated by the comparison here of the polygonal and ellipsoidal programming methods.

* * *

LINEAR PROGRAMMING PROBLEMS are a special class of constrained optimization problems where all functions are linear. That is, we seek to maximize or minimize a linear objective function $c_1x_1 + \ldots + c_nx_n$ of variables $x_1, \ldots, x_n$ that must be nonnegative and satisfy a set of linear inequalities (constraints) of the form $a_{i1}x_1 + a_{i2}x_2 + \ldots + a_{in}x_n \leq b_i$, where $i = 1, \ldots, m$.

Such problems arise in industry—oil, steel, and banking, for example—as resource allocation problems (see box). Since 1950, these problems have been solved using the simplex method developed originally by G.B. Dantzig. As computer codes have become more sophisticated, computer memories and computer speeds have increased and the size of solvable problems has grown to the point where today problems involving thousands of variables and thousands of inequalities can be solved in a reasonable amount of time.

Recently, much press attention has been given to a new algorithm based on ellipsoids developed by several Soviet mathematicians, including L.G. Khachian. We will describe briefly the geometric idea behind each of these methods and compare them practically as well as theoretically.

The Simplex Method

Each inequality $a_{a1}x_i + \ldots + a_{in}x_n \leq b_i$ or $x_i \geq 0$ defines a half space of points in the n-dimensional variable space consisting of points that satisfy the inequality. The set of possible solutions (feasible points) is the intersection of all

Figure 1
A TWO-DIMENSIONAL SOLUTION SET

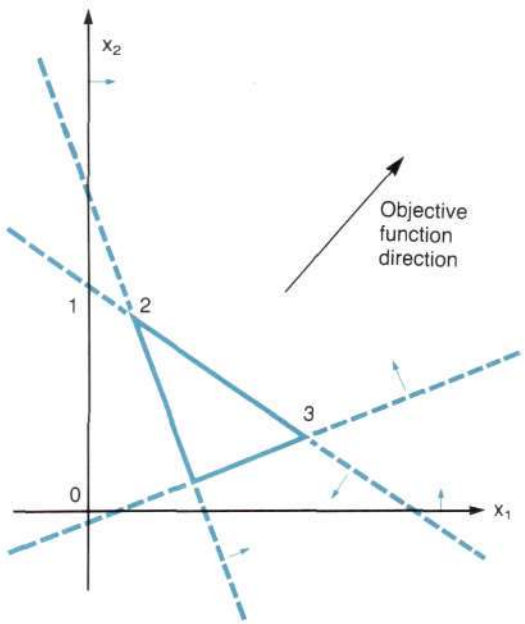
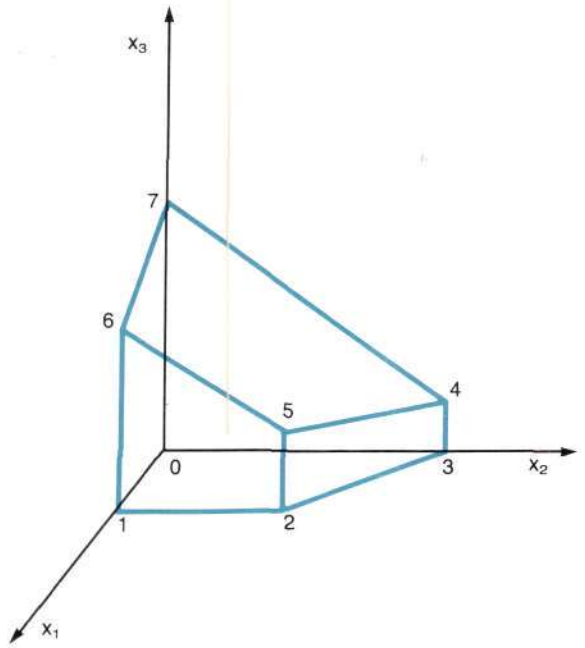


Figure 2
A THREE-DIMENSIONAL SOLUTION SET



these half spaces (Figure 1), a convex polytope or n-dimensional polygon. (See Figure 2 for a three-dimensional example.)

A basic theorem of linear programming states that the optimum must occur at a corner (vertex) of this polytope. The simplex method performs a test that examines all possible paths from vertex to vertex and picks that vertex that produces the best solution. The simplex method first searches for a corner of the polytope (not all intersections of boundary planes are corners; for example corners 0,1 of Figure 1). Once a corner has been found, the simplex method moves from one corner to an adjacent corner if such a move will increase the objective function. When no such move will increase the objective function, we must be at an optimum point.

A theoretical drawback to the simplex method is that it may search through many vertices before it finds the optimum point. Examples have been given with *m* inequalities, giving a polytope with 2^m vertices, all of which are searched before the optimum is found. For example, in Figure 2 if we start at vertex 0 we could pass through all vertices in order before reaching the optimum at vertex 7. Since the number of steps, in the worst possible case, can increase exponentially with the number of inequalities, we say that the simplex method computes in *exponential* time (theoretically). For many years an outstanding theoretical question was: Is there a method that solves linear programming problems in less than exponential or polynomial time?

As a practical matter it should be pointed out that the simplex method seems to solve real world problems in about three times as many steps as there are inequalities. Thus, in practice, the simplex method computes in linear time. The more sophisticated linear programming algorithms also solve the "exponential time" problems quite quickly. In addition, the simplex method is amenable to solving part of the problem at a time and to taking advantage of a large number of zeros in the coefficients a_{ij}, which is quite common in real problems.

These advantages have allowed solution of problems with 7,000 variables and 8,000 inequalities, for instance. Since there is such a large disparity between the run-of-the-mill problem and the worst case problem, concerns about the computational efficiency of the simplex method are largely theoretical rather than practical.

The Ellipsoid Method

This method, developed by Soviet mathematicians Shor, Judin, Nemirovskii, and Khachian, is also quite geometrical in character. The idea is to begin with an ellipsoid that contains the solution and shrink the ellipsoid stepwise, always including the solution point. More precisely, if the center of the current ellipsoid does not satisfy all the inequalities (Figure 3), we choose an inequality $a_1x_1 + \ldots + a_nx_n \leq b$ that is not satisfied. We take the part of the ellipsoid cut off by this half space and construct a new, smaller ellipsoid about this part of the old ellipsoid (the dotted-line ellipse in Figure 3.)

The new ellipsoid contains all solutions to the problem that were contained in the old ellipsoid. If the center of

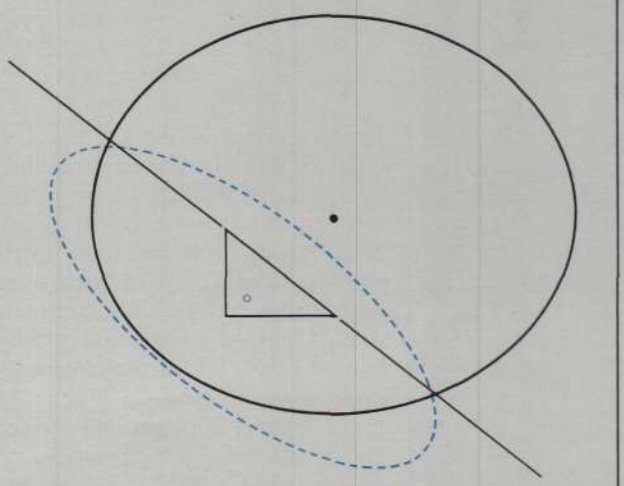


Figure 3
ONE STEP IN THE ELLIPSOID METHOD
The center of the old ellipsoid does not satisfy all inequalities.

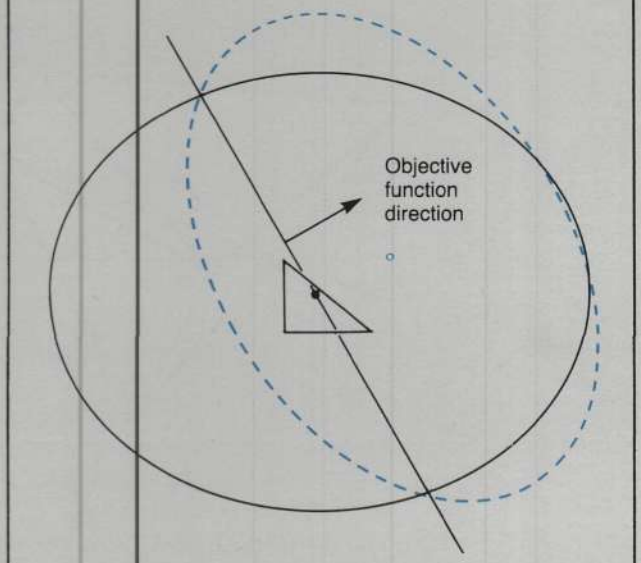


Figure 4
ONE STEP IN THE ELLIPSOID METHOD
The center of old ellipsoid does satisfy all inequalities. The objective function is used to define a new ellipsoid.

An Example of the Simplex Method

The most frequent type of linear programming problem is that of optimizing a function that is subject to many constraint inequalities, involving a large number of inequalities (m) and several thousand parameters (n).

Such a problem can be placed in the form

$$b_i \geq a_{i1}x_1 + a_{i2}x_2 + \ldots + a_{in}x_n$$

where b is constant.

Suppose that we wish to optimize the production of gasoline in an oil refinery. We want to get as much gasoline out of a barrel of oil as possible, at the same time using as little heat (in the form of "cracking" heat) as possible. We know that the lowest cracking temperature from crude to gasoline is 1,500 degrees Celsius and that from one barrel of crude we get 2 gallons of gasoline for each 1,000 calories of heat used. At the same time, we know that the *maximum* cracking temperature is 2,500 degrees Celsius, for which we get 20 gallons of gasoline at 2,800 calories of heat used. (All these figures are fictitious.)

When these figures are placed into the form of the equation presented above, it gives a system of inequalities that define the area in which the function we seek must be optimized. For the fictitious example given here the function we wish to optimize is $x_1 - 1{,}200x_2$. That is, within the constraints given, we want to expend no more than 1,200 calories per gallon of gasoline produced. (We have not included the units here, but it is straightforward to place the entire system in the same units; here we say that the conversion factor is 1.)

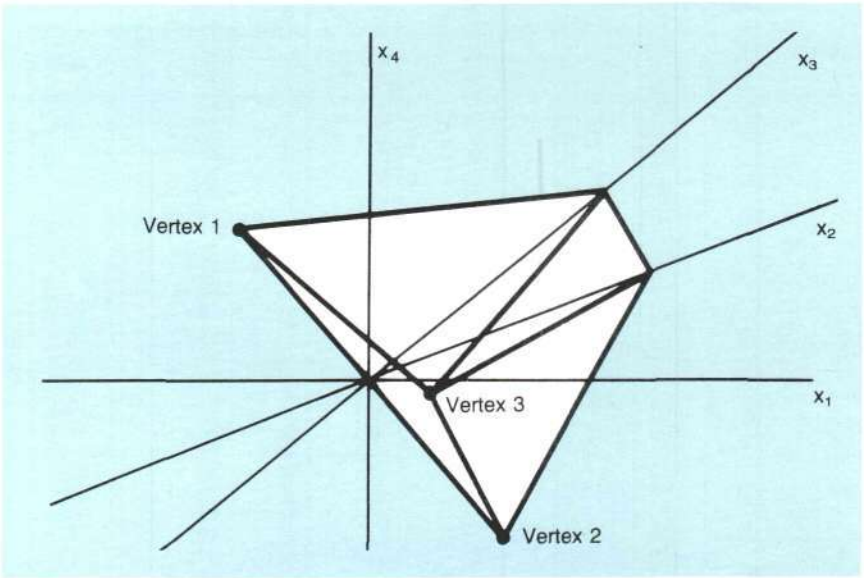


Figure 6
THE SIMPLEX SOLUTION TO A HYPOTHETICAL PRACTICAL PROBLEM

The four-dimensional polytope that corresponds to the variables in the problem is shown here. Each side of the polytope is determined by the particular constraints in the problem. We start at vertex 1, or (0, 0, –1,500, 2,500). The decision about where to go next is based on which variable is best minimized. Picking vertex 2, we move to (0, 25/28, 0, –964.2). But this vertex is not the solution, so we move to vertex 3 or (.006, 0, 0, –2.54). This vertex is the solution, and the objective function is $x_1 - 1{,}200x_2 = 1{,}049$.

This gives us the following system of inequalities:

$$1{,}500 \leq 2x_1 + 1{,}000x_2 \quad \text{and}$$

$$2{,}500 \geq 20x_1 + 2{,}800x_2 ,$$

where variable x_1 is the number of gallons of gasoline produced divided by the number of gallons of crude, and variable x_2 is the number of calories per gallon of crude.

First, the equations must be put into the correct form. To do this, we multiply the first inequality by minus 1, in order to have all the inequalities of the same form, making the system easier to solve. This yields a new set of inequalities:

$$-1{,}500 \geq 2x_1 - 1{,}000x_2 \quad \text{and}$$

$$2{,}500 \geq 20x_1 + 2{,}800x_2.$$

Next, we define what are called the slack variables of the system. These are fictitious variables that do not exist in the real problem. They are used to ensure that the equations are positive and that a linear equation can be set up that allows solution of the problem. In this case, the slack variables are:

$$x_3 = -1{,}500 - 2x_1 + 1{,}000x_2 \text{ and}$$

$$x_4 = 2{,}500 - 20x_1 - 2{,}800x_2.$$

The new system of inequalities developed here is then used to define a convex polytope whose dimensions correspond to the number of variables in the problem, in this case four dimensions (see Figure 6). Each side of the polytope is determined by the constraints that are active in the problem. At least one of the vertices formed is a solution to the problem.

In using the simplex method to solve the system of equations, we move from one vertex to another until we arrive at the vertex of solution. We start at the vertex (0, 0, –1,500, + 2,500) and then move on to the next vertex, which is (0, 25/28, 0, –964.2). The next move is to the point (.006, 0, 0, –2.54), which provides the solution for the objective function: $x_1 - 1{,}200\ x_2 = 1{,}049$.

the old ellipsoid satisfies all the inequalities, we move in a direction determined to increase the objective function (Figure 4). The procedure continues until the ellipsoid is so small that the center cannot be far from the true solution, which is still contained in the ellipsoid. The sequence of moves for a simple two-dimensional problem is illustrated in Figure 5. It would take about 20 steps to find a solution accurate to about 10^{-2} or 10^{-3}.

Khachian showed theoretically that the ellipsoid method will solve linear programming problems using a number of steps equal to Cn^2L, where C is a constant, n is the number of variables, and L is a measure of the amount of space required to store the problem. Thus, we say that the ellipsoid method computes in *polynomial* time.

Khachian has answered the theoretical question raised earlier of finding an algorithm that requires less than exponential time. Unlike the simplex method, however, run-of-the-mill problems using the ellipsoid method also seem to take Cn^2L steps. (Incidentally, some investigators claim that the ellipsoid method is not truly polynomial in computation, since the number of steps depends on the parameter L as well as the number of variables.) This fact about ordinary problems means that although it is theoretically superior to the simplex method, the ellipsoid method cannot compete practically as it was originally formulated.

George Dantzig estimated that the ellipsoid method would take some 50 million years to solve most problems done at his laboratory in a half-hour. For instance, a problem with 1,000 variables and 1,000 inequalities might require 3,000 simplex steps but 60,000,000 ($6x10^7$) ellipsoid steps. Of course, if the problem were a "bad" simplex problem it could take $2^{1,000}x10^{300}$ steps.

Also, the ellipsoid algorithm requires more core storage, is less amenable to solving the problem one part at a time, and the matrices involved tend to have mostly nonzero entries.

This is not the only instance of a problem where two algorithms compare differently on a run-of-the-mill or worst-case basis. There are, for instance, two algorithms for finding shortest paths in graphs. One does far better in the worst possible case, while the other is superior for most problems.

Suggested Improvements

Several investigators have suggested various methods for making the ellipsoids shrink more rapidly, but all these improvements require Cn^2L steps (with smaller values of C and L) and none is competitive with the simplex method. One problem is that the center of the ellipsoid may be quite close to the solution but we will not know this until the ellipsoid shrinks. In part, this is because the ellipsoid method does not take advantage of the fact that the optimum must occur at a vertex. Three different modifications of the ellipsoid method have been suggested that do use this information.

Jones and Marwill have suggested a method called *dimension reduction*. In this procedure the ellipsoid method is applied to a related problem rather than directly to

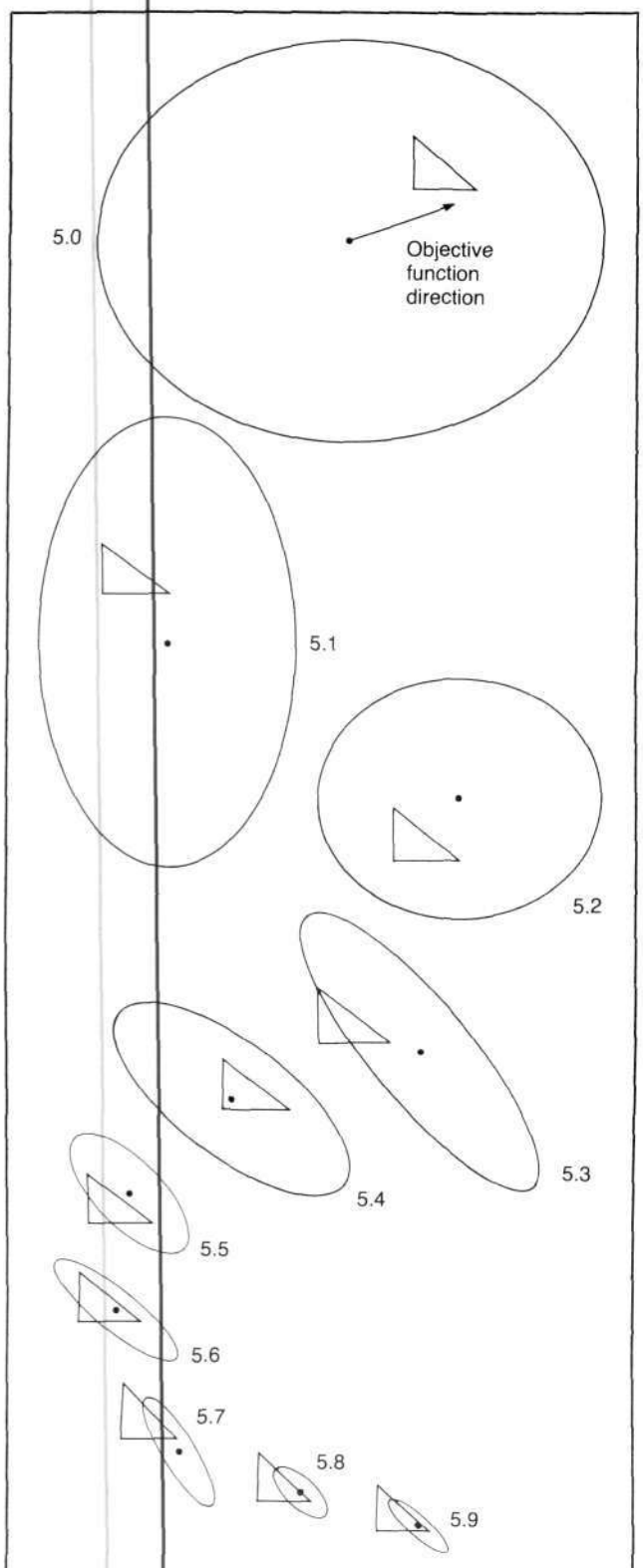


Figure 5
SERIES OF STEPS IN THE ELLIPSOID METHOD
This illustrates a sequence of nine steps taken by the ellipsoid method, each step coming closer to the area of solution.

the original problem. This is done in such a way that the variables may be eliminated one by one until all variables are determined. This method seems to have promise although the related problem starts out with twice as many variables as the original problem, so each step takes much more computation.

Goldfarb and Todd (as well as others, independently) have suggested the *elimination* method. The idea is to use the ellipsoid method until only one vertex is left in the ellipsoid. This vertex then must be the solution. In the example of Figure 5, we could stop at step 5.7. A major problem with this idea is that if there is another vertex close to the solution vertex, it may take many ellipsoid steps before the nonsolution vertex is eliminated.

To date, the most promising method seems to be the *ellipsoid-simplex hybrid* method suggested by P.F. Pickel. In this method we start out using the ellipsoid method, but periodically we move to a vertex in such a way that the objective function increases. This vertex is then tested to see if it is the optimum as in the simplex method. We may take one or two simplex steps, then return to the ellipsoid method to try to shrink things down more. (In Figure 5, for example, this move to a vertex might be done at step 5.3.) In computer tests against the simplex method on small problems, the ellipsoid-simplex hybrid seems to be competitive in terms of time. Unfortunately, it requires two to four times as much core storage and does not have the other nice attributes of the simplex method.

One thing that might be pointed out is that the simplex method computation time seems to depend much more heavily on the number of inequalities and only slightly on the number of variables while the ellipsoid method and its derivatives are the opposite. Thus, the ellipsoid-simplex hybrid might have application to problems in which the number of inequalities is much greater than the number of variables. This can also be approached by using the so-called dual simplex algorithm which, in effect, reverses the roles of variables and inequalities.

Other than isolated instances, however, it seems that the method of choice will be the simplex method in the future.

Fred Pickel teaches at the Polytechnic Institute of New York in Farmingdale, and Robert McLaughlin is a computer programmer in New York City.

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Computer Technology
The Next Decade:

by Mark Stahlman

THE TECHNOLOGICAL BASE EXISTS today to dramatically change the ways we capture, store, retrieve, and transmit information. If implemented, these technologies will provide new scientific capabilities and radically increase labor productivity in both the factory and the office. Advanced planning techniques could harness data never before available to manage enterprises previously too complicated to be run efficiently. And the general population could have tools to greatly increase their knowledge and capability and keep abreast of breaking developments.

Computer technology has already had an enormous impact in the 30 years since its infancy. But such an impact is small compared to today's potential. Needless to say, the outcome depends upon a good deal of capital investment and intelligence, both of which, it may be argued, are in short supply in today's computer industry.

The cost-performance ratio of computer and related electronics has fallen steadily over the last three decades. It is true that the quarter-million-dollar business computer of the late 1950s can be matched or bettered in most microprocessor-based systems that cost a thousand dollars or less today. However, that does not mean that one could completely automate a business with much success on such low-cost systems. The cost-performance ratio typically involves quite different considerations at the bottom, middle, and top of the scale. At the very high end with so-called *supercomputers*, cost is not as significant as maximum power. At the low end, the product most often has sharply limited utility.

There are three significant components of the cost-performance ratio of entire computer systems or, more broadly speaking, networks of computer systems: the cost of providing processing power as measured by instructions executed per second; the cost of computer storage accessible at a particular speed; and the cost of providing communications or links between computers as measured in bits of information at a particular data rate. Each of these components should undergo major changes over the next decade, some of it caused by technologies basic to all three and some caused by specific breakthroughs.

I'll review here the major expected areas of development beginning with supercomputers, the machines that will probably have a fundamental effect on our lives because of the scientific research that depends on them.

Supercomputers

In 1976, the U.S. Army outlined a procedure for evaluating computers for scientific applications. Although the procedure described is insightful and apparently success-

Will the Supercomputer Arrive?

ful in predicting the problem performance of numerous computer systems, the article is perhaps more noteworthy for the author's assessment of the wide gulf between available systems and existing research problems:

> A survey of various Army laboratories showed that problems with over 50 nonlinear simultaneous differential equations were considered overly expensive to solve by digital techniques because of excessive computation time. . . . For problems requiring 600,000 operations/cycle of the highest frequency, effective bandwidth of present-day large-scale digital computers is less than 170 hertz. However, from our survey, there are real-time requirements for computers which can process problem bandwidths of at least 10 kilohertz and approach a performance capability of 600×10^6 operations/sec.—three orders of magnitude faster than available computers (Wolin 1976).

In the four years since this was written, no new supercomputers have been announced, although lower-cost scientific processors have appeared. If anything, the research requirements now demand even higher performance. Among the long list of commercial and military applications areas requiring such high-speed computers are *signal processing:* weather prediction, radar, sonar, seismology, biomedical analysis, and image processing; *optimization and planning*: simulation, power guide systems, and linear and dynamic programming; and *science and economics*: econometrics, geophysical analysis, and modeling.

High-speed computation in digital computers is measured as the number of operations a machine can execute within a time period. Usually this is expressed as millions of instructions per second (MIPS)* or millions of floating point operations per second (MFLOPS),* depending on the computer manufacturer. In either case, what is being measured is the product of the basic machine cycle time* and the average number of operations that can be performed in a machine cycle.

For instance, an IBM 3033 (the fastest commercial member of the System 370 family) has a basic machine cycle of 57 nanoseconds (17.5 million cycles per second), and IBM says that it takes 3.9 cycles to perform the average instruction (.256 instructions per cycle), giving a result of 4.5 MIPS.

Or, compare the speed of the CRAY-1. It has a cycle time of 12.5 nanoseconds, and it can execute scalar operations* in 4.0 cycles and vector operations* in 0.6 cycles (1.75 operations per cycle) to yield 20 and 140 MFLOPS respectively.

The terms that produce the instruction rate are *cycle time* and *execution efficiency*.* Cycle time is determined by the technology used to build the particular computer and the complexity of its circuitry. Execution efficiency is determined by the actual problem tested (instruction stream) and the design architecture of the machine.

There are no less than eight quite differently architected supercomputers now on the market, as well more than a dozen somewhat cheaper "scientific processors" and no doubt a few classified high-speed machines for cryptographic or related work (Thurber 1979). The differences among these machines do not stem from differences in the basic technology of their implementation, but rather in the variety of ways that they attempt to produce parallel computations.

Since there is a fixed speed limit to the circuit technology, which for all these machines is fairly closely matched, machine designers attempt to build products that under the right conditions will execute multiple instructions simultaneously in separate, parallel computing elements. All the computers referred to in this section theoretically could execute at least one instruction per machine cycle, but by and large they fall far short of this ideal. In theory, some machines could produce much faster results, since they are constructed to have multiple execution units that independently and concurrently process machine instructions.

The theoretical maximum parallel processing speed is never attained for any length of time because in practice instructions are not executed independently. For example, the IBM System 360 Model 91 (195) has four different types of execution units linked simultaneously to process 16 words of instruction for a maximum aggregate throughput of 70 MIPS. Interdependence of one instruction on others is much more the rule than the exception, and an estimated 60 percent of the model 91's circuitry exist only to detect and resolve interdependence problems. In benchmark tests, the system attained only 14 MIPS on scientific applications and 3 MIPS on more general job streams where conditional branching* and interrupts* further affected throughput (Turton 1979).

The CRAY-1

The CRAY-1 has probably stirred the most interest in the supercomputer class. Priced near $4.5 million each and produced at a rate of only four or five per year, the CRAY-1

*Terms followed by an asterisk can be found in the accompanying glossary.

is the newest machine in its class and the only one produced by a small, independent computer manufacturer. Seymour Cray, the company's principal architect, some years ago was a founder of Control Data Corporation and helped design its 6600 and 7600 model computers, which are often used in support of scientific research work.

The CRAY-1 architecture is designed purely as a "number crunching" machine. It has no native capability of supporting input or output devices and must be linked to some more general purpose computer, which, in turn, controls disk drivers, printers, terminals, and the like. (Cray describes it as a second-generation vector processor.) Like other super machines, it is designed with parallel execution units—in this case, 12 functional units of different types. Six of these units are intended to operate on vector data consisting of 64 elements (64 bits each) rather than scalar data. When processing vector data in multiples of 64 elements, the CRAY-1 proves to be perhaps the fastest commercially available computer, blazing along at a steady 140 MPS.

Many commonly occurring problems can be tackled using operations like the Fast Fourier Transform (FFT),* convolutions,* and correlations. These operations can be vectorized to maximize their execution on the CRAY-1 or similar machines. However, writing programs that directly use either the vector or the parallel facilities of such a computer architecture has often proved to be a difficult task. Furthermore, supercomputers each have particular strengths in different problem areas requiring careful consideration to optimize parallel execution* capabilities.

Table 1
GATE CHARACTERISTICS OF POPULAR CURRENT TECHNOLOGIES

Technology (and year of introduction)	Function	Gate Delay (nanoseconds)	Power (milliwatts)	Speed-Power Product (picojoule)	Density (gate per square millimeter)
ECL-III	('68) NOR	1.1	60	66	30
ECL-1000	('71) NOR	2.0	25	50	30
S/TTL	('70) NAND	3.0	20	60	30
LS/TTL	('72) NAND	10.0	2	20	30
FAST	('78) NAND	2.0	4	8	—
NMOS	('73)	100.0	0.1	10	130

Table 2
GATE CHARACTERISTICS OF THE FASTEST CURRENT TECHNOLOGY

Technology	Gate Delay (picoseconds)	Power (milliwatts)	Speed-Power Product (picojoules)	Density (gates/per square millimeter)
ECL-III	1,100	6,000	66	30
CIL	30	6	0.000180	10

Table 3
CHARACTERISTICS OF IBM HYPOTHETICAL COMPUTER USING JOSEPHSON JUNCTION TECHNOLOGY

Performance	70 MIPS
CPU cycle time	4 nanoseconds
Cache capacity	32 K bytes
Main RAM capacity	16 M bytes
Cache access time	4 nanoseconds
Main RAM access time	20 nanoseconds
I/O rate (max)	360 M bits/second
Power at 4 degrees Kelvin	7 watts
Power at 300 degrees Kelvin	15 kilowatts
Volume of mainframe	4 liters
Volume of cooling system	460 liters

Alternate Technologies

The most promising area for increasing the processor power of the next-generation supercomputers is in developing new basic technologies that permit significantly faster circuits. Existing computers are fabricated largely out of silicon semiconductor* devices, known as integrated circuits (ICs)* or chips.

Semiconductors are built according to one of a number of processes, which, in turn, give rise to families of technologies. Broadly speaking, the silicon semiconductor families are known as metal oxide semiconductor (MOS)* and bipolar.* MOS family members include CMOS, NMOS, VMOS, HMOS, and others. Historically, the MOS technologies have been slower but consume less power than their bipolar counterparts. The bipolar family contains technologies known as TTL, STTL, LSTTL, ECL, I^2L and the newer FAST, AS, and LS^2 technologies.

Circuit speed is usually measured in terms of the time delay incurred by a signal passing through the elementary component of the digital logic, known as a gate.* The so-called natural gate* differs for different technologies and is defined as the Boolean operation* that requires the minimum number of transistors while giving maximum speed.

Table 1 summarizes the principal gate characteristics of some currently popular technologies.

By and large, the logic circuits of supercomputers are implemented in ECL integrated circuits. Looking at Table 1, one can see that the price paid for this high-speed technology is both high power consumption and low gate density. Both of these factors will have to be significantly improved by any future circuit fabrication technologies. There is, in fact, a relationship between the two since power consumption (heat) limits gate density.

High performance ECL chips consume and therefore

dissipate so much heat that special precautions have to be taken to keep circuits within operating temperature range. These cooling systems add significant bulk to computer architecture. The largest IBM machines are water-cooled, and the CRAY-1 is literally a computer built inside an air conditioner, with each circuit board frame containing freon pipes. The heat-sinking of ECL circuits adds to the already limited density of the fabricated integrated circuits. This bulk further limits systems speed since electronic impulses traveling at the speed of light will move only 1.5 centimeters in 100 picoseconds.

Josephson Junctions

In 1962, Brian Josephson developed a superconducting device known as the Josephson junction that may well lead to a new era of computer technology (Anacker 1979). The Josephson junction is not a semiconductor phenomenon; it results from superconducting materials operating cryogenically at near absolute zero temperature (−459.69 degrees Fahrenheit or 0 degrees Kelvin). At these temperatures, certain materials such as tin, lead, and niobium alter their electrical and magnetic properties, totally losing resistance to the flow of electric current and becoming impenetrable to magnetic flux. Electrons form what are known as Cooper pairs, setting off the superconductor energy levels from the normal conduction states by a superconducting energy gap in the electron energy spectrum of the metal.

Under these conditions when two superconducting materials form a junction with a very thin oxide layer (about 40 angstroms thick) that is sandwiched in between, the oxide, which is normally an insulating barrier, allows a current to flow in a tunneling mechanism. Based on this phenomenon, one can build all the necessary logical functions and memory needed to construct a complete digital computer. In fact, even though the technology is quite new, research at IBM has produced a family of Josephson devices known as current injection logic (CIL).* Gates in the Josephson technology have been termed superconducting quantum interface devices (SQUID).

For comparison, Table 2 shows the basic gate parameters of current injection logic and ECL-III, the fastest currently available technologies. Although gate densities for current experimental Josephson devices are low, there is already discussion of fabricating significantly denser chips. Present Josephson current injection logic devices are based on 5 micrometer junction diameters. Preliminary experiments and designs of circuits with junction diameters of 2.5 micrometers have already indicated that improvements of about two-fold in on-chip performance and about three-fold in circuit density can be achieved.

Another comparison one can make is between current injection logic random access memories* (RAM) and their semiconductor counterparts with comparable density. The semiconductors require about 20 times longer access and over 1,000 times more power.

Based on Josephson junction technology, IBM has designed a hypothetical computer that compares in circuit

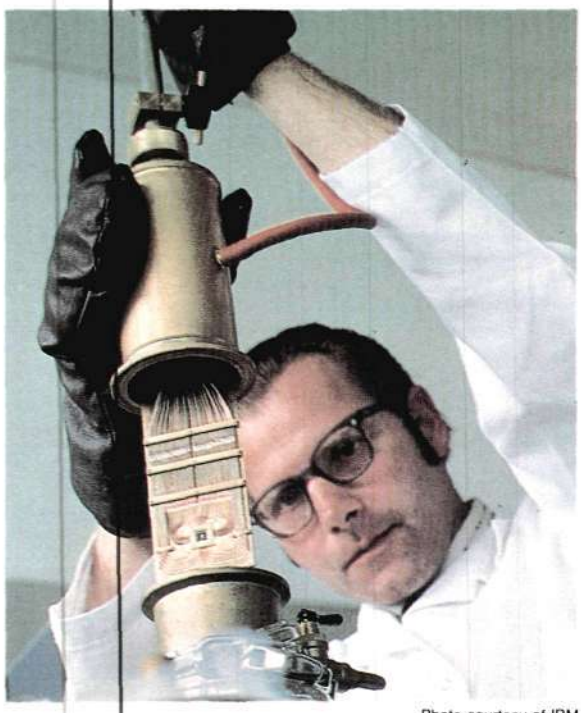
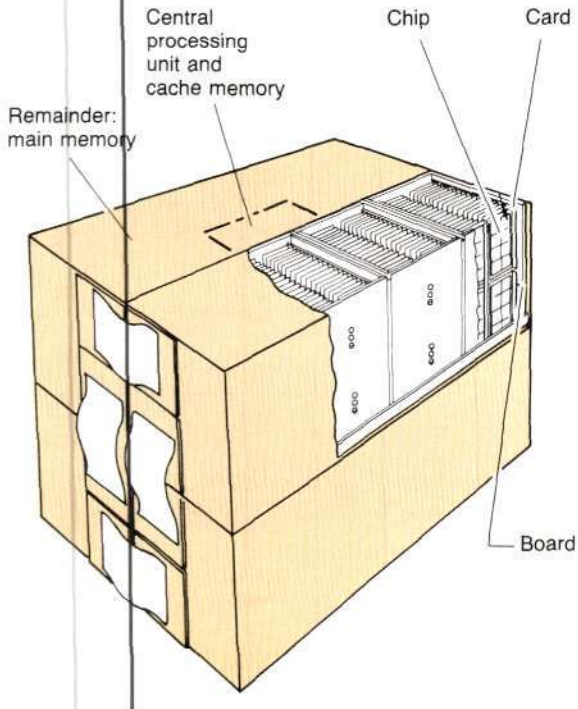


Photo courtesy of IBM

Above: This experimental Josephson computer circuit fabricated by IBM is capable of switching many times faster than circuits in today's most powerful systems. Below: A sketch of a hypothetical high-speed, high-performance Josephson computer that can be packaged in a 15-centimeter cube.



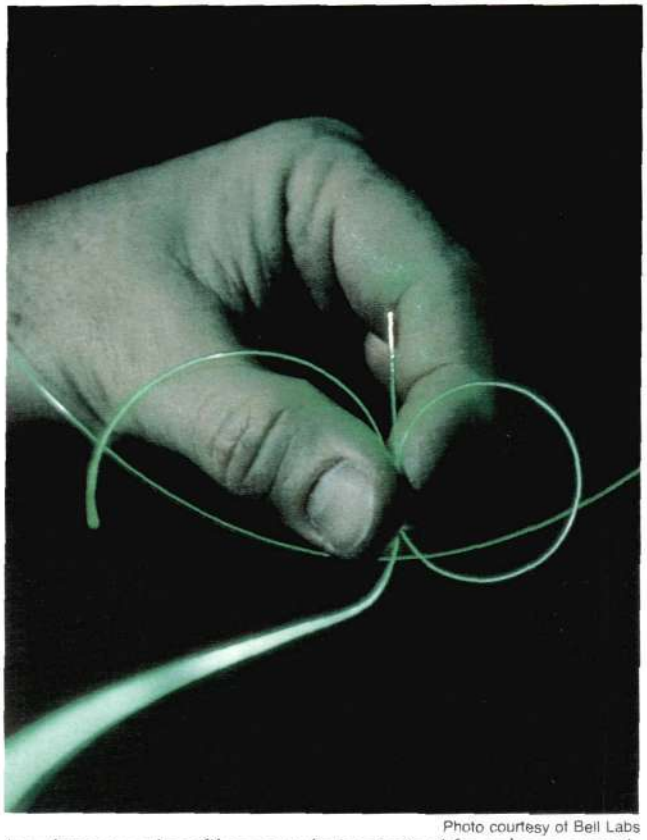


Photo courtesy of Bell Labs

An ultrapure glass fiber now being tested for telecommunications "wires" carries communications on beams of light.

complexity to a System 370/168. Although the hypothetical computer is a conservative estimation, the results are nevertheless staggering, as Table 3 shows. The hypothetical device could be packaged in a space measuring 15 cubic centimeters, but would require a much larger space for its cooling system. This system keeps the computer at 4 degrees Kelvin and at the same time removes the small amount of heat dissipated by the circuits.

The potentially very high reliability of the cryogenic environment may eventually allow the construction of extremely complex computers with millions of logic circuits. However, machines this size have not been attempted with semiconductor technologies partly because of the high likelihood that such computers would never function.

The cost per circuit of Josephson and semiconductor devices with comparable dimensions would be similar, because the process used and the yields expected are nearly identical. However, the performance of Josephson circuits is currently estimated to be 10 to 20 times that of the best available semiconductors, which makes the possible construction of 1,000-2,000 MIPS machines a technological reality.

Gallium Arsenide

There is another semiconductor technology sneaking up on the devices now based on the currently hegemonic silicon. Rockwell has fabricated integrated circuits based on gallium arsenide that show a gate delay of less than 100 picoseconds (Anatek 1980). Gallium arsenide circuits show a power dissipation 25 to 40 times lower than silicon oper-

Glossary

bipolar: a transistor consisting of a sandwich made of two different kinds of semiconductors.

bit: the smallest digital unit; can have a value of "on" (1) or "off" (0).

Boolean operation: operations like AND, OR, NOT, and so forth that are used as the basic building blocks of all digital logic (named after George Boole, 1815-64, whose algebra system deals with logical relationships).

byte: 8 bits of data.

conditional branching: a computer instruction that redirects the execution flow based on evaluating a particular instruction.

convolution: a mathematical operation involving the integral of the product of two functions at different times or positions.

current injection logic (CIL): an IBM family of Josephson junction devices.

cycle time: the time period for the smallest complete cycle of a central processor logic; the fastest instruction usually takes one cycle to complete.

execution efficiency: the numbers of central processor cycles needed on the average to execute an instruction.

Fast Fourier Transform (FFT): a fast algorithm for determining the spectral analysis of a function.

gate: a hardware implementation of a Boolean logic function, built out of transistors.

integrated circuit (IC): a circuit that integrates a large number of gates on a single piece of substrate, usually silicon.

interrupt: an interruption in the execution of a program that occurs at unpredictable intervals; interrupts are caused by such events as program errors or input/output events.

logic: the part of computer circuitry that performs logical or Boolean operations.

magnetic bubble memory: a memory technology that relies on small magnetic domains to store bits of data.

ating at the same temperature. These chips have a sixfold performance boost over equal silicon devices at the same power-delay product.

A long list of companies is investigating gallium arsenide, including Rockwell, IBM, Texas Instruments, Lockheed, TRW, and Hewlett-Packard. A good deal of this research is related to finding faster, more powerful microwave circuits. Rockwell has set itself the goal of producing 1,000-gate large-scale integration integrated circuits by 1981.

Gallium arsenide technology can also benefit from reduced temperatures. For example, gallium arsenide FET channels exhibit much greater mobility (and hence, speed) at liquid nitrogen temperatures. The combination of submicron geometrics and low temperatures could yield integrated circuits with properties rivaling those of Josephson junction circuits, which currently have more formidable requirements of operation at liquid helium temperatures.

Scales of Integration

There has been a steady progress since the early 1960s in the number of gates that can be fabricated in the same chip area, a trend that applies to all the above-mentioned technologies. This tendency is significant, because within certain limits the cost of producing a particular size chip stays the same regardless of its complexity (assuming an equal number of mask steps or roughly different layers involved).

The general milestones along the way have been called discrete circuits (one active element per chip), followed by small-scale integration, medium-scale integration, large-scale integration, and very large-scale integration. Currently, the most complicated chips have 50,000 to 80,000 active elements per integrated circuit. Most industry projections put the density crossing the 1 million active elements per chip in 1985-1986.

These levels of integration permit compression onto a single chip of a logic* that used to require a number of large logic cards. The revolution in consumer electronics—calculators, cameras, watches, and so forth— is a result of these integrated circuits. The microprocessor, a relatively simple computer fabricated on one to a handful of chips, is now being used to control everything from automobile ignitions to microwave ovens. Large-scale and very large-scale integrations are being used to produce special single-purpose devices like video games or extremely high-density memories. Additionally, more complicated computer architectures are being cast in silicon using very-large-scale integration techniques.

IBM has pioneered in the widespread commercial application of very-large-scale integrated circuits in its newly announced 4300 series (E series) computers. These use memory with each chip storing 64,000 bits of data, fabricated from a technology called SAMOS. This memory sells for only $18,000 per million characters, a small fraction of the cost of a few years ago.

Thin Film Heads

The same photolithographic processes used to produce the semiconducting and superconducting devices described above is now being used to manufacture recording heads for disk drives. These thin film heads are being used on the latest IBM disk product, the 3370, which has more than double the bit density (7.7 million bits per square inch) of its IBM predecessor (Yencharis 1980).

The computer disk drive is by far the most important peripheral component in most computer configurations. Disks are the storage medium for data bases, and their cost-per-bit-stored is second in importance only to main computer memory. Disks usually form the second tier in a hierarchy of memories and are used by the largest system as well as by the smallest. They often represent the majority of a systems's cost and contribute significantly to its unreliability.

IBM's 3370 disk stores 670 megabytes (million byte, byte = 8 bits) of data. Previously 100-to 300-megabyte drives were the largest installed. Because a drive of this sort generally will cost the same regardless of its capacity, IBM effectively has cut in half the cost of large disk storage. For example, the cost of such a drive is approximately $150 per megabyte, compared with main memory, which even with the 64,000-chip breakthrough, costs $18,000 per megabyte. The main memory, however, is almost 1,000 times faster in accessing data for the central processing unit. A typical large computer installation might have 4 to 8 megabytes of main memory and a few gigabytes (billion bytes) of disk storage.

The technology that IBM introduced in the predecessor to the 3370, the 3350 (known as Winchester after an IBM product codename), is now being used in low-cost 8-inch

millions of instructions per second (MIPS): an instruction is the smallest step in a computer program.

millions of floating point operations per second (MFLOPS): operations on numbers that are stored in a format in which the decimal point is not fixed.

natural gate: the logical operation that can be formed by using the smallest number of transistors.

parallel execution: the ability to simultaneously execute two or more complete instructions.

random access memories (RAM): memory that can be read and written at equal speed independent of location; location-dependent memories are serial in access.

scalar operation: a single element of data, in effect a zero-dimensioned array.

semiconductor: a substance with electrical conductivity properties intermediate between a metal and an insulator.

vector operation: a one-dimensional array of data.

disk products, which for the first time make feasible large amounts (20 to 40 megabytes) of storage located at a terminal or small computer site.

Various nonrotating substitutes such as charge-coupled devices and magnetic bubble memories* have been suggested to replace disk drives (the rotating mass storage devices). Although this was unlikely before, it is now a more distant possibility as advances in disk technologies continue to be made and nonrotating substitutes have an even longer way to catch up.

Fiber Optics

The fiber optic link, a high-speed and low-cost channel technology, may offer some of the answers to the problems of limited band widths for satellite communications. Bell Telephone has already replaced cables in a number of test locations with fibers. There are also numerous fiber optics products now available to the computer designer for the interconnection of central processors and peripheral equipment like printers and disks. In fact, the process is underway to rewire a good deal of the United States. The rewiring for telephone purposes will likely bring with it a shift toward all-digital networks, allowing the home computer of the future to access vast information resources by the high-speed data jack on the kitchen wall.

The Future

Over the past year, the price of many basic electronic components has increased as some computer manufactures boosted prices for the first time in their history. There are also shortages. Any company trying to manufacture computer-related products knows that there is an incredible shortage in integrated circuits almost across the board, which has a tremendous impact on the ability of new companies to enter the market. Scalpers sell chips at 5 to 10 times the manufacturer's list price, and there is no end in sight.

In each area of computer systems covered, there are available, economical technologies for dramatically reducing cost-performance ratios. But whether this tremendous potential is realized depends entirely on the future of U.S. science policy in general. Technological advances, like scientific breakthroughs, require capital investment, a trained workforce, and a growing economy.

Mark Stahlman is the vice president of Computron Technologies Corp. in charge of research and development.

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Interview with Dr. Fred Tappert

Advanced Applications of Numerical Computer Technology

What are the advanced applications of numerical computer technology to plasma physics and what kinds of problems exist? To find out the state of the art, Fusion *interviewed Dr. Fred Tappert, one of the country's leading experts in the field. Tappert, a professor at the University of Miami in Florida, has a joint appointment with the School of Marine Science and the Department of Physics. The interviewer is Dr. John Schoonover, director of physics research for the Fusion Energy Foundation.*

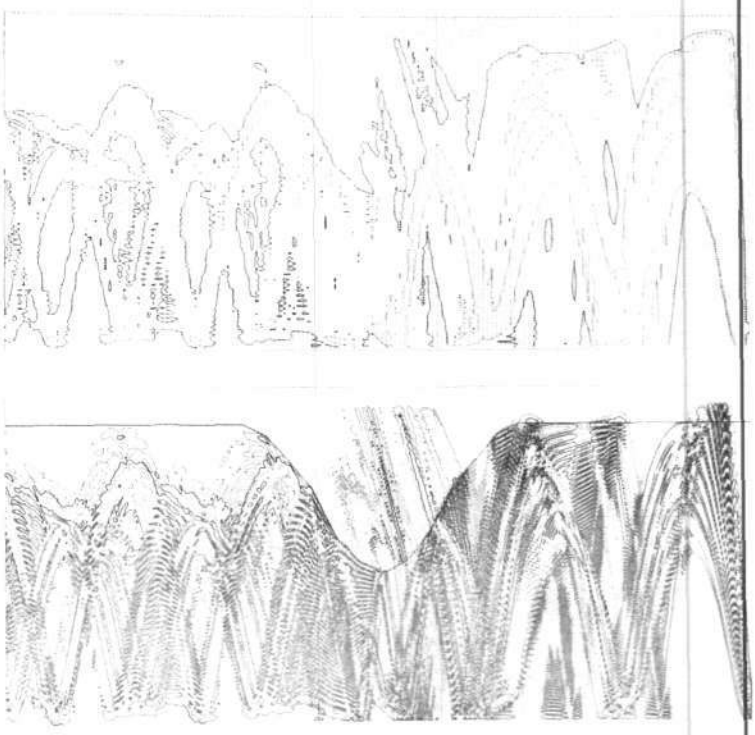
* * *

Question: *What are the frontier areas in numerical computer applications in continuum mechanics, plasma physics, fluid dynamics, meteorology, oceanography, etc?*

Let me reply by listing the applications that are of major importance right now and that with the use of powerful computing machines could get some astonishing results. The first area deals with very strong shock waves interacting with each other. This would have application especially to inertial confinement fusion, as well as to problems of hypersonic flight and reentry vehicles.

The second area, one that especially interests me, is the theory of compressible fluid dynamics and turbulence. There has already been a great deal of theory and numerical work on incompressible fluid turbulence, and I think it's time to move ahead to the study of compressible fluid dynamic turbulence.

The third area also has to do with turbulence, the question of magnetohydrodynamic (MHD) turbulence, espe-



COMPUTERS AND SOUND FIELDS
In this example of numerical computer applications, the source is at the upper left (500 ft deep); the ocean here is about 18,000 ft deep, and the total range shown is about 200 nautical miles (1 nautical mile = 6,076 ft). The acoustic wave equation was solved numerically using the "split-step Fourier" algorithm developed by Hardin and Tappert at Bell Laboratories in 1972. Contours of acoustic intensity in decibels are plotted throughout the ocean, using a high resolution computer microfilm graphics facility. This run illustrates the effect of a seamount to hinder the propagation of sound waves in the ocean and to provide locations for possible targets (for example, submarines) to conceal themselves. Analogous methods are used in laser fusion research to calculate the propagation of laser beams through the targets.

cially in connection with self-organizing MHD vortices and dynamo theory, and the generation of magnetic energy as a result of turbulent fluctuations.

The fourth area is a quasi-static decription of MHD diffusion across magnetic field lines. This would have great impact on magnetic confinement fusion reasearch.

The fifth area deals with propagation of nonlinear dispersive waves including turbulence effects or scattering of these nonlinear dispersive waves from random fluctuations in the medium through which they propagate.

Question: *What kinds of problems have you worked on?*

I have worked in continuum mechanics and stochastic wave propagation theory, solid state physics, and plasma physics. In all these areas I have enjoyed using computers to learn more about the actual world. I do most of my own programming, although I like working with other people who are also good programmers and sharing the task of getting data into the machine and useful numbers out.

Question: *Could you describe one of your projects?*

One problem I have worked on is using computer methods to simulate high-power laser beams propagating in nonlinear materials. I noted that a laser beam will spontaneously break up into filaments, each of which could be identified with a two-dimensional, solitary wave. The numerical method made use of Fast Fourier Transforms[1] to solve a nonlinear partial differential equation. The computer results were displayed in the form of movie films showing the intensity of the laser beam as a function of distance through the material. The break up of the initially homogeneous beam into filaments, actually into solitons, occurred in the material.

Question: *Turbulence seems to be an important factor in the areas that use numerical computer application.*

Yes, turbulence and stochastic[2] processes are both important. Turbulence is a generic name for any kind of random fluctuation behavior. Random may not be the most precise word; more accurate would be complex problems where a statistical description is needed. For example, if you have waves being emitted by a source undergoing a stochastic motion, you have to deal with the combined problem of wave propagation and stochastic or statistical fluctuation phenomena.

Question: *What is the most significant stumbling block to further progress in these areas?*

The main stumbling block right now is the organization of interdisciplinary teams of researchers. Especially in this country we have experts in hardware, experts in software, experts in the scientific applications; but getting groups of people together and working positively together for mission-oriented results is apparently very difficult. What tends to happen often is that a project will splinter into different areas. The hardware people will go off by themselves and design very fast machines using modern concepts of machine architecture without taking into account how the machines will actually be used or which algorithms will be implemented with them.

I can give examples from the other side, too. Related to that is the reluctance of many working scientists to get

involved with actually programming machines. Most scientists enjoy watching results that are achieved by numerical computation, but actually getting their hands dirty with the programming or with design of algorithms or machine architecture is something that many very good scientists are unwilling to do.

This is mainly a problem in education. I think more and more of the younger generation of scientists are quite willing to use computers themselves to achieve research understanding and breakthroughs, but the older generation, which mainly is in charge of our educational system, tends to bias the younger people against using computers.

As to forming teams, that is largely a question of the sociology of science and of forming the right kinds of schools with the right kinds of leadership. Building and maintaining and enhancing the power of these interdisciplinary scientific research teams is something that really needs to be worked on.

Another stumbling block is that big machines are not available to university research workers. At the national laboratories and at some of the large industrial laboratories huge amounts of machine power are available to the working scientists. University people, however, do not have access on a regular basis to these machines. I think that if some arrangement were possible whereby university people were able to get access either by high-speed tie lines between the central computer facilities and the universities or by using the machines in person, then productivity would really increase and the impact of computers on research would be much greater.

Question: *The progress in computer applications in these scientific areas over the last 30 years has been staggering, but there does not seem to be much room for more than one or two orders of magnitude of further increase in speed and size of computers using known technologies. What options are there for continuing progress?*

There are two ways to make rapid progress given the possible slowdown in increases in hardware speed and size. First, you could increase the use of special-purpose machines, designing the machine architecture from the very beginning to solve a particular class of scientific problems. For example, hydrodynamic calculations, which use a certain class of algorithms, are readily adapted to vectorized processing machines. In fact, you could go even farther and design these algorithms into the basic structure of the machine. In other words, you could hard wire a class of algorithms that would then give you a special-purpose computing machine for solving a class of scientific problems. For example, one machine might do hydrodynamics, another machine signal processing, another machine particle mechanics and orbital trajectory calculations, and another machine might solve wave equations. Just by specializing the structure of the machine, I think that one can get great increases in the output.

A second way to make rapid progress is to invest more research effort in algorithm design. The Fast Fourier Transform is an example of where one good algorithm can save factors of hundreds or thousands in processing time on ordinary computers. Simply through invention of new algorithms, you can achieve orders of magnitude increase in computer power.

Question: *Would these be more likely digital types of calculations, or do you have in mind analog[3] machines?*

I am thinking entirely in terms of digital machines. The calculations would still be done in binary form, but the programming of the machine would be done largely in hard wire form. For example, it is now possible with microprocessors to design a chip that carries out a set of very complex algorithms. A chip that does a Fast Fourier Transform is currently available.

Question: *What have we learned from performing digital computing solutions of nonlinear partial differential equations?*

Computers have been a major factor in our understanding of hydrodynamics and of systems based on fluid dynamical concepts. For example, the success of inertial confinement fusion has depended on knowledge learned from numerical studies of hydrodynamic implosions. We have also learned about the nearly universal appearance of self-organizing structures in continuum mechanics. The self-organizing structures might be shock waves, or they might be solitons or solitary wave-type phenomena. We have also learned about the influence of geometry on wave propagation motion; for example, how spherically converging shock waves tend to intensify while spherically diverging shock waves tend to weaken.

Question: *Do you think there are any problems in continuum mechanics that are insoluble on present-day computers or on any conceivable computers?*

I do not know of any insoluble problems, although a number of experts have claimed that the problem of fluid dynamic turbulence at very high Reynolds numbers[4] is simply not feasible on current-generation computers or even on those computers we can foresee being constructed in the future. High Reynolds number turbulence requires the use of two very different scales: the outer scale of turbulence and the inner scale of turbulence, the ratio of which could easily be of the order of 1 to 10,000. If you need this ratio of scale length in each of three dimensions, you can calculate the time it would require to solve the fluid equations for one eddy circulation time, and it is nearly astronomical. However, this pessimistic estimate overlooks the development of special-purpose machines designed to solve the turbulence problem and the development of much faster, more efficient algorithms for solving the fluid equations.

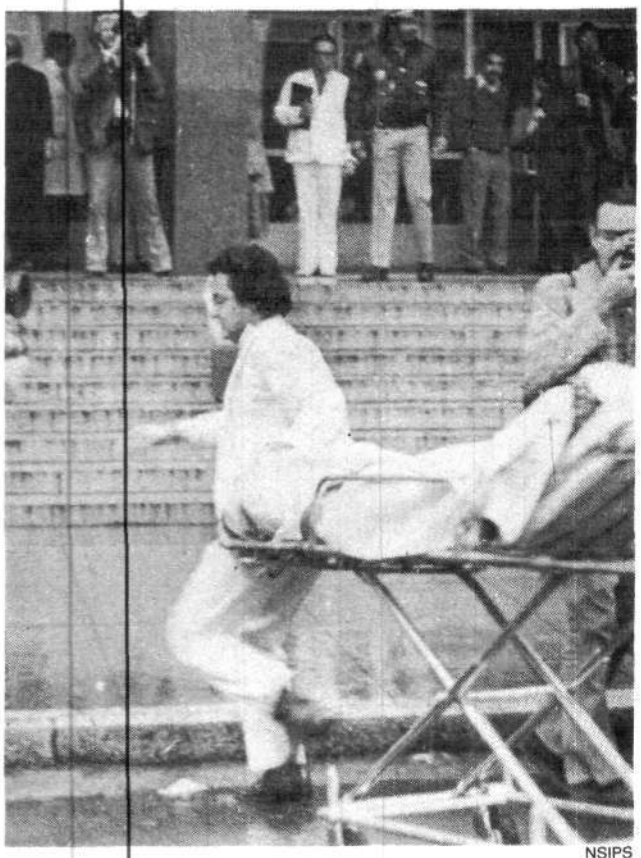
Notes

1. An integral equation used in unsteady-state problems of flow, and heat and mass transfer in turbulent fluids.
2. Processes pertaining to random variables dependent upon a parameter that usually denotes time.
3. Analog computers operate with variables represented in continuous forms analogous to physical processes being investigated. In contrast, digital data have discrete values (the form of digits).
4. A number descriptive of the effects of viscosity on the velocity and flow pattern of turbulent fluids.

Bioethics

A Final Solution for U.S. Medical Science?

by Ned Rosinsky, M.D.



NSIPS

"Whatever proportions [Nazi-doctor] crimes finally assumed, it became evident to all who investigated them that they had started from small beginnings. The beginnings at first were merely a subtle shift in emphasis in the basic attitude of the physicians. It started with the acceptance of the attitude, basic in the euthanasia movement, that there is such a thing as life not worthy to be lived. This attitude in its early stages concerned itself merely with the severely and chronically sick. Gradually the sphere of those to be included in this category was enlarged to encompass the socially unproductive, the ideologically unwanted, the racially unwanted and finally all non-Germans. But it is important to realize that the infinitely small wedged-in lever from which this entire trend of mind received its impetus was the attitude toward the non-rehabilitable sick."

LEO ALEXANDER, AN AMERICAN medical doctor who was special advisor to the chief counsel for war crimes at the Nuremberg Tribunal trials of Nazi doctors, wrote these words in 1949 in the *New England Journal of Medicine*. In his article, Alexander described in detail the crimes of the Nazi doctors, including experiments on efficient methods of mass murder, murder by freezing, and murder by exposure to low air pressure (high altitude simulation) to test the limits of human endurance. More than 270,000 people were killed in the experiments.

Under the subtitle "The situation in the United States," Dr. Alexander wrote:

The question that [the facts on how the Nazi policy of euthanasia began] prompts is whether there are any danger signs that American physicians have also been infected with Hegelian, cold-blooded, utilitarian philosophy and whether early traces of it can be detected in their medical thinking that may make them vulnerable to departures of the type that occurred in Germany. . . .

Hospitals like to limit themselves to the care of patients who can be fully rehabilitated, and the patient whose full rehabilitation is unlikely finds himself, at least in the best and most advanced centers of healing, as a second-class patient faced with a reluctance on the part of both the visiting and the house staff to suggest and apply therapeutic procedures that are not likely to bring about immediately striking results in terms of recovery. I wish to emphasize that this point of view did not arise primarily within the medical profession, which has always been outstanding in a highly competitive economic society for giving freely and unstintingly of its time and efforts, but was imposed by the shortage of funds available, both private and public. From the attitude of easing patients with chronic diseases away from the doors of the best types of treatment facilities available to the actual dispatching of such patients to killing centers is a long but nevertheless logical step. . . .

The trend of development in the facilities available for the chronically ill outlined above will not necessarily be altered by public or state medicine. With provi-

WHO photo by J. Bland

Senator Kennedy, Jan. 29, 1979: "The American industrial high-technology model of health care has hurt medical care in the United States and we cannot allow it to be established elsewhere." Here a street vendor sells medicinal plants in La Paz, Bolivia.

> sion of public funds in any setting of public activity the question is bound to come up, "Is it worthwhile to spend a certain amount of effort to restore a certain type of patient?" This rationalistic point of view has insidiously crept into the motivation of medical effort, supplanting the old Hippocratic point of view. . . .
>
> There can be no doubt that in a subtle way the Hegelian premise of "what is useful is right" has infected society, including the medical portion.

The trend toward cost-cutting and budget consciousness in American medical practice that frightened Dr. Alexander shortly after his Nuremberg experience with the horrors of Nazi medicine has today, three decades later, captured the federal government's outlook toward health care planning. Advanced medical technology is attacked as too expensive and not really necessary, and discussions of cutbacks in medical care—of the sort that Dr. Alexander notes were initially the product of shortages of funds available in Nazi Germany—are commonplace. (For example, consider the media debate about whether hospitals need CAT scanners.)

The irony, of course, is that only by investing now in basic medical research and the development of high-technology medical care will the nation be able to *decrease* the costs of basic medical care in the future.[1]

One of the most publicized examples of the cost-cutting mentality is the national health insurance bill proposed by Senator Edward Kennedy, a piece of legislation that is dominating debate over the future direction of U.S. health care. In the senator's own words, "budgeting is at the heart of the Health Care for All Americans Act."

The Kennedy health bill would close hospitals, constrict vital medical research and development, add a mountain of bureaucratic red tape onto medical establishment operations, and, in the very short run, vastly diminish the quality and intensity of health care enjoyed by all Americans—all in the name of cost-effectiveness. In fact, the bill's zero-growth provision that the growth rate of the national medical bill not exceed the growth rate in the Gross National Product, would ensure deep cuts in medical care expenses under current conditions of economic collapse. To stay within budget guidelines, doctors would soon be faced with gruesome choices: for example, opting for euthanasia through the denial of advanced treatment to chronically sick elderly citizens, such as Earle Spring of Massachusetts, whose case made national headlines recently, or denying of prenatal care to pregnant women.

When the reality of Kennedy's health bill policies is presented to a doctor or even the average layman, the understandable response is "what possible reason could anyone have for advocating such policies?" A look at what is behind the Kennedy bill helps to answer this question.

The cost-effective propaganda that Kennedy is campaigning on is not of his personal invention. The formulations basic to the legislation and the thinking behind it come from the Georgetown University Center for Bioethics, which was founded in 1971 with a grant from the Joseph P. Kennedy, Jr. Foundation.

The Bioethics Center is part of a larger Kennedy Institute at Georgetown that includes a Population Center and a human reproductive biology laboratory. The Population Center was set up in 1962 with Ford Foundation money as a think tank for zero-growth economics.

The Kennedy Bioethics Center, as it is known, functions for no other reason than to inculcate the economics of austerity into medical and scientific professional layers as well as the population at large. The center has spent millions of dollars creating the new discipline of bioethics, promulgating it in various seminars and publications, and defining subdisciplines such as "the ethics of scarcity," in which questions of insufficient medical resources are examined, and "the ethics of autonomy," dealing with patients rights.

Who are the bioethicists? Among the top-level promoters of bioethics is Kennedy's bother-in-law Sargent Shriver, "the brains behind the whole bioethics movement," according to the current director of the Kennedy Foundation. (Ted Kennedy is president of the Foundation and his sister, Eunice Shriver, wife of Sargent Shriver, is executive vice president.)

Other bioethics leaders include theologians such as Richard McCormick, a Jesuit priest who is the current director of the Bioethics Center, and a variety of linguistics specialists, such as Daniel Callaghan, a linguistics philosopher who did his doctoral work in theological linguistics at the Harvard University Department of Philosophy under Henry Aikens. Aikens is a follower of linguistician Noam

Chomsky, who is known for his use of linguistics in the promotion of anarchist groups.

The most notable theological bioethicist is Hans Kung, the irrationalist Catholic theologian who was recently barred from teaching church theology by the Pope. Kung, who has been a regular part of the Bioethics Center for years, espouses a "do your own thing" brand of religion, with mystical formulations of God that are explicitly outside the realm of reason. For Kung, God, in fact, is the very opposite of reason, "neither of this world nor outside of it."

How has Kung's radical theology contributed to the bioethics philosophy? Writing in the fall 1979 issue of the Kennedy Institute Quarterly Report, Sargent Shriver reported on a lecture Kung gave to the Kennedy Institute delegation in China last August:

> One of the highlights of these last two days was Hans Kung's lecture on "Science and Religion." Kung's talk emphasized that the question of the God of the ancient worldview is obsolete; God as a miracle-working helper in need, as a stop-gap, who is always invoked when we cannot get further with our human science or technology or cannot cope with our personal life.

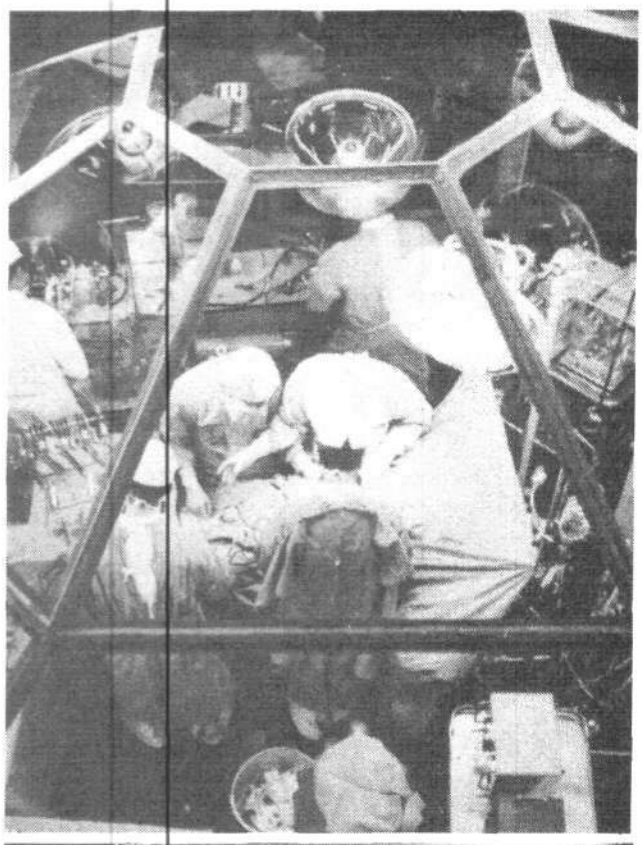
That is, don't bother praying, it doesn't do any good. Accept your "fate."

Not surprisingly, this new discipline of bioethics is fundamentally antiscience and antiprogress. On specific issues of basic research such as genetic recombinant DNA, or gene splicing, the center has been vigorously opposed. On advanced technology, director McCormick has said, "no person judged incompetent who needs renal dialysis should ever be put on the machine in the first place." That is, he should be left to die.

To spread its bioethics creation, the Bioethics Center has directly or indirectly set up courses in bioethics in more than half of the nation's medical schools over the past five years. Hundreds of hospitals, including most of the nation's major medical centers, have defensively set up "bioethics committees" to decide on plug-pulling policy. Members of the Kennedy Center and allied think tanks staff a special President's Commission on Bioethics in the White House and a bioethics oversight committee in the National Institutes of Health. The Center has supplied the "ethical justifications" for every one of the Kennedy (and other) attacks on the health care system, including his arbitrary budget caps, his attempts to cut back technology, and his bill to stifle pharmaceutical research.

Legitimizing Bioethics

Various founding members of the center, such as McCormick and Dr. Robert Cooke, began the public relations job of legitimizing "bioethics" in the mid-and late-1960s by using issues such as abortion and experimentation on humans as the subject of well-funded conferences. In the late 1960s the overall amount of medical services provided in the United States began to increase rapidly, after the passage of the federal Medicaid and Medicare programs in



Dr. Leo Alexander on the attitude of Nazi doctors: "It is important to realize that the infinitely small wedged in lever from which this entire state of mind received its impetus was the attitude toward the nonrehabilitable sick."

1965. In the next 10 years, the rise in U.S. medical costs was predominantly the result of the increase of needed medical services in these programs. Although still attacked as "wasteful," this spending for medical care resulted in a plunge in U.S. infant mortality and a sizable increase in the life expectancy of the elderly.

During this period, the underlying policy of the Kennedy Institute and the Bioethics Center began to emerge more clearly as antitechnology, antiprogress, and zero growth. Coming under particular attack by the Bioethics Center were new methods of treatment and life support that utilized advanced technology, such as heart monitors.

The Bioethics Center simultaneously served as a think tank for the various attacks on the medical profession at that time, especially the counterculture "patients' rights" movement and the malpractice crisis. The main argument here was the ethical question of the "autonomy" of the patient, counterposed against the "authoritarian" doctor. Similarly, the antitechnology argument was couched in the utilitarian ethic, "greatest good for the greatest number" arguments demanding that the "nonrehabilitable" be sacrificed so that "scarce medical resources" could be conserved.

The medical profession was a prime target of Bioethics Center propaganda for good reason. After the 1971 financial crisis and the abandoning of the NASA effort, the medical profession was virtually the only organized lobby for progress in the United States that combined the qualities of scientific commitment, respect by the public and by Congress, and powerful financial clout.

NASA

Encyclopedia of Ethics: "Medical care is expensive, and its expense is due in large part to halfway technologies." Here a biological isolation garment (a germ-free environment) and the Apollo Radiation Warmer (used for burn victims), both spinoffs of NASA technologies.

The Quinlan Case

The 1976 New Jersey Court case of Karen Ann Quinlan was central to the Bioethics Center's efforts to dissuade Americans from their commitment to progress in medical care and from their support of the research and development efforts of the nation's medical scientists. Although there were no substantive legal issues or issues of medical ethics involved in the case, it dominated coast-to-coast headlines month after month, hammering away at Americans on the question of whether Karen Quinlan's parents should "pull the plug" on their comatose daughter. Supreme Court Justice Morris Pashman stated as much during one hearing on the question: As he told State Attorney General Hyland, the case "doesn't belong [in court], it should never have been started."

A brief review of the Quinlan case shows why.

In April 1975, Karen Quinlan, 21 years old and from a deeply religious Catholic family, stopped breathing temporarily and fell into a coma for reasons that were never ascertained. During the next several weeks her condition changed to what is described as a chronic vegetative state, in which her eyes are open during periods of the day and she responds in a reflex fashion to light, sound, touch, pain, and other stimulation.

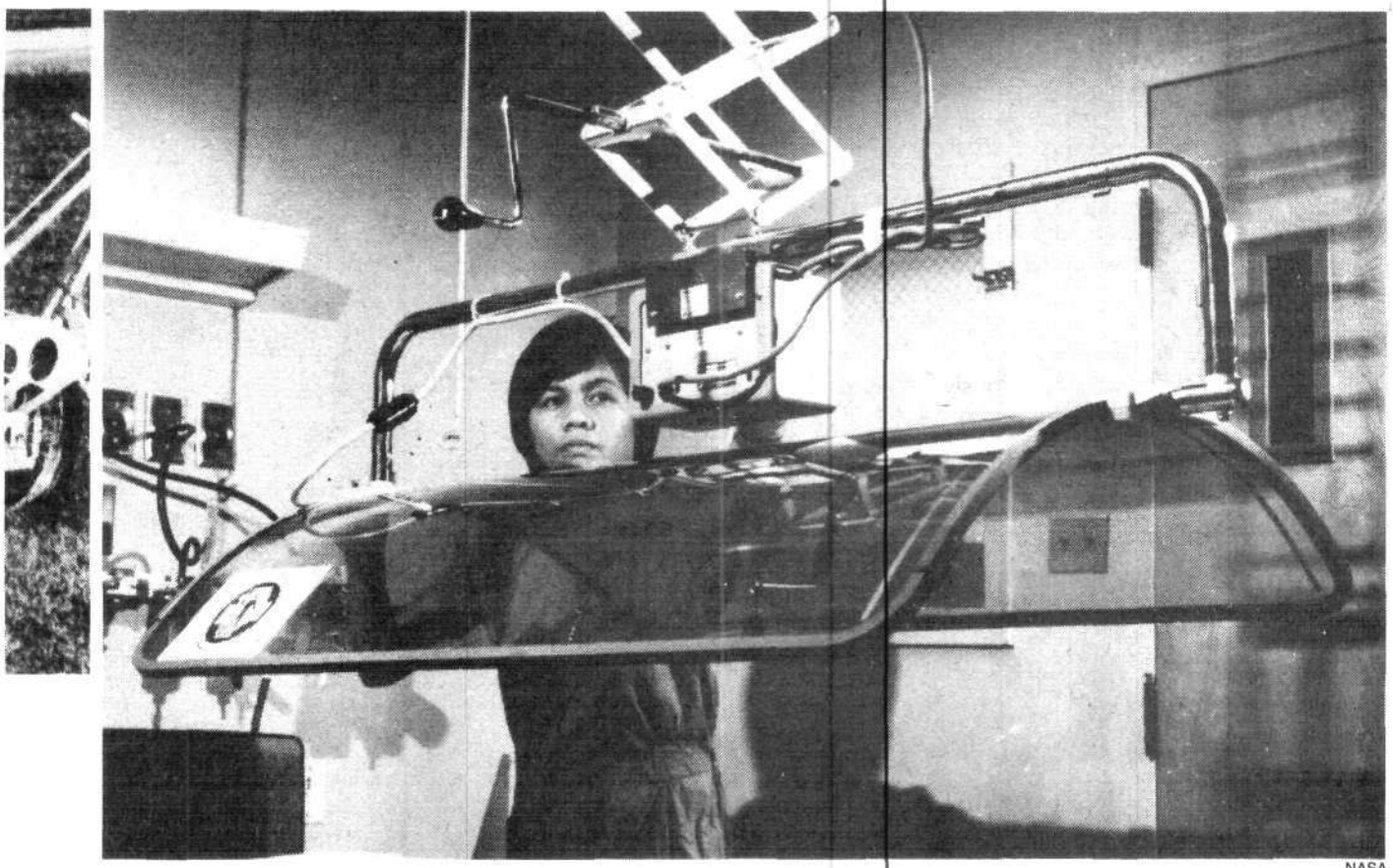
Even though Karen Quinlan has measurable brain waves to this day, however, it is generally presumed that she has no thinking functions or even conscious perception of stimulation as such. Doctors believe that the reason for this is that the "higher" portions of the brain, the cerebral structures, have been destroyed (in this case by oxygen deprivation), while the "lower" portions responsible for reflexes, temperature regulation, and so on, have been spared.

During the early phases of Quinlan's treatment she had not been able to breathe on her own and so was placed on a respirator. Over the first several weeks attempts to wean her off the respirator by taking her off for short periods of time failed. In addition to the respirator, she was treated with tube feedings through a nasogastric tube and intravenous antibiotics for recurring bouts of pneumonia.

After several months of no improvement, the Quinlan family accepted the doctor's opinion that reversal of the condition was highly unlikely, and requested that the doctor remove the respirator.

The doctor refused to take her off the respirator, however, most likely because of the highly charged malpractice atmosphere that had been developing since the late 1960s due to precedents set by California Governor Jerry Brown and the state's insurance regulators. Instead of simply changing doctors, the family got a lawyer. And instead of advising changing doctors, the lawyer, Paul Armstrong, went to court, knowing full well what he would be putting the family through. "If your case goes to court, it's likely to cause some controversy," Armstrong told Karen's father Joe. "Maybe a great deal of controversy. The newspapers will report it."

The petition to the court asked that Joe Quinlan be



NASA

made Karen's legal guardian "with the express power of authorizing the discontinuance of all extraordinary means of sustaining the vital processes of his daughter, Karen Ann Quinlan." Nothing in the petition implied that the doctors were being forced to comply with the request. The doctors however, objected to this unnecessary intervention. The counsel they had retained argued against the petition and won in the lower court.

Armstrong, however, prepared to continue the legal battle. He put his case together with the help of the largest law firm in the world, Shearman and Sterling located at 53 Wall Street. The firm is one of the principal banking law firms, with close ties to the New York Council on Foreign Relations, and clients such as Citibank and other New York banks. One of the key senior partners in the firm is Michael Forrestal, a member of the Council on Foreign Relations, who was on the White House National Security Council staff under McGeorge Bundy, and who is now advisor to Jimmy Carter. Armstrong and another member of the firm who helped him on the Quinlan case, James Crowley, were given "secretarial assistance, clerical supplies, printing and duplicating services—and the use of Shearman and Sterling's offices as a headquarters for preparation of the briefs," all donated by "the senior law partners, Henry Harfield and Myles Wayland," according to Armstrong.

After losing the lower court case, Armstrong appealed to the State Supreme Court. Before the hearing, Armstrong went to the Kennedy Bioethics Center and for four days "held intensive dialogue with the priests, physicians, lawyers, and ethicists on the moral, constitutional, and religious issues which formed the heart of the Quinlan plea."

Chief among these experts was Richard J. McCormick. Next, Armstrong conferred with Robert Veatch of the Hastings Institute, a bioethics think tank in New York. After these meetings Armstrong stated, "Our minds were well honed for the tasks ahead."

During the months between the lower court ruling and the appeal, the world was inundated with an unending series of headlines such as "Father Seeks Legal Right to Let His Gravely Ill Daughter Die," "Family Wants to Pull Plug."

The fraud was finally exposed in the appeal hearing. There, Armstrong admitted under questioning that he had originally not asked the Quinlans simply to find another doctor who would honor their request to remove Karen from the respirator because he wanted the court to "provide guidelines," to "make new law" in the tradition of "the evolution of common law, since its inception in England." He neglected to mention the relevance of the U.S. Constitution with regard to legislative powers of the courts.

Despite this public display of legal absurdity, the court ruled unanimously to allow Joe Quinlan to request the discontinuation of the respirator. After some weeks, the doctors successfully weaned Karen off, and she is still alive now in a nursing home, her state of consciousness unchanged.

The rest of the world, however, is quite changed. For eight

months daily headlines identified advanced medical technology as "extraordinary" and therefore not "ethically required," pushed cost-benefit analysis in a time of "limited resources," charged doctors with an imperious "disregard for the rights of the patient," and waged psychological warfare against the Catholic Church based on perverting Pope Pius XII's 1957 definition of "extraordinary" as damaging to the "spiritual life," to mean unusual or expensive. (Pope Pius XII said in 1957 that life should be preserved unless there were extraordinary circumstances that damaged the "spiritual life" of family members.)

The Right to Die

In the immediate aftermath of its successful mass brainwashing with the Quinlan case, the Kennedy Bioethics Center stepped up other efforts to eliminate advanced medical science in America by promoting the right to die.

In late 1976, Andre Hellegers, founder and director of the Kennedy Bioethics Center, joined the advisory council of the National Committee on the Treatment of Intractable Pain to demand the use of heroin for pain treatment. With Hellegers on the council were Rev. Lawrence J. Madden, S.J. vice president of Georgetown University; and Norman E. Zinberg, M.D., a Harvard psychiatrist and member of the Advisory Board of the National Organization for the Reform of Marijuana Laws.

Dr. Peter Bourne, special advisor to Carter on drug abuse and an advocate of marijuana decriminalization, was quoted in an intractable pain committee brochure as saying "I think you can rest assured. . . . that there is a good deal of sympathy with the concerns of your organization within the federal government." Pressure from the committee, along with the willing compliance of Health, Education and Welfare Secretary Joseph Califano, forced through National Institute of Health funding for several large heroin testing programs, one of these at New York's Memorial Sloan-Kettering Cancer Research Center. As the doctors had predicted before the experiments began, heroin was no better than the standard therapies such as morphine, so its use was not recommended after the testing programs.

However, as with the Quinlan case, the effect on public opinion was nevertheless real; if doctors are experimenting with heroin, then it can't be all that bad for you.

Another bioethics plan coming out of the Quinlan case was the "living will" law passed in California, which allows healthy persons to sign a "living will" stipulating that they be put to death if they ever become incurably sick. A complementary effort is the cost-cutting hospice movement, pushed by Kennedy Center advisor Elizabeth Kubler-Ross, who did the original studies of the dying that served as the basis for hospices and who claims she has not only talked to the dead but has received letters from them!

Codifying Bioethics

One of the major projects of the Kennedy Bioethics Center is a four-volume *Encyclopedia of Ethics* that contains a number of bioethics policy positions, each of which translates immediately into budget cuts.

The article on "Philosophy of Technology" states: "In biomedical practice the increasing use of technological instruments and rationalized systems of diagnosis has raised the problem of alienation in the form of questions about depersonalization of health care techniques and organizations." In other words, technology, such as EKG machines is bad, because it "puts distance" between you and your doctor.

The article on "Biomedical Research" states: "Medical care is expensive, and its expense is due in large part to halfway technologies. There are those who argue that we should stop developing new technologies in favor of learning how to distribute efficiently what we have now. Others propose that we might choose not to develop a new, expensive technology unless it can be distributed equitably among all persons. On the other hand, if we concentrate on learning the causes of disease we can expect to develop specific cures and preventions that tend not only to be inexpensive but also to render obsolete the very expensive halfway technologies and nontechnologies."

Seemingly quite fair, except that it leaves out one important opinion: those who insist that "halfway technologies," such as renal dialysis, must be continued to be produced and provided for patients until such time as specific cures come along.

On life-support systems, The *Encyclopedia* says: "They often create chronic states of modified illness rather than curing. This has considerable consequences for the persons, for the medical care system, and for society. Persons may find themselves living compromised lives at great expense to themselves or their families. Physicians enticed by the brilliance of the technology may concentrate great effort and resources on these systems to the detriment of other, possibly more effective forms of care. The costs of the sophisticated machinery, the need for highly trained technicians, the temptation to develop more intensive care units than are necessary, all contribute to the escalating costs of medical care borne by individuals and by society. In addition there is suspicion, seemingly confirmed by some studies, that much of the technology employed in intensive care units results in little or no improvement in care or cure of the patients."

What becomes clear even from this brief review is that the bioethicists are not just attacking doctors and medicine; they are attacking the American idea of progress and the role of science in securing for each citizen the "life, liberty, and the pursuit of happiness." Dr. Leo Alexander warned in his description of the Nazi doctors that they "had started from small beginnings." What is alarming today is that such beginnings are large and well funded, and that they are pursued in the name of "ethics."

Ned Rosinsky, a staff member of the Fusion Energy Foundation, is a practicing physician in New York City.

Note

1. For an overall view of the nation's health system and the role of advanced medical technology, see the author's "Making the U.S. Health System Healthy," *Fusion*, Feb. 1979, pp. 38-49.

French Tour U.S. Fusion Labs

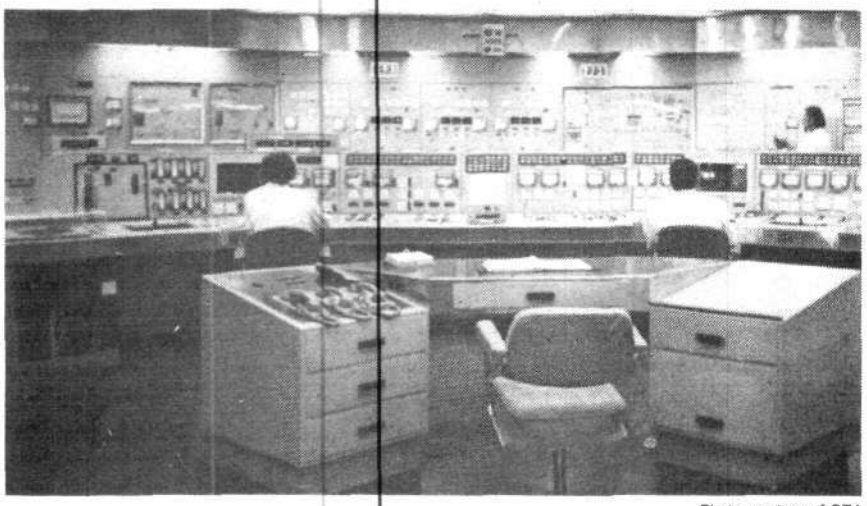


Photo courtesy of CEA

Poniatowski returned from his U.S. visit "more than ever convinced of the necessity to pursue the French nuclear program." Here the control room of the Phenix breeder.

A French delegation led by Michel Poniatowski, including journalists and representatives of the state monopoly electricity company, Electricité de France, toured fusion laboratories at the Massachusetts Institute of Technology, Lawrence Livermore, Los Alamos, and Sandia during a trip here late March.

The purpose of the trip was to look into the state of American research in plasma physics and particle beams, Poniatowski told a French television audience just prior to his departure. Poniatowski, a close associate of French President Giscard d'Estaing, is the head of the Development Commission of the European Assembly in Strasbourg. He said that his understanding of major Soviet advances in this field had led him to believe that if there were a lack of parity on the part of the United States, this could lead to serious threats to world peace.

Poniatowski had been scheduled to meet with officials from the Department of Energy as well as with National Security advisor Zbigniew Brzezinski. Those talks were canceled, however, after it was revealed that in a March 10 interview with the West Germany weekly *Stern*, Poniatowski had called President Carter an "imbecile" for his handling of such situations as the taking of American hostages in Iran.

According to sources directly involved in the talks here, the French group was mainly interested in learning about fusion energy and hydrogen fuel—meeting the energy needs of the next century. At Los Alamos, the French delegation took a ride in a liquid-hydrogen-fueled automobile, noting that liquid hydrogen was the direction to go in the move away from gasoline.

American "scientists are calling for a [fusion] effort comparable to the Apollo program for space research," Daniel Seguin, a journalist with *Le Figaro* who was part of the visiting delegation, reported April 1. These scientists also admit, Seguin wrote, that "to obtain the necessary money, it would take either a war or a new president."

Seguin added that Poniatowski returned from his visit "more than ever convinced of the necessity to pursue and develop the French nuclear program," already the world's most ambitious. Fusion is the only possible future alternative to oil, and in the meantime, nuclear energy and the fast breeder reactors—in which France has the world lead—are the necessary transition he wrote. Said one American scientist: "France is working for the benefit of the entire world."

—Dana Sloan

France Puts Inertial Fusion Under Nat'l Defense Department

The government of France has restricted research in inertial confinement fusion to researchers who obtain authorization from the French equivalent of the Department of Defense, the Defense Nationale, according to the April 6 *Journal Officiel*. In particular, all research using lasers or particle beams to achieve fusion will now fall under the control of Defense Nationale.

According to the official announcement, the new measures were instituted to ensure that research "does not lead to the creation of information, devices, or processes the exploitation of which would be harmful to the national defense."

The control of activities and research in the area of inertial confinement fusion will come under the secretary general for national defense. In the future, any person or institution wishing to engage in this type of research will be required to make a declaration of intent to the committee under the secretary general's chairmanship, *Journal Officiel* reported.

Velikhov Sees Hydrid Breeder As Next Step

E.P. Velikhov

E.P. Velikhov, former head of the Soviet fusion program and now the leader of the nuclear energy development program, addressed the Swedish Academy of Engineering Sciences March 10 in Stockholm, just days before the Swedish referendum on nuclear power. This report on the Velikhov speech was written by Michael Ericson, an editor of Energi, *the monthly magazine of the Swedish Association for Nuclear Power Development.*

* * *

"We estimate that after the INTOR project [an internationally sponsored tokamak machine] achieves the technological demonstration of fusion power, we will take the next step in the form of fission-fusion hybrid systems, which produce not only heat and electricity, but also fissionable material.

"This is guided by our policy in the Soviet Union that nuclear power must be developed by all the means available, and not only for the production of electricity, but also for the production of heat. Small nuclear reactors will produce heat for outlying regions, and standard breeder reactors are inadequate to supply them with fuel. We therefore need an additional source of fissionable material, and hybrid systems provide a very good such source."

This is how Soviet Academician E.P. Velikhov laid out his country's plans for exploiting nuclear energy in a March 10 speech to the Swedish Academy of Engineering Sciences. The Soviet program will rely on a diversity of nuclear technologies to provide the energy supplies for massive development of the nation's countryside, particularly the Siberian region. As Velikhov emphasized, these development plans will rely on rapidly increasing Soviet nuclear energy resources by using fuel produced in a fusion-powered breeder reactor.

The Soviet Union is matching its aggressive development of the hybrid breeder with an aggressive research effort into fusion power, which is proceeding along several different theoretical pathways simultaneously. The Soviet's clear commitment to expanded international cooperation in the energy development field, contrasted to the counterproductive classification policies of the United States, was also a theme of Velikhov's remarks.

Fusion by 2000

Velikhov, who has steered the successful Soviet research programs in thermonuclear fusion power and magnetohydrodynamics for the past decade, was the feaured speaker at the Swedish meeting of engineers. His audience, composed mainly of Swedish nuclear researchers and scientists, was highly impressed by the depth and scope of the Soviet research effort he described.

What impressed the assembled scientists perhaps the most was Velikhov's strong statement on behalf of the development of thermonuclear fusion power. In his opening remarks, the Soviet academician stressed that fusion power is completely safe—and unlimited. The second generation of fusion reactors, fueled by the reaction of two molecules of the hydrogen isotope deuterium (which can be extracted from seawater), will, said Velikhov, make "energy available in unlimited amounts for all nations." The introduction of fusion technologies on a wide scale will transform international relations, he hinted, noting that "with fusion, we will not have the problems faced today with oil."

The Soviet academician also outlined the Soviet program for achieving the commercial introduction of revolutionizing fusion technologies before the year 2000.

The Soviets have put a major emphasis on magnetic confinement fusion and tokamak fusion devices. The Soviet Union, according to Velikhov, is determined to "go all the way" to a demonstration commercial tokamak fusion reactor by the mid-1990s. The central problem now receiving research attention is the low beta values in current tokamak machines; that is, the inadequate efficiency of the devices in confining the fusion plasmas within the magnetic field long enough to reach fusion ignition temperature. Plans for increasing the beta values include the use of superconducting magnets to increase the strength of the magnetic field generated in the donut-shaped tokamak reactors.

The Soviet Union is following two lines of development for the tokamak program, Velikhov elaborated. It is scaling up its machines and building bigger tokamak devices in order to approach conditions in commercial reactors. At the same time, it is building smaller machines, with relatively stronger magnetic fields, in which substantially higher beta values have been achieved.

And in much the same way an automobile engine needs spark plugs, the Soviet nuclear scientist explained, the tokamak devices now used in the experimental Soviet programs require additional heating systems to approach the fusion ignition temperature of more than 50 million degrees Kelvin. The Soviets are planning to use two methods for auxiliary heating of the

fusion plasma: neutral particle beam technology that has been in existence for several years and the new microwave generator that is just going into application in the Soviet program.

The INTOR Project

In 1978, Velikhov proposed a broadened international cooperation in magnetic confinement fusion power research. His proposal was partly realized in the creation of the INTOR project, in which the Soviet Union, the United States, Japan, and the European Community nations have been participating for the past year under the auspices of the International Atomic Energy Agency. According to Velikhov's report to the Swedish Academy, several hundred fusion scientists from all over the world have been at work for the past year to outline the nature of the technological problems to be overcome on the road to reaching a demonstration commercial reactor by the mid-1990s. That accomplished, he said, the INTOR team will now undertake discussions on the conceptual design of a tokamak device to be constructed.

Velikhov reported with pride on INTOR's progress. "I think it represents a very great leap, not only for fusion but for international science generally," he said. "Fusion is in a very special and suitable position for international cooperation. The technology of magnetic confinement fusion has no military applications, and as yet no commercial connections, thus providing an opportunity for international cooperation. In 10 to 15 years that possibility will be lost. Once we reach the stage of commercial demonstration, we will have a situation much less suitable for international cooperation. I think that with INTOR there is a great possibility to have a very important experience of international cooperation."

The Soviet scientist also presented a brief outline of his country's research efforts in other fusion technologies. The Soviets plan to build large mirror machines and stellarators, both of which are applications of magnetic confinement technologies, and to pursue other magnetic confinement technologies.

In the field of inertial confinement, where very high energy beams are used to ignite a fusion reaction in a small frozen pellet of hydrogen, the greater part of the Soviet effort is being concentrated on careful investigation of various power beams: laser beams, electron beams, and other particle beams. The goal is to be able, within the next five years, to select the beam most suitable for use in commercial reactors.

Meanwhile, the Soviet Angara experiment, which involves the use of 48 beams simultaneously targeting one pellet in the same reactor, is proceeding apace Velikhov said. With this reactor, Soviet scientists hope to be able to achieve a scientific demonstration of how to harness fusion energy using a completely different principle than that of the tokamak.

Soviet Fast Breeder On Line in Urals

A 600-megawatt nuclear fast breeder reactor has begun commercial operation at the Beloyarsk power station in the Ural Mountains, according to the Soviet news agency Tass April 8. The BN-600 reactor is the largest breeder reactor in the world and the first commercial-scale use of fast breeder technology.

A smaller fast breeder reactor, 150 megawatts electric, has been in use for water desalination at Sherchenko on the Caspian Sea in a demonstration project.

A decade ago, when the fast breeder programs of the United States, the Soviet Union, France, and England were all at the demonstration reactor stage, America had the lead. Since then, however, the Carter administration's blocking of funds for the Clinch River Breeder Reactor and banning of the commercial nuclear fuel reprocessing plant in Barnwell, S.C., have deprived the United States of this crucial nuclear technology, which produces more nuclear fuel than it consumes.

The reactor commissioned at Beloyarsk is part of the official Soviet policy of giving breeder technology a prominent role in a nuclear power expansion program that is scheduled to take the Soviet Union from a current nuclear-generating capacity of approximately 10,000 megawatts-electric (under 10 percent of total national capacity) to 110,000 megawatts-electric in 1990, supplying 25 percent of the country's projected electricity needs in that year.

Why Nuclear?

Although U.S. Central Intelligence Agency scenarios for the speedy depletion of Soviet fossil fuels resources have been authoritatively refuted, including by a widely publicized independent Swedish study in 1979, the Soviet Union has good reasons for rapidly shifting into nuclear power.

Soviet oil and gas reserves, located in Siberia where every industry requires special cold-weather technologies, are increasingly expensive to tap. The Russians also have to contend with the import demand from their allies in Eastern Europe, some of whom were squeezed by cut-offs of Iranian natural gas and by the price of fuel that they purchase from suppliers other than the Soviet Union.

Above and beyond these considerations, Soviet scientists and energy planners rightly believe that fossil fuels burned to generate electricity have missed their calling. For example, State Atomic Energy Committee scientist Oleg Kazachkovskii pointed out in a current article that scientists have known for the past 100 years that the most efficient use of the energy potential in fossil fuel is as raw materials for the chemicals industry, not combustion.

Writing in the February issue of the popular Soviet science magazine *Priroda* (Nature), Kazachkovskii's enthusiastic and educational report typifies the Soviet attitude to a nuclear energy program that includes fission reactors, the breeder, and controlled thermonuclear fusion research, all full speed ahead.

—Rachel Douglas

Mexico:

More Oil For More Development

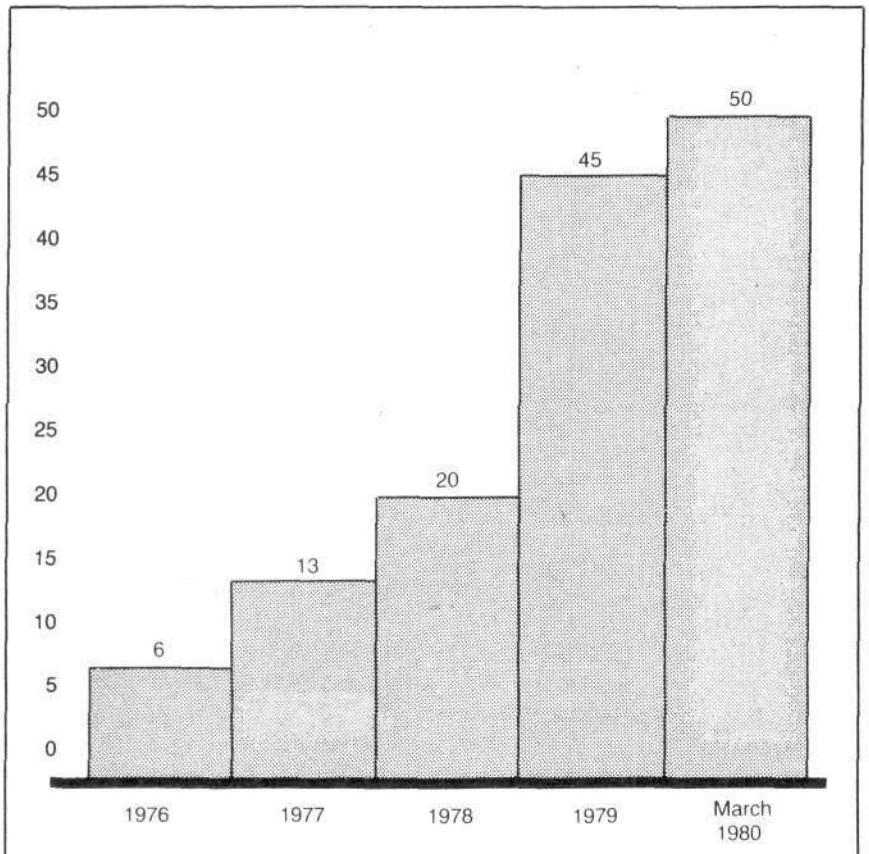
Mexican President José López Portillo announced March 18 that Mexico will begin further expansion of its oil production capabilities, beginning with a 10 percent increase above the previous ceiling set for the end of 1980.

López Portillo took the occasion of the annual commemoration of the 1938 nationalization of Mexico's oil to announce also that Mexico will not enter the General Agreement on Trade and Tariffs (GATT) and that the government will launch a new, "global" attack on Mexico's serious and worsening agricultural situation, called the Mexican Food System.

The three decisions, which set the direction of Mexican economic policy for the two and one-half years remaining in his presidential term, had been hotly debated in Mexico for months; and the first two had been the subject of extensive speculation in the foreign press.

"With what we call 'a consolidated platform' of 2.5 to 2.7 million barrels per day, with this 10 percent extra effort . . . we can liberate domestic resources . . . for this great national effort, and we will obtain enough foreign exchange to begin reaching some of the other priority goals," López Portillo said. The Mexican president reasserted in new terms the fundamental tenet of his administration's economic policies: using oil to convert Mexico into a modern industrial nation by upgrading the cultural level, skills, and living standard of the labor force.

Although the decision to increase oil production is most dramatic, the fact that Mexico finally decided not to join GATT reasserts the Mexican government as an advocate of national trade protection and cuts short an intense campaign launched by the "free traders" in Mexico and the United States to force Mexico into joining GATT. As some observers noted, the battle was similar to U.S. Founding Fathers' arguments against the British free trade system that aimed to loot the colonies, keeping them impoverished and dependent.



INCREASE IN MEXICO'S PROVEN RESERVES
(in billions of barrels, oil and gas)

Jorge Diaz Serrano, director of Mexico's national oil industry, Pemex, announced March 18 that Mexico's proven petroleum reserves were up to 50,022 billion barrels, an increase of 690 over proven reserves in Nov. 1976. "The new figure puts Mexico in sixth place in the world. It would take 64 years to drain our reserves at current production rates," Diaz Serrano said.

An 'Inopportune Visit'

Washington's reaction to the announcement of an increase in oil production—and especially to the strong indication that Mexico intends to step up its policy of using oil in more bilateral "oil for technology" deals with Japan, France, and Sweden—was to send U.S. Energy Secretary Charles Duncan to Mexico City April 4.

In what was characterized by one Mexican official as a "most inopportune visit," Duncan let the Mexican government know that Mexico's new gas price of $4.47 per metric cubic foot—equal to Canada's current price—was considered by Washington to be only "temporary." Washington insists on a "permanent pricing relationship," Duncan told the Mexican government, which translates into requiring Mexico to abandon its policy of pricing revisions to keep prices equal to or higher than prevailing world prices.

López Portillo responded to Duncan's pressures by reaffirming that "Mexico is no one's looting ground . . . but rather a supplier that sells on the basis of its own development interests." Despite the fact that Mexican officials took Duncan's visit in stride, however, it was noted that the deteriorating Mideast situation was bound to bring more U.S. pressures for a "permanent" oil price.

—Dolia E. Pettingell

Argentina Diversifies Nuclear Suppliers

Argentina has turned to West Germany, Switzerland, and even traditional political adversaries such as the Soviet Union and Brazil for nuclear cooperation in response to the Carter administration's efforts to thwart nuclear development.

Until last October, when West Germany's Kraftwerk Union (KWU) beat out Canada's CANDU for the contract for building Argentina's third nuclear power station, it was expected that the Canadians would continue to dominate in Argentina, because they are the only producers of the heavy-water reactors that use the natural uranium found in abundance in Argentina. However, fearing that the Canadians are too vulnerable to political pressures from Washington, the Argentines chose KWU for the power plant and the Swiss Sulzer for the heavy-water fuel plant, which will make the Argentine nuclear energy cycle entirely self-sufficient.

While Gerard C. Smith, Carter's Special Ambassador for Nonproliferation Matters, was left cooling his heels in Buenos Aires March 25, German Undersecretary for International Economic Relations, Dr. Per Fischer, worked out an agreement "on the basic political considerations for nuclear collaboration concerning the supply for the Atucha Two nuclear plant," the West German Embassy reported. The West Germans were satisfied with Argentina's adherence to International Atomic Energy Association standards for international inspection of all present nuclear facilities. On the contrary, the Carter administration and Congress have indicated that anything short of signing the Nonproliferation Treaty (which Argentina has not done) signifies that a country wants the bomb.

The Carter administration, accordingly, is cutting off 55 pounds per year of enriched uranium to an Argentine test reactor built under President Eisenhower's Atoms for Peace program. In response, Argentine nuclear chief Vice-Admiral Carlos Castro Madero sent a delegation to the Soviet Union to tour nuclear facilities. Upon its return, Castro Madero reported: "The results were excellent; the talks were fruitful and profitable, especially taking into account this was the first trip made with a view to exploring a possible cooperation plan with the Soviet Union."

Soviet officials offered the Argentines enriched uranium and other nuclear cooperation to help offset the 10 to 1 trade imbalance created by Argentina's sale of most of its wheat and coarse grain exports to the Soviet Union.

Although successful in staving off its foreign adversaries, the Argentine nuclear faction has been less successful at home. The overall policy of severe fiscal austerity and the elimination of incentives for industrial growth carried out by Finance Minister José Martínez de Hoz has forced cutbacks in the nuclear energy program from early projections of 30,000 megawatts by 1997 to the meager 3,300 megawatts now firmly scheduled.

A 'Bridge to Peace'

At the same time that he is opening up channels for the inflow of nuclear technology from Western Europe and the Soviet Union, Castro Madero sees nuclear cooperation with countries less advanced in the area than Argentina as a "bridge to peace." This is especially true of Brazil, despite the fact that Washington has billed a nuclear arms race between Brazil and its Argentine neighbor. In fact, the two top men in Brazil's nuclear program made a friendly visit to Argentina in late March to plan an extensive nuclear agreement to be signed during the visit of Brazilian President Figueiredo to Argentina in May.

In June, Argentina will host the first meeting on nuclear cooperation of the nonaligned countries, with delegates from nations as diverse as Cuba, Egypt, and Yugoslavia. Castro Madero has pledged Argentine nuclear aid to Third World countries, "especially those which are beginning to demonstrate interest in the application of nuclear energy for peaceful use in the field of energy, nuclear medicine, and the development of industry and agriculture."

—Mark Sonnenblick

TMI Cleanup

Continued from page 24

The three completed evaluations of the venting made it clear that the venting should not be indiscriminantly delayed, because the containment building was not designed to be a long-term storage tank for radioactive gas and it could begin leaking to the outside atmosphere at any time. This, of course, would be an uncontrolled venting.

One of the major concerns is that containment building ventilation fans might fail, allowing a pressure to develop inside the containment building that would force krypton gas to leak out any cracks that are there now or that might develop. The fans, which have been operating continuously and unattended for more than a year, are used to draw a continuous vacuum in the containment building insuring that any leakage is inward and that no krypton gas can get out.

Perhaps the greatest danger is that the governor is setting a precedent for involving the antinuclear movement in the day-to-day operations of the nuclear power industry.

What Is the UCS?

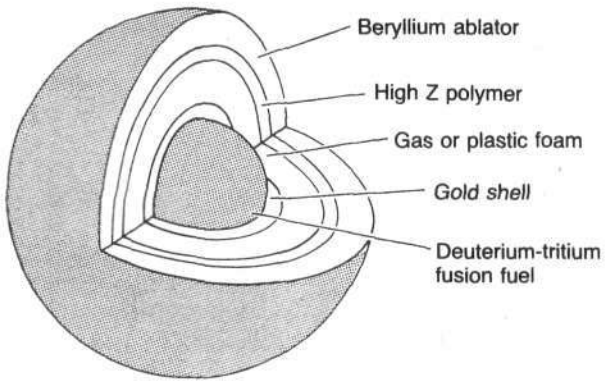
The Union of Concerned Scientists operates as the "professional" wing of the antinuclear movement.

The UCS team that will work on the krypton opinion is led by Henry Kendall and Daniel Ford, two of its founders. The team will draw on the opinions of Greg Minor and Dale Bridenbaugh from MHB Technical Associates Inc.; Robert Pollard, a dropout from the Nuclear Regulatory Commission; Jan Beyea, a member of the Audubon Society who teaches at the Princeton University Center for Environment and Energy Policy; and Dr. Edward Radford of the University of Pittsburgh School of Public Health. Overseeing the entire project is an eccentric physicist, Frank von Hippel, from Princeton University.

The unifying feature of this group is that nearly all of them have lost their scientific credentials through encounter-group sensitivity sessions.

For more details on the UCS, see Fusion, *June 1979, pp. 12-15.*

LLL Double Shell Target Achieves Compression Advance



DOUBLE SHELL TARGET DESIGN

This cutout diagram of a complex, double shell laser fusion target shows the various layers of the spherical pellet. The outer layer is made up of low atomic number material, beryllium, which provides for the efficient absorption of incident laser light. The ablation of this material drives the compression shocks that implode the interior layers of the target. The second layer of the target consists of a high atomic number element (High Z), which is a polymer chemical structure. This material helps shield the interior layers while being efficiently imploded. The third layer consists of gas or plastic foam that acts as a buffer but does not obstruct the implosion. The next layer, actually the inner shell of the double shell target, is made with gold. The gold shell absorbs the implosion shock of the outer layers while protecting the fusion fuel from preheating.

Preliminary results from high-density experiments with the Lawrence Livermore Laboratory Shiva laser system indicate that compressions of hydrogen fusion fuel up to 200 times its liquid density have been achieved using a new double shell target design. If confirmed in further experiments, the result represents a major advance toward achieving the conditions needed for practical energy generation by laser fusion systems. The highest previous compression achieved was 50 times liquid density.

From the perspective of fundamental science, these experiments could also lead to theoretical breakthroughs affecting every branch of physics.

The new advance in compression used a target in which an outer shell absorbs the incident laser energy and implodes toward an inner shell containing the hydrogen fusion fuel. The resulting collision leads to the formation of an imploding shock wave compressing the inner shell with very little heat generated. This so-called cold compression permits more efficient compression to high densities.

Laser fusion is an inertial confinement approach in which intense laser beams implode microscopic pellets containing hydrogen to extremely high densities like those found in the centers of stars. The implosion process also leads to the heating of a minute portion of the core of the compressed pellet, achieving fusion ignition temperatures. Because of the high densities to which the hydrogen is driven, the ignited core is able to heat and burn the remaining compressed fusion fuel before the pellet blows up; therefore, inertia is the only thing that confines the fusion fuel while burning.

The key to attaining energy gains (a ratio of energy generated to laser energy injected) that are high enough for practical laser fusion power plants, is to achieve high densities efficiently, without loss of energy.

The same approach is used in hydrogen bombs. In an H-bomb, the radiation from an atomic fission bomb replaces the laser beam as a means of driving the hydrogen fusion fuel to high densities and explosion.

Although experimental generation of hundred-million-degree Celsius temperatures has been routinely accomplished in laser laboratories throughout the world since the mid-1970s, only in November 1978 were high compressions of hydrogen attained. Experiments on the Livermore Shiva laser achieved densities of greater than 50 times hydrogen's liquid density.

To achieve energy gains high enough for practical energy generation, it is projected that efficient compressions to 1,000 to 10,000 times liquid density will be needed.

Double Shells Efficient

The new preliminary results achieved with the double shell target are not just important because of the fourfold increase in density. Significantly, this was accomplished with no increase in temperature over that generated in the experiments achieving only 50 times liquid density. This is a crucial indicator that the compression process is more efficient. More of the laser energy injected is going into compressing the fuel as opposed to simply heating it.

U.S. Japan Begin Joint Fusion Work

The fusion energy research program in Japan is now comparable in size to the the U.S. program, according to Department of Energy scientists who recently returned from Japan.

Transfer of knowledge and experience in a joint U.S.-Japan program will be primarily from the more mature U.S. program to the Japanese program, although, some scientists feel it may begin to go the other way as areas of Japan's program develop, especially in superconducting magnet technology and materials development. The Japanese also have the world's largest stellarator fusion device coming on line soon, with U.S. scientists anticipating benefits from joint work on the machine.

Over the past year, an initiating agreement for collaboration on all aspects of fusion research was signed between the United States and Japan. The first implementation of that agreement has been the participation of the Japanese in work on the Doublet III fusion device at General Atomic Co. in San Diego, California.

As part of that project, the Japanese government will contribute approximately $60 million to upgrade the experiment, which includes the cost of bringing hardware and additional diagnostic equipment over from Japan. The agreement calls for $12 million per year from the Japanese over a five-year period, matching the Department of Energy's funding for the program.

Working with American scientists on Doublet III will give the Japanese "training and hands-on experience" that they would have to go to great expense to obtain without such collaboration.

Technology Cooperation

The next phase of such cooperation will involve joint work on the development of needed new technologies. According to Dr. Franklin Coffman, DOE fusion-office director for technology development who recently visited Japan, collaboration on the Rotating Target Neutron Source at Lawrence Livermore Lab is currently under negotiation. This program, which studies fusion reactor materials damage due to high-energy neutrons emitted during fusion reactions, would be the first bilateral agreement on joint technology development.

A handful of Japanese fusion materials specialists will arrive in the United States over the next few months. They will work with Livermore research teams on RTNS and participation in a second area, the large coil program, is now under discussion. It is proposed that the Japanese, who have done much work in magnet design and engineering, contribute a $10 million coil for America.

The original initiative on fusion collaboration came two years ago from then-premier Takeo Fukuda who proposed a broad-based cooperation effort. Although the top officials at DOE reacted with disinterest, scientists in the department, in industry, and in national laboratories have viewed the offer as a great opportunity.

Bostick on Self-Organizing Plasmas

Experimental evidence demonstrates that energy-dense plasmas are dominated by self-organizing structures, Dr. Winston Bostick reported to the American Physical Society meeting in New York March 27. Bostick, associated with the Stevens Institute in New Jersey and now working at Kirtland Air Force Laboratory in Albuquerque, New Mexico, titled his presentation "Condensation of Plasma and Energy Densities by Vortex Structures."

Bostick reported that continuing plasma research at Stevens Institute is primarily based on a small plasma focus experiment, while his latest work at Kirtland Air Force Base utilizes a giant electron beam gun developed originally for simulating the effects of nuclear weapons. Yet the results are the same: the plasma beams form spiral patterns.

The difference in scale of the two experiments is such that the plasma focus at Stevens will fit on top of a

Soviets Build Giant Lasers

The Soviet Union is currently building laser systems with multi-hundred-kilojoule outputs and has undertaken other significant new initiatives in developing the inertial confinement approach to fusion energy development, according to Japanese scientists who received reports from Soviet researchers. The scale of lasers now being built, according to published papers by Soviet scientists, would permit net-energy-generating fusion ignition.

The laser described is evidently similar to the Shiva-Nova glass laser now under construction at the Lawrence Livermore Laboratory in California. Before the Carter administration had called for cutting all funds for the Nova project in its 1981 budget proposals, Nova was scheduled for completion in the mid-1980s.

It now appears that the Soviet Union will have both laser and electron beam experiments in fusion breakeven completed years in advance of those projected for the United States. The Angara V electron beam project is being constructed under the direction of L. Rudakov, a leading figure in the Soviet fusion effort.

The reports on the Soviet program from Japanese scientists are among the first received in the West since the administration's curtailment of scientific exchanges with the Soviet Union.

desk, while the Kirtland electron gun is the size of a freight train. The fact that similar experimental results were obtained demonstrates that those results are not due to the peculiarities of either apparatus.

The primary diagnostic Bostick described is the physical impression (damage) made on solid plates by beams of plasma. The plates are located in the experiments in such a manner that the plasma beams intersect them. Highly ordered, well-focused spiral impressions are found on the plates after their collision with plasma beams, with individual spirals also forming larger patterns of spiral shape! Variation of experimental conditions established that these spiral structures are characteristic of both electron and ion beams.

Report New Model For Ball Lightning

A new model of ball lightning has been developed at Zeldenrust College in Terneuzen, the Netherlands by G.C. Dijhkuis, who reported his work in the March 13 issue of the British magazine *Nature*.

The rarely observed ball lightning form is important to fusion research because unlike the ordinary linear variety of lightning seen during thunderstorms, it apparently consists of a self-organizing plasma-electromagnetic energy structure that can exist stably for a lengthy time (seconds). Dijkhuis's model, in fact, supports the hypothesis that thermonuclear fusion can be ignited within the interior of a ball lightning configuration.

Dijkhuis bases his model on the hypothesis that "turbulence in the ball lightning plasma enhances charge transfer to the point that charged vortices transport electricity the way electrons do in a superconductor." The charged plasma vortices exert centrifugal forces on each other which lead to a "sponge-like structure of tenuous vortex cores nested in dense ambient plasma." As a result, a stable sphere of plasma is contained and insulated from ordinary air.

The concept of vortical structures evolving out of a turbulent plasma was pioneered in the United States by Winston Bostick and Dan Wells, two fusion scientists. What distinguishes the Dijkhuis model for the ball lightning case is its peculiar geometry. Most other models postulate a donut-shaped configuration.

LLL Mirror Results Better Than Expected

A report soon to be issued by the 1980 Mirror Senior Review Panel says that the Tandem Mirror Experiment at Lawrence Livermore Laboratory in California has had results three times better than those expected in terms of fuel temperature, density, and confinement time, demonstrating the feasibility of this approach to fusion energy. The panel is composed of leading fusion scientists and engineers brought together by the Department of Energy.

The Tandem Mirror Experiment device, the TMX, consists of a long cylindrical plasma with a simple solenoidal magnetic field and two magnetic mirrors, one at each end, to prevent plasma from flowing out of the cylinder.

According to the panel, in addition to the good results achieved in the experiment, the entire spectrum of plasma physics advances made in the last five years indicates that further modifications in the tandem configuration can be made to significantly reduce the scientific and technological difficulties of building a practical fusion reactor of this type. In particular, the introduction of an ignited fusion plasma and operation with the advanced fusion fuel cycle—all deuterium—appears quite feasible.

An ignited system means that the primary energy for maintaining the fusion plasma at the several-hundred-million degree temperatures needed for fusion reactions comes from the fusion reactions themselves, rather than from costly external heating sources like neutral beams and microwave generators. More of the fusion energy would be in the form of high-voltage ions and therefore amenable to direct conversion to electricity.

It appears that the tandem will be able to attain such high temperatures because it is appropriate to a so-called classical mode of confining fusion plasma. In this type of confinement, the efficiency of confinement (and so, the maintenance of fusion conditions) increases with increasing temperature—the opposite of what is generally encountered in other magnetic fusion experiments.

Proposed Modification

The modification proposed by the Mirror Senior Review panel involves tailoring the end-cell plasma temperature and density profiles by use of

DOE Awards Theory Center to U. of Texas

The U.S. Department of Energy announced March 24 that the University of Texas at Austin has won the DOE grant for establishment of a new U.S. Institute for Fusion Studies. The institute is planned to be the theoretical center for the U.S. fusion program. Other universities that had submitted bids were the University of Maryland, New York University, the Massachusetts Institute of Technology, Yale University, and the University of California at Los Angeles.

Dr. Marshall Rosenbluth, currently at the Princeton Plasma Physics Laboratory and the Institute for Advanced Studies, will head the new Texas institute. He is generally acknowledged to be the leading U.S. theoretician in plasma physics.

According to unconfirmed reports, Steven Weinberg, the Harvard University astrophysicist, will also join the institute, and John Wheeler, who is now at the University of Texas, may join its board of advisors.

microwave and neutral beam injection, and the addition of a second set of mirror end-cells. The feasibility of this proposal can be experimentally checked by modifying the existing Livermore device.

The panel unanimously concluded that the mirror effort should be rapidly expanded, and that the Livermore $125 million Mirror Fusion Test Facility-B should get a green light. The MFTF-B could be completed by 1983 and would generate the physical conditions needed for reactor-grade plasmas in a tandem configuration. Moreover, the technology involved in the test facility would be close to that required for actual fusion power plants.

Elmo Bumpy Torus Gets POP OK

The Elmo Bumpy Torus (EBT) has received offical go-ahead for a major proof-of-principle (POP) experiment with funding in the 1981 budget, according to sources in the Department of Energy. The EBT, a magnetic fusion approach developed at Oak Ridge National Laboratory in Tennessee, is thought of as the leading alternative approach in the U.S. program to the tokamak and magnetic mirror approaches, now the two mainline systems.

The EBT combines features of both tokamaks and mirrors. Mirror machines are open-ended magnetic bottles that use two regions of intense magnetic field to confine a plasma within the weaker magnetic field section. The EBT consists of a series of mirrors whose ends are connected together to form a torus, like a tokamak, so that no plasma can escape out the ends of the mirror bottle as in the open ended mirror system.

The combined effect of its local mirror and global toroidal geometry enhances the overall confinement of hot plasma, so that the EBT could provide the basis for energy dense, steady-state fusion reactors.

When completed, the EBT's proof-of-principle experiment should demonstrate the scientific principles of this promising alternative approach.

Conferences

Riemannian Economics Seminar
Washington, D.C., April 8

Administration's Inflation Policy Heading Nation for Collapse

In a presentation that stunned the 30 economists, businessmen, and foreign diplomats present, Uwe Parpart reported that the "antiinflation" policies of the Carter administration are intersecting its "energy conservation" policy to assure that a hyperinflationary collapse of the American economy will occur within three to six months. Parpart, director of research for the Fusion Energy Foundation and a contributing editor to the weekly *Executive Intelligence Review*, spoke at a symposium on the Riemann-LaRouche economic model jointly sponsored by the Fusion Energy Foundation and *EIR* April 8 in Washington, D.C.

Parpart, an expert on the work of 19th-century mathematician Bernhard Riemann, based his analysis of the Carter-Volcker measures on the groundbreaking Riemannian-LaRouche econometric model employed by FEF and *EIR* and developed in collaboration with economist Lyndon LaRouche. He prefaced his talk by challenging his audience to name "any other voice" raised that had predicted the inflationary effects of the highly restrictive credit policy Federal Reserve Chairman Paul Volcker announced last October.

Analysts working with the Riemannian model were alone in understanding that those measures, as well as the new steps announced by the president March 14, would worsen inflation, not attenuate it, Parpart said.

"How did we know this?" asked Parpart, referring to the climb from 7 percent to an annualized average 20 percent inflation rate since Carter assumed office. "Everyone called these measures antiinflationary. Mind you, we did not say Volcker's measures would have no effect, or that their effect would be offset by other factors. We said that these measures would themselves be a major contributing factor in turning inflation into Weimar-style hyperinflation by February 1980. This has now happened. Did we just make a lucky guess?"

Two Kinds of Inflation

Two distinct but interrelated phenomena constitute inflation. "First, there is structural inflation," said Parpart. "The long-term trend in the U.S. economy has been for a shift into 'service-oriented activity' away from employment in production of tangible, useful industrial output. Whereas 58 percent of the labor force was productively employed after World War II, only 38 percent are so employed now; the rest, however necessary or unnecessary their service, constitute pure 'overhead' costs."

"Worse, beginning in the 1960s, this relative decline was accompanied by an absolute shrinkage in the productive labor force. If you view the economy as a whole, as a single corporation, those operations generating profit against those generating costs pegged to indebtedness is declining. So, if we measure the growth of the totality of indebtedness in the economy against the growth of the totality of output, we clearly see the economy heading toward insolvency."

But this, he said, accounts for only "the single-digit component of inflation," the rate of inflation obtaining when Jimmy Carter took office.

Parpart directly related a second source of inflation to the decline in the value of the U.S. dollar. "It is fashionable to argue that a lower value of the dollar will increase U.S. exports, by making their price more competitive. On the contrary, it is empirically the case that the dollar's decline has occurred because of and in direct corre-

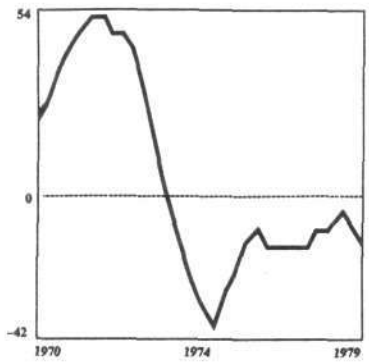


FIGURE 6
Reinvested profit since 1970
The reinvested profit (S') in the U.S. economy suffered a collapse in 1973 from which it has not recovered, even in the past five years of supposed upturn. This lack of capital investment is the fundamental causal feature of the present state of the economy.

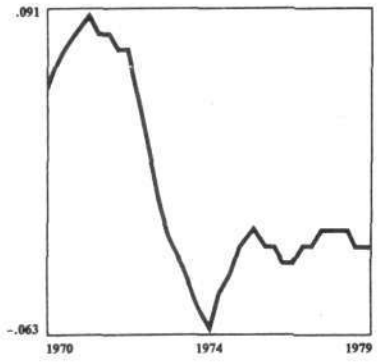


FIGURE 7
Free-energy ratio of the U.S. economy since 1970
The underlying thermodynamic state of the economy is shown by the ratio of the reinvested profit (usable or free thermodynamic energy) to the replacement costs of the economy S'/(C+V). As this graph shows, there was a drop in this ratio of catastrophic proportions in 1973-1974.

EIR May 6, 1980

REINVESTED PROFIT AND FREE—ENERGY RATIO OF THE U.S. ECONOMY SINCE 1970

These computer graphs from the Riemannian-LaRouche model show the collapse in reinvested profit and the collapse of the ratio of this profit to the replacement costs of the economy since the 1973-74 period.

lation with the decline in U.S. exports."

Currency speculation allows dollars abroad to earn profits, he said. But this "is like putting a $10 bill in a drawer and coming back the next day to find a $20 bill. Although dollar earnings may grow, there is no connection to reality. Nothing has occurred to increase production and trade volumes sustained by these dollars. And this difference in face value and real value is nothing but the definition of inflation. There are nearly a trillion footloose dollars trotting the globe not tied to actual trade or related production in any way."

The shift from productive to nonproductive "services" must be reversed by a combination of "interest rate and tax policy measures placing the premium on long-term, capital-intensive, technology-vectored investment to increase both industrial output and productivity," said Parpart. "How can this be done under Volcker's policy!?"

At present, Parpart said, "anyone who wants to come by some funds must invest them speculatively, to get *quick* returns in order to cope with the pressure of inflation and high interest rates. Volcker's measures penalize the kind of fixed capital investment needed to end structural inflation, precisely because that kind of investment takes of the longest time to mature."

If we restore incentives for U.S. industrial growth, he continued, the problem of inflation is reduced to restoring the dollar "to the kind of currency it was before John Connally took it off gold in August 1971."

"Gold-backed notes issued by European Monetary System nations, the Treasury, and possibly regional pools of Third World nations could absorb the mass of Eurodollars speculating on money markets, with the effect of soaking up these funds and converting them to useful investment, connecting them to real trade, and primarily, investment in the Third World," Parpart said.

"This would permit us not only to defeat monetary inflation, but to undertake what is without any doubt the primary human task of the next two decades, the industrialization of the Third World." If U.S. industrial output is geared up, then by augmenting the lending capacity of the Export-Import Bank, "U.S. industrial growth can be directly tied to Third World development through exports," he stressed.

Why Collapse Is Imminent

The most foolish and dangerous feature of Carter policies, said Parpart, is "energy conservation" in the form associated with the recommendations of two Harvard economists, Hudson and Jorgenson. They propose that the economy will not suffer if human labor is substituted for energy use. "Some people say, 'Great! If we increase energy conservation, we can solve not only our energy problem, but get rid of unemployment by substituting labor.'"

"But if you substitute labor for machinery," Parpart said, "what you do is decrease the energy intensity of the economy and effect a decline in labor productivity. It is that simple. And 10,000 years of human history back up that assertion."

"But what does recovery from inflation depend on if not adjustments in the economy to *increase* productivity? Thus, as Carter and Volcker have pursued short-term policies in the domestic and foreign economic realm producing hyperinflation, they are pursuing an energy conservation policy that is destroying the basis in the productivity of labor for any potential recovery."

"In sum," Parpart concluded, "short-term economic policy measures are converging with long-term energy policy measures to destroy the very foundation of the type of economy we have known; and they are rapidly removing the potential to ever restore that type of economy—the type of economy that could feed the world with both food and technology, the type of economy that has been the most productive the world has ever known throughout the postwar years. This economy, as things now stand, without a quick and directed reversal of these policies, will be destroyed within three to six months."

—Vin Berg

A detailed analysis of the Riemann-LaRouche economic model appeared in the July 1979 issue of Fusion. *Reprints of the article are available from the FEF at $1.25 postpaid.*

ASME 20th Symposium:
'Many Fusion Approaches Will Work'

More than 100 persons attended a fusion symposium sponsored by the New Mexico section of the American Society of Mechanical Engineers and the College of Engineering of the University of New Mexico to hear top fusion researchers from around the nation discuss the current fusion program. The 20th annual ASME symposium was held in Albuquerque, New Mexico, March 20-21.

Dr. Stephen Dean, the president of Fusion Power Associates, gave the keynote address. A 17-year veteran of the government fusion effort, Dean began by telling a story: "Once upon a time, more than 10 years ago, at a time of great skepticism that any approach to fusion would work, a well-known advisor to the government was quoted as saying, 'If one approach to fusion can be found which will work, there will be many which will work.' "

Dean then discussed the decade of the 1970s and the emergence "of the first approach to fusion which, from a physics point-of-view, is guaranteed to be able to achieve the conditions of net energy release"—the tokamak. The 1970s also saw the emergence of a whole new field of fusion research, inertial confinement fusion, and progress has been impressive here as well as in the nontokamak magnetic fusion experiments, he said.

"Some people find this variety to be confusing at best and disturbing at worst," Dean continued. "They ask questions such as 'How can we afford to pursue so many approaches?' " "Such questions, he explained, miss the "essential unity of fusion science and engineering. Most if not all of what is learned in one area benefits the activities in other areas. It is through this variety that the principles of fusion science become firmly established, the engineering problems get properly posed, and the required technology emerges. . . . The responsible parties are quite capable of resolving such issues provided that external, less knowledgeable groups are not given the power to force precipitous decisions."

Dean's introductory remarks were followed by Bob Scott from the Electric Power Research Institute, who discussed the engineering aspects of fusion that concern the electric utilities. The rest of the conference was devoted to specific technical presentations describing the fusion research at Lawrence Livermore, Los Alamos Scientific, Princeton Plasma Physics, and Sandia laboratories. Specific technology development fields such as materials research and the most recent fusion design studies done by the University of Wisconsin were also covered.

Energy Technology Conf. Goes 'Soft'

The seventh annual Energy Technology Conference, titled "Expanding Energy Supplies," eliminated any discussion of the advanced nuclear and fusion possibilities to achieve that goal in the future.

The conference, held in Washington, D.C. March 24-26, was dominated by "soft" technology—synthetic fuels, all forms of solar energy, and conservation. For the first time, there were no fusion papers delivered at all, and the only nuclear panel was on safety.

Fortunately this abandonment of advanced technologies was not reflected in the more than 300 company exhibits at the conference, where fusion and all advanced nuclear development fields were represented.

The conference is sponsored annually by the American Gas Association, the Gas Research Institute, the Electric Power Research Institute, and the National Coal Association.

Military Science

When Will The Soviets Have E-Beam Weapons?

A recent flurry of intelligence and media reports has pointed to the possible early deployment of electron beam antiballistic-missile (ABM) weapons by the Soviet Union. This is the evaluation, for example, of French military intelligence circles in the light of estimated Soviet efforts in this area and the abrupt announcement in March that previously existing missile-based ABM systems around Moscow had been removed without explanation.

The existence of an e-beam ABM system, capable of much more rapid retargeting and firing than conventional missile-based ABM systems would add significantly to Soviet thermonuclear war-fighting and survival capabilities.

Other allegations of Soviet e-beam development were aired during closed hearings of the House and Senate Armed Services Committees in late 1979. These hearings were more broadly aimed at reviewing the feasibility of the entire spectrum of high powered beam weapons, from lasers to particle beams. Reportedly representatives of leading aerospace and high-technology corporations made a deep impression on committee members and their staff assistants with specific recommendations on how to develop viable weapons systems of this type.

The question of Soviet capabilities

was addressed during the hearings by former Air Force Intelligence chief General George Keegan, who, sources report, used Fusion Energy Foundation evaluations as one of his cited sources. Keegan raised the same issue in a debate on a Miami, Florida television station with Massachusetts Institute of Technology professor Kosta Tsipis; and also in March he appeared on Public Broadcasting stations reviewing hypothetical e-beam and proton beam weapons in a year-old BBC documentary.

What Are Beam Weapons?

Although some defense-related journals have devoted considerable space to describing laser weapons as defense systems on large naval craft against incoming missiles and high-powered lasers in space to hit missiles above the atmosphere, these are unlikely to be viable strategic weapons systems other than for blinding satellites.

High-powered, light-weight laser systems may be developed using chemical lasers as the energy source, but they would have two serious deficiencies. First is their inability to propagate in the atmosphere; second is their susceptibility to countermeasures such as reflective coatings. The debate on lasers in space has raged—for example, between Wyoming Senator Malcolm Wallop and IBM scientist Richard Garwin—but it is widely thought that an effective system would become prohibitively costly if all countermeasures were to be overcome.

Particle beams, by contrast, can penetrate through the skin of missiles and wreck either guidance or triggering mechanisms, as well as possibly ruining the nuclear explosives on board. The key scientific questions have been the ability to efficiently generate and propagate the appropriate type of lethal particle beams (in addition to the important problem of tracking the targets).

One possible type of generator was described by General Keegan in the BBC film and by the Fusion Energy Foundation in a 1977 study, *Sputnik of the 70s*. This involves the generation of very intense pulses of electromagnetic energy by the conversion of small thermonuclear explosions into specially designed magnetohydrodynamic outputs. One possible intermediate conversion mechanism would be the use of nuclear-heated liquid metal foams driven through the MHD channel.

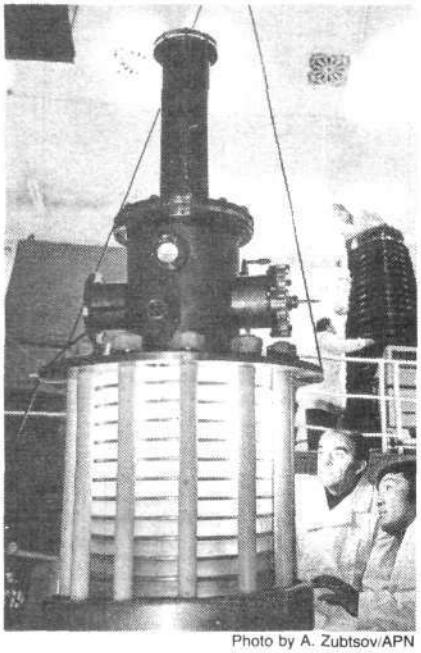


Photo by A. Zubtsov/APN

A Soviet electron gun in an experimental accelerator in Tomsk, Siberia.

Soviet Capabilities

There is some evidence for Soviet work on each of these. First, aerial monitoring has revealed evidence of fusion miniexplosions at the secret Soviet research center at Semipalitinsk. Second, Soviet scientists reported publicly on work on nuclear-driven liquid-metal MHD during a recent seminar series in the United States sponsored by Control Data Corporation. The latter report has caused deep concern among U.S. scientific and military intelligence specialists in this area.

Finally, given the intense Soviet efforts to develop the 48-beam, 100 terawatt Angara V e-beam fusion system, there is little doubt that the Soviets are well along in developing the power systems for e-beam generation. They may also be developing proton beams.

Keegan has argued that the Soviets have been working for 30 years to develop the collective acceleration effect described by Soviet scientist Wechsler in the late 1940s. This converts e-beams reasonably efficiently into proton beams that contain the power of thousands of tons of high explosive to demolish missile warheads.

Striking collective acceleration effects, in fact, have been observed in the beam and plasma research of U.S. scientists Winston Bostick, John Luce, and Harry Sahlin, the latter two now deceased.

Beam Propagation

The question of beam propagation is more intriguing. Although most work in this area remains classified, one important conclusion about e-beam weapons is available, and some interesting new results have recently been reported. In March testimony before the Armed Services Committee of Congress, the head of Defense Department Research and Engineering, William J. Perry and the director of the Advanced Research Projects Agency (ARPA) of DOD, Robert A. Fossum, both indicated that the United States has successfully concluded the first phases of testing of e-beam systems and is preparing to move on to the development of prototype weapon systems.

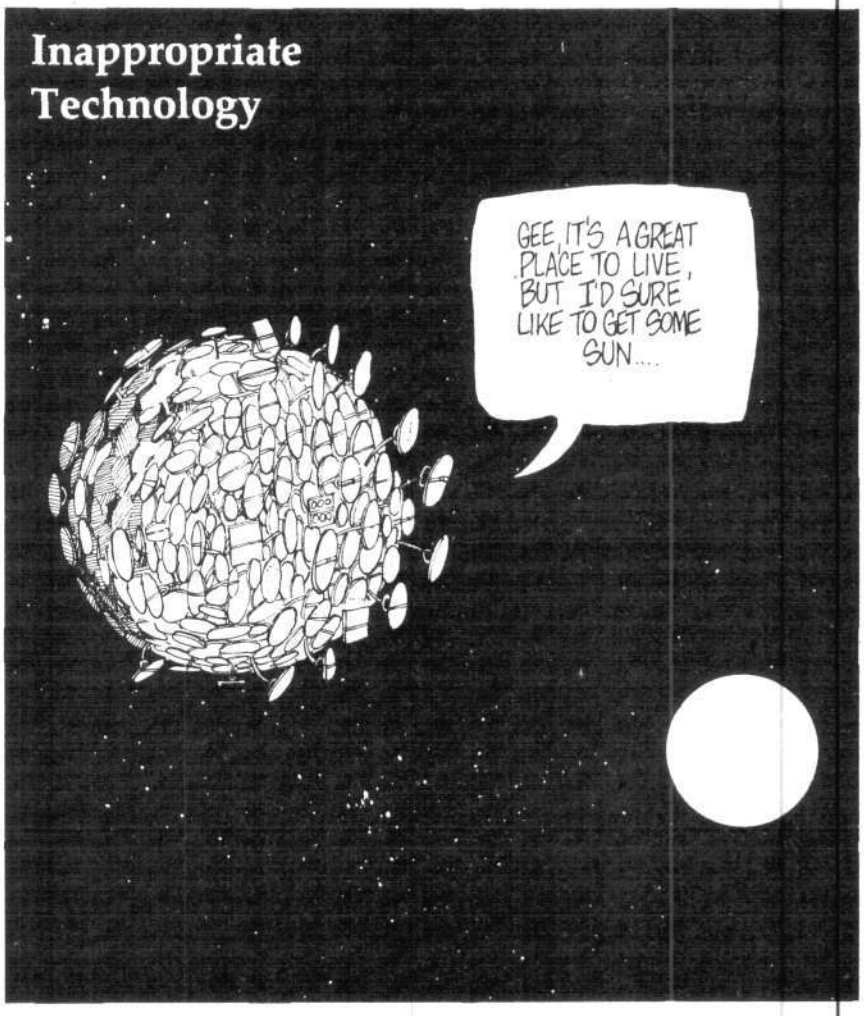
Interviews with leading scientists have also established that high-powered e-beams can successfully propagate the 10-kilometer distance required to defend the limited zone around a hardened IBM site.

Unclassified research by Winston Bostick and his associates at Stevens Institute and Kirtland Air Force weapons laboratory have also shown that e-beams generated in partial vacuum will spontaneously form a plasma filament that can propagate indefinitely. Under the higher ambient pressure conditions in the atmosphere, however, the vortical beams are subject to instabilities that disperse them. E-beam systems in space would be highly potent against missiles coming over the atmosphere and against missiles attempting to attack them, but would be very costly and immediately detectable.

Thus, the strategically critical question at this time is how much beyond these known capabilities have the Soviets developed in ground-based, high-repetition rate, high-powered e-beams?

Estimates of the time of deployment of such Soviet systems range from the early to the late 1980s. Under present strained international conditions there can be little doubt, however, that the Soviets are working strenuously toward the goal, with a program many times larger than that of the United States.

—Dr. Morris Levitt



Solar Energy Won't Work

When the National Academy of Science's Committee on Nuclear and Alternative Energy Systems (CONAES) reported that solar energy would continue to be too expensive to be practical, the *New York Times* accused the National Academy of "undocumented and unrealistic calculations that would shame a graduate student." In a lead editorial March 1, the *Times* complained, "The academy's reputation led us to accept [its conclusion] that solar technologies would make only a modest contribution over the next three decades—unless the federal government used compulsion and subsidies to force widespread use."

In their reply on behalf of CONAES, National Academy of Science spokesmen Philip Handler and Harvey Brooks again made it clear that even within the very generous assumptions made by CONAES, the cost of solar technologies currently under development would have to decline by yet another factor of at least 2 or 3 in order to be economically competitive with other energy systems by the year 2010. (These figures, incidentally, refer only to cost of the direct energy-collecting apparatus, the photovoltaic cell arrays.)

The National Academy of Sciences is on the right track. It is the Council on Environmental Quality, whose word the *Times* is evidently prepared to accept on faith instead of reputation, that bases its solar pronouncements on some very "undocumented and unrealistic calculations." I will go into the specific numbers below. First, it is important to understand the Malthusian basis from which the CEQ argues.

For example, the CEQ recently announced that the U.S. economy can sustain growth of the Gross National Product through the year 2000 on the basis of current or lower levels of energy consumption. In a pamphlet titled "The Good News About Energy," The CEQ happily states that this growth can be accomplished by accelerating the trend away from industries that produce a product toward more labor-intensive "service industries."

This is not a very "realistic calculation" for a nation whose prosperity has always been based on industrial growth and development. Yet advocates of solar power like the CEQ argue that solar energy will become economically attractive *only if* the de-industrialization trend is continued, stringent conservation measures are implemented, the cost of fossil fuels becomes prohibitive, and nuclear energy is shut down. For them the historical trend over millennia—the investment of time, effort, and ingenuity to escape dependence on the sun for energy—must be reversed.

The true cost of the economy's switch to heavy dependence on solar energy, however, has to include the precipitous drop in living standards that zero growth or low growth implies. For example, in all cases where solar energy is projected as a significant factor in future U.S. energy production—in the range from about 15 to 25 percent of total energy production to as high as 50 percent—these projections also mandate zero growth or low energy growth over the next several decades. In any projection that includes even modest energy growth, the importance of solar energy drops sharply, with estimates generally in the 3 to 5 percent range.

It would be very difficult for any scientific body to find an excuse to argue in favor of using solar energy as a significant component in the national energy economy. The reason for this is quite simple. Sunlight is an extremely diffuse energy source; the energy flux density is very low. Consequently, large amounts of effort must be expended for relatively meager returns in energy captured.

The figures in the table illustrate the very large spread in power densities associated with a number of different solar technologies as well as for conventional fossil fuels and nuclear fission and fusion.

Wood and Windmills

How this translates into energy costs can be seen in a Canadian study of the two least energy-dense forms of solar energy. During the middle 1970s, the Canadian government studied the merits of using wood burning and windmills to power the city of Toronto, a metropolitan area with a population of about 2 million and a moderately active industrial base. Their findings were quite telling. First, if wood were used to generate energy for Toronto, within a few years, well before the forests could be regenerated, the entire wood supply in the Province of Ontario would be depleted. Incidentally, most of the province is uninhabited forest.

Hoping to take advantage of the high winds characteristic of the flat, open areas of southern Ontario, the government study set about determining the optimum array of modern large wingspan windmills that could power Toronto. Spaced at three windmills per square mile, in order to take maximum advantage of the available wind without interfering with each other, they found that it would take about 160,000 windmills spread over more than 50,000 square miles. This area represents most of the inhabited part of Ontario.

Quite obviously, these two forms of solar energy are out of the question as significant components of the total energy supply picture, but direct capture has a higher energy density than either of these. Is is possible to make use of direct capture?

A quick calculation shows why solar energy from direct capture is also not promising. At the earth's surface, somewhat less than 1,000 watts of solar power falls on 1 square meter of collecting surface when the sun is shining. To convert this energy into electricity, we would use arrays of photovoltaic cells made from silicon or cadmium. In theory, these devices have a conversion efficiency no greater than about 25 percent; in practice, however, photovoltaic cells have not yet reached even this efficiency. To be very generous, then, we could estimate that 1 square meter of collector surface could generate 250 watts; that is, it could keep perhaps two standard household lightbulbs burning as long as the sun is shining.

Since no one would seriously consider producing electricity from such a small unit, we should really compare solar electrical generation to modern 1,000-megawatt power stations. A simple scale-up shows that it would be necessary to devote 4 million square meters to solar collector panels simply to match the output of the power plant during daylight hours. To achieve the same 1,000-megawatt output around the clock would require at least an additional 4 million square meters of collector surface connected to a 100-percent efficient energy storage system.

So far, the assumption has been made that the sun shines directly on the collectors with maximum power for 12 hours a day, every day. In the real world, however, this does not happen. All in all, the estimate of 8 million square meters of collector surface (that's about 5 square miles) is a generous concession to solar energy advocates. When room is allotted between collectors for maintenance personnel (mirror polishers) and transportation vehicles, the total area for a 1,000-megawatt site could easily reach into the range of 10 to 15 square miles.

By comparison, the total land occupied by a fossil or nuclear plant with the same capacity is less than 1 square mile, and the energy-collecting surface is less than 1,000 square meters.

Many solar advocates would at this point object that no such large areas need be devoted to energy production, because each home would have its own solar unit designed into the structure. The lunacy of this proposal is readily apparent to an urban apartment dweller as well as any homeowner who has tried to get a plumber or a roofer to repair his home. The repair problems are seriously compounded when the significantly more complex solar energy units are added to the problem.

And how many families in this period of two-digit inflation have $30,000 to build an on-site decentralized solar power plant?

Ultimately, the economics of solar energy are such that unless major gov-

Carlos Wesley/NSIPS

Barry Commoner, a leading solar advocate, is shown here at Columbia University just after a student asked him how he planned to make solar power viable since by his own admission it would cost $10,000 to run a solar toaster.

ENERGY FLUX DENSITY
(megawatts per square meter)

Solar—biomass	0.0000001
Solar—earth surface	0.0002
Solar—near-earth orbit	0.001
Solar—near-solar orbit (5 million miles)	1.0
Fossil	10.0
Fusion (first generation)	2.0 to 50.0
Fission	50.0 to 200.0
Fusion (theoretical)	trillions

Energy flux density, or power density, through the surface of various energy-collecting systems is shown. The range of densities spans a factor of a billion between the least dense, biomass, and the most dense, fission and fusion. With an energy flux density of 1 megawatt per square meter, the energy passing through 1 square meter in 1 second is sufficient to raise the temperature of about 65 gallons of water by 1 degree Celsius.

ernment subsidies are introduced or the price of energy goes through the ceiling, solar energy could *never* compete with fossil and nuclear sources. This is the argument that led to the *New York Times* pique. The CONAES spokesmen summarized this specifically in their March 27 letter to the *New York Times*: "Current silicon or cadmium cell photovoltaic arrays are available for $10,000 to $30,000 per peak Kw_e [kilowatt output]. The [CONAES] report assumed, for purpose of calculation, a reduction to $2,000 per peak Kw_e, which, for the arrays themselves, independent of all other costs of such systems, yields approximately $1.5 trillion for 12.4 quads of solar-generated electricity."

This figure represents only that part of the capital costs devoted to the photovoltaic cells. One would also have to include the costs involved in siting these structures over many square miles and collecting the energy for transmission.

The CONAES letter continued: ". . . What is apparent is that even with the generous cost assumptions made by CONAES the costs of solar technologies currently under development would have to decline by yet another factor of at least 2 or 3 in order to be economically competitive with other energy systems by 2010. Alternatively, massive governmental subsidy would be required to deploy solar energy on the projected scale.

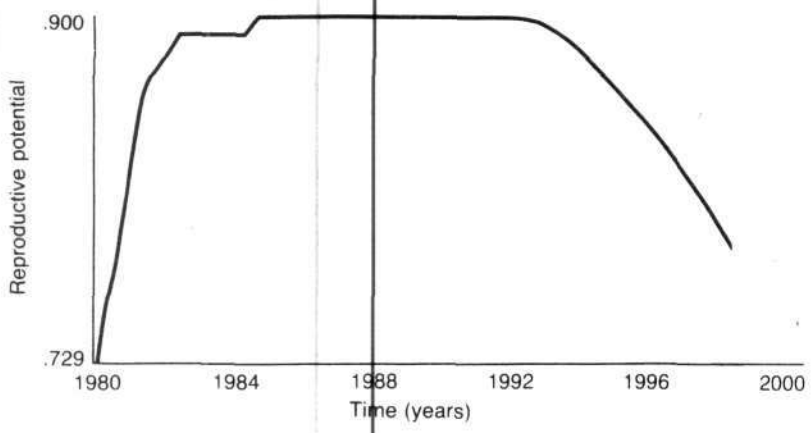
"However, the scientific bases even for CONAES's projected costs have not yet been achieved. Yet lower cost projections represent *goals* for the future, and there is no consensus within the relevant technical community that they can be achieved."

In other words, by bending over backwards, the CONAES study was able to bring the cost of solar energy down to only about 2 to 3 times conventional sources, when, in fact, the cost ranges from 10 to 45 times more expensive, based on current solar technology.

By comparison, the same amount of electrical energy (12.4 quads) could be generated using nuclear power for an initial capital investment of $400 to 600 billion—2 to 3 times *less* than the best solar estimate. Yet even these nuclear capital costs are inflated, because they reflect the current sorry state of the nuclear industry. Not only have mass production techniques for reactors not yet been introduced, but environmentalist obstructions in the law have increased the time required to build a plant from the range of 4 to 6 years up to 10 to 12 years. In fact, the actual cost to install the nuclear capacity could be significantly lower than these cited figures, at the current technology.

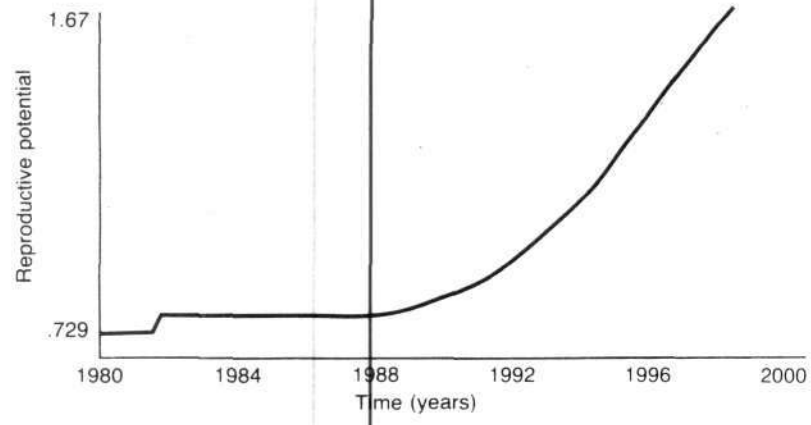
The payoff from using nuclear energy is tremendous compared to solar in terms of the economic future. Solar energy would turn large areas into deserts of mirrors and the like; nuclear energy can turn actual deserts into gardens. The so-called nuplex, or nuclear powered agroindustrial complex, is the model for city building now and into the near-term future. A cluster of power plants producing different qualities of energy—electricity, and low-temperature and high-temperature process heat—could irrigate arid regions for agriculture while factories produce the fertilizers and machinery to work the land and carry out resource extraction and other industrial processes.

Figure 1
THE REPRODUCTIVE POTENTIAL FOR THE U.S. ECONOMY UNDER A TYPICAL SOFT ENERGY PLAN (SOLAR)



This model used an optimistic set of figures for availability and cost of solar energy for centralized power production.

Figure 2
THE REPRODUCTIVE POTENTIAL FOR THE U.S. ECONOMY UNDER AN AGGRESSIVE NUCLEAR ENERGY PLAN



Such nuplexes could support entire cities with populations of hundreds of thousands to millions of highly skilled, employed industrial and agricultural workers and their families.

The Riemannian-LaRouche Analysis

What this kind of economic expansion would look like over the next 20 years—and the corresponding disaster of going solar—can be seen from the econometric analysis of the U.S. economy carried out by the Fusion Energy Foundation using the Riemannian-LaRouche economic model. This computer model (discussed in *Fusion*, May 1980, pp. 55-58 and in more detail in *Fusion* July 1979, pp. 32-50), unlike all other econometric models, is capable of distinguishing between productive and nonproductive investments.

The basic criterion in terms of the effect of an energy system on the total economy in the Riemannian-LaRouche model is whether the energy system contributes to the profit or surplus generated by the total economy (above and beyond simple reproduction of living standards) that can be reinvested in new technologies. For the real economic base to increase, this reinvestment surplus must grow at an accelerating rate. The accompanying figures show dramatically what happens with a solar economy (Figure 1) and a nuclear-based economy (Figure 2).

Specifically, the figures show the reproductive potential of the economy as a function of time—the ratio of the reinvested profit to the amount of investment required for replacement costs in the economy as a whole. For the soft path, the figure shows a decline in economic health for six or seven years, and then a sudden drop through the economic floor. This breakdown should not be surprising; solar energy, as I have shown, is a net energy consumer, using more energy to build, maintain, and operate a solar energy plant than the plant will produce in its lifetime.

The nuclear path, on the contrary, shows a generalized "take-off" in the economy, leading to unprecedented growth rates and levels of affluence.

Let's leave solar energy where it's indispensable and most effective—in agriculture.

—Dr. John Schoonover

Research

Photo courtesy of IBM

The display on the IBM terminal is a digital sound spectrogram of the words: "John saw one example of speech from several thousand runs."

IBM Computer Transcribes Speech

IBM research scientists have used a computer to transcribe speech, composed of sentences drawn from a 1,000-word vocabulary and read at a normal speaking pace, into printed form. The accuracy of the computer is believed to be the best yet obtained under complex experimental conditions—91 percent.

The experimental laboratory results, reported recently at a scientific meeting, represent an "encouraging, early, step along an enormously difficult path that someday may lead to computer recognition of unlimited continuous speech," said Dr. Frederick Jelinek. Jelinek heads the continuous speech recognition group at the IBM Thomas J. Watson Research Center, Yorktown Heights, N.Y.

Advanced Dictation Machines

Although much work remains before continuous speech recognition devices can come into practical use, laboratory results indicate that this goal stands a reasonable chance of being achieved, Jelinek said. He visualizes the ideal voice recognition device as one that provides instantaneously transcribed speech (as a person speaks into a microphone) as well as an immediate verbal editing feature to correct mistakes and make ongoing revisions; in effect, a very advanced dictation machine.

The task of having a computer "recognize" continuously spoken speech is far different than the jobs for which speech-input devices are being used today, such as sorting packages by destination codes or controlling inventory. These devices typically use built-in microprocessors to respond to a very small vocabulary enunciated in a very careful way.

The voice recognition experiments are carried out on an IBM System/370 Model 168 computer in a "quiet room" environment with high fidelity equipment. The speaker talks into a microphone, and after a period of analysis that may be quite long, the words as recognized by the computer appear on a computer terminal screen.

Although the experiments to date have involved only one speaker, Jelinek says the computerized voice analysis methods devised by his group are designed to adapt easily to different speakers. "Our strategies are based not on rules developed from trying to intuit how people recognize sentences, but on careful statistical modeling of all the speech processes involved: sentence production, speaker's pronunciation, and processing of the speech signal," he said. "This approach is both accurate and flexible: As the speaker or the components of the system change, our self-organizing programs remain valid, and computer time is all that is required to adjust to a new configuration."

Let Them Eat Karma

The Aquarian Conspiracy: Personal and Social Transformation in the 1980s
Marilyn Ferguson
Los Angeles: J. P. Tarcher, Inc. 1980

The intended victims of the Aquarian conspiracy are people like you and me. For this is a conspiracy against Western industrial society, against Reason, and against science. It is a conspiracy to convince Americans not only that "small is beautiful" as conspirator E.F. Schumacher titled his zero-growth book, but also that it is only in a small world that each individual can "find" himself. Using meditation, mysticism, psychedelic drugs, and transactional therapy to reach "consciousness," the transformed individual can leave behind the big, ugly, materialist society and "do his thing." (The concept is akin to what in the old days, was called being a "spoiled brat.")

And who are these Aquarian conspirators that fill Ferguson's account of a transformed America? You will recognize many, as I did. They are the mindless antinuclear demonstrators who whine that nuclear power is unnatural, a former college friend who tells you how happy she is now that she has "gotten in touch with her gayness," the Ivy League consultant earning $200 a day helping people in the broken-down South Bronx ghetto build windmills and solar heaters for a natural energy system, the businessman who can't function without his biofeedback and meditation, the professional who drops out to California and group therapy. (California, Ferguson says, is the Aquarian heartland.)

If this were like most of the books found in the "self-help" section of the bookstore, it might be ignored. As such books go, it is consummately boring, an endless litany of yin-yang gobbledy-gook ("If the mind can heal and transform, why can't minds join to heal and transform society?" or "We cannot leave the trap until we know we are in it," or "In the transformative process we become the artists and scientists of our own lives.") interspersed with quotations from famous and not-so-famous conspirators.

Not an Ordinary Book

But this is not an ordinary book. It is a declaration of war—a war to make you and me accept "consciousness" as a way of life in place of progress, in place of national governments, in place of industry, technology, advanced medicine, and, especially, in place of a scientific method that says it can *know* the world. "We have to move into the unknown. The known has failed us too completely," Ferguson says. "We have oversold the benefit of technology and external manipulation; we have undersold the importance of human relationships and the complexity of nature."

The usefulness of Ferguson's book is that it shows plainly to those who before were skeptical that there is indeed an evil, deliberate conspiracy to stop progress. Ferguson specifically locates the ideological predecessors and planners of the Aquarian Conspiracy from H.G. Wells and the "open conspiracy" he planned, to Kenneth Boulding, former president of the American Association for the Advancement of Science, to physicist Ilya Prigogine, (about whom *Fusion* will have more to say in the next issue), to Aldous Huxley and the nexus of British and U.S. Intelligence agents who launched the Aquarians in the United States with a deliberate plan to force psychedelic drugs on the college population in the 1960s.

Ferguson writes: "The growing use of marijuana dealt a blow to authority: medical, legal and parental. . . . Ironically, the introduction of major psychedelics, like LSD, in the 1960s, was largely attributable to the Central Intelligence Agency's investigation into the substances for possible military use. Experiments on more than 80 college campuses, under various CIA code names, unintentionally popularized LSD. Thousands of graduate students served as guinea pigs. Soon they were synthesizing their own acid. By 1972, according to the National Commission on Drug and Marijuana Abuse, nearly 5 percent of all American adults had tried LSD or a similar major psychedelic at least once."

As Ferguson happily relates in detail the personnel who carried this psychedelic transformation to how Aquarian heights, there can be no mistaking the fact for those who have watched American society unravel bit by bit that there were conspirators at the top deliberately pulling the threads.

Consciousness?

The conspirators are out to convince you and me that the world is not real but just a holograph, that man's mind has reached a new cosmic consciousness, a new dimension that we can all participate in, that this is the real "energy" of the future. To use Ferguson's neuroscience terms, it is the coming into prominence of the "right brain," which controls intuition and feeling, going beyond the "left brain" where reason is located.

For the introspective novice, Ferguson provides the ABC's of reaching "consciousness": First, the *entry point*, usually a traumatic experience or a drug induced vision; then, *exploration* of this new state, followed by *integration*, and, finally, the state of *conspiracy*. Personal histories are provided for description of each stage, drawing from 185 questionnaires filled out for Ferguson by conspirators.

You can't describe this consciousness to someone else explicitly, Ferguson says, only through metaphor (for example, "it's like adding sonar, radar, and powerful lenses to the mind." In return for this blissful state of mush, the conspirator-to-be receives "freedom" from the constrictions of industrial society. Morality? Responsibility toward future generations? Aquarians aren't breaking the traditional rules, Ferguson says, because they "don't accept" society's rules to begin with.

How successful have the conspirators been? Here's what Ferguson says in her introduction: "There are le-

gions of conspirators. They are in corporations, universities, and hospitals, on the faculties of public schools, in factories and doctors' offices, in state and federal agencies, on city councils, and the White House staff, in state legislatures, in volunteer organizations, in virtually all arenas of policymaking in the country."

And the book is replete with instances of creeping consciousness in the highest of places (Admiral Elmo Zumwalt, for example, who instituted "touchy-feely" consciousness groups for naval officers.)

Austerity Consciousness

The evil of the conspiracy can be seen in its specific applications to everyday modern life. The chapter on "Healing Ourselves," for example, justifies the dismantling of the present medical system. After all, Ferguson notes in disgust, American medicine is "the third largest" business in the United States. And not only are doctors greedy, but "Even those [patients] to whom cost is no problem may only buy technological failure. . . . One of the most prevalent medical problems of our times is *iatrogenic* illness. It means—literally—doctor caused."

The Aquarian cure? "holistic" health care and "alternative medicine." Translated, this means that only people who have the proper "feeling" and consciousness can really heal; too much technology and book-learning alienates doctors and other professionals. As Ferguson puts it: "It is not a simple physical change but rather the state of mind that is the key to health. . . . All illness, whether cancer or schizophrenia or a cold, originates in the bodymind."

How has this "non-Western" concept of healing taken hold? Ferguson relates how Blue Cross-Blue Shield funded a series of "small conferences at Airliehouse, Virginia, near Washington, to acquaint government officials and legislative aides with the power of holistic concepts and alternative medicine." And how the Rockefeller Foundation and the University of California "cosponsored a meeting at the Waldorf-Astoria Hotel in New York City, where 200 top policymakers were introduced to alternative health approaches, emphasizing the importance of the 'inner physician.'"

Other American institutions don't fare any better. It's appropriate technology instead of oppressive big machines; schools without walls and without authority figures; marriage with built-in promiscuity ("People who are 'good for you' are often not those who excite you sexually"); spiritual adventure" instead of religion (40 percent of Americans in a poll said that they had had a genuine mystical experience); decentralized "Ecotopian" villages instead of cities.

For the vast majority of Americans who have been fortunate enough to avoid the Aquarian consciousness, this book is a challenge to the nation's grasp on reality and indeed the nation's survival. The Aquarians have declared war on us. Will America fight back?

—Marjorie Mazel Hecht

Fusion *intends to provide readers with the ammunition to wage this fight with articles detailing the Aquarian Conspiracy. The FEF is also collaborating on a pamphlet exposing the Aquarians and a forthcoming book on the "New Dark Ages."*

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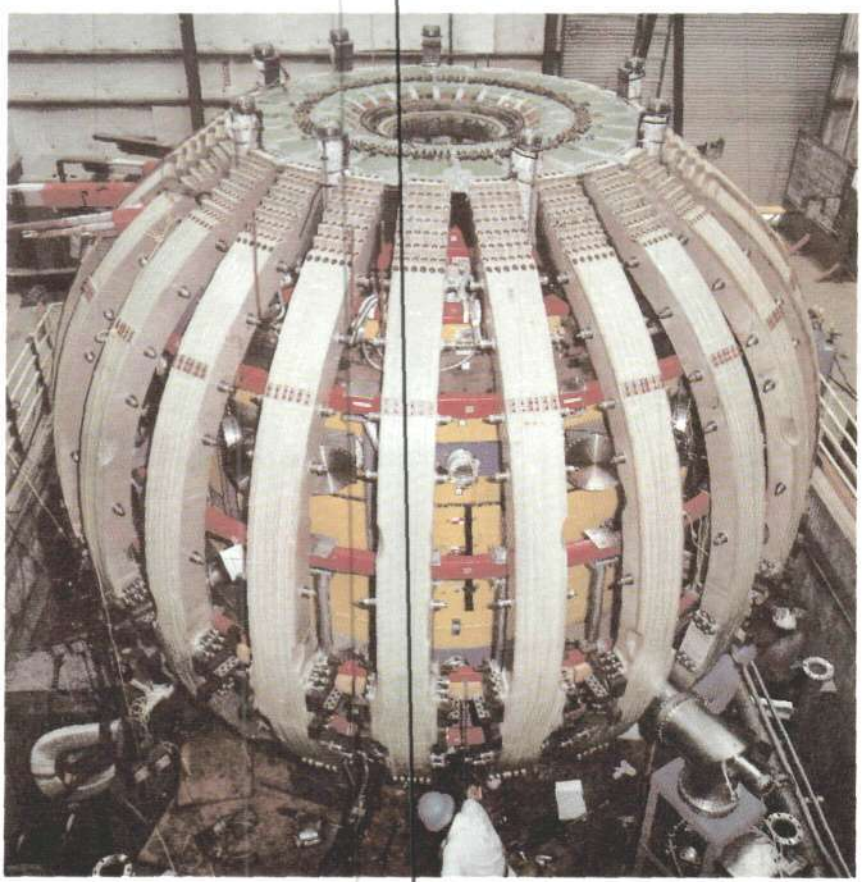
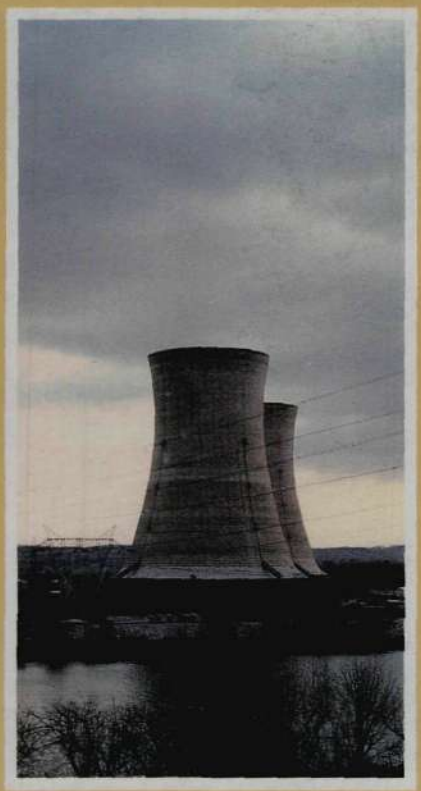


The Doublet III tokamak fusion device, courtesy of General Atomic Co., San Diego, California

In This Issue

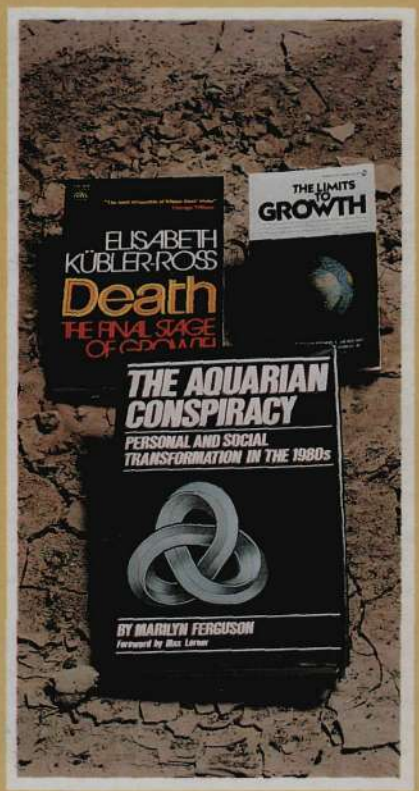
COMPUTERS AND SCIENTIFIC BREAKTHROUGHS IN THE 1980s

Supercomputers and a new generation of computer algorithms and hardware advances could provide solutions to longstanding scientific problems. The most advanced scientific computers have the potential to produce exciting results in fusion, economic and industrial planning, plasma physics, meteorology, and oceanography. This issue's lead feature outlines the scope of this potential and some of the toughest problems that must be solved in order to reap the benefits of this frontier area of technology.



THREE MILE ISLAND AND THE SABOTAGE QUESTION

Who shut off the two emergency feedwater valves at TMI? This question is critical to determining whether sabotage triggered the TMI incident. Yet the government, the utilities, and the nuclear industry have deliberately stopped short of the investigation necessary to answer the question. This month's Nuclear Report updates the TMI story and presents a sobering view of how America's electrical grid is being shut down, with New York state as a case study.



THE 'AQUARIAN CONSPIRACY': KOOKERY AGAINST SCIENCE

This issue's Special Report and related articles document what is called the "Aquarian Conspiracy," an organized effort to replace the traditional American way of life—science, technology, growth, morality—with values more appropriate to a zero-growth world: cultism, mysticism, and the supernatural. The verbatim reports of what the conspirators intend are shocking; even more shocking is their growing control over the U.S. government.

Cover: Cover design by Christopher Sloan: Josephson circuit, magnified 1,000 times (above left), courtesy of IBM; TMI photograph by Carlos de Hoyos; book covers photograph by Philip Ulanowsky; photograph of Harris hybrid circuit on front cover by Bill Pappas, courtesy of the Harris Corporation.