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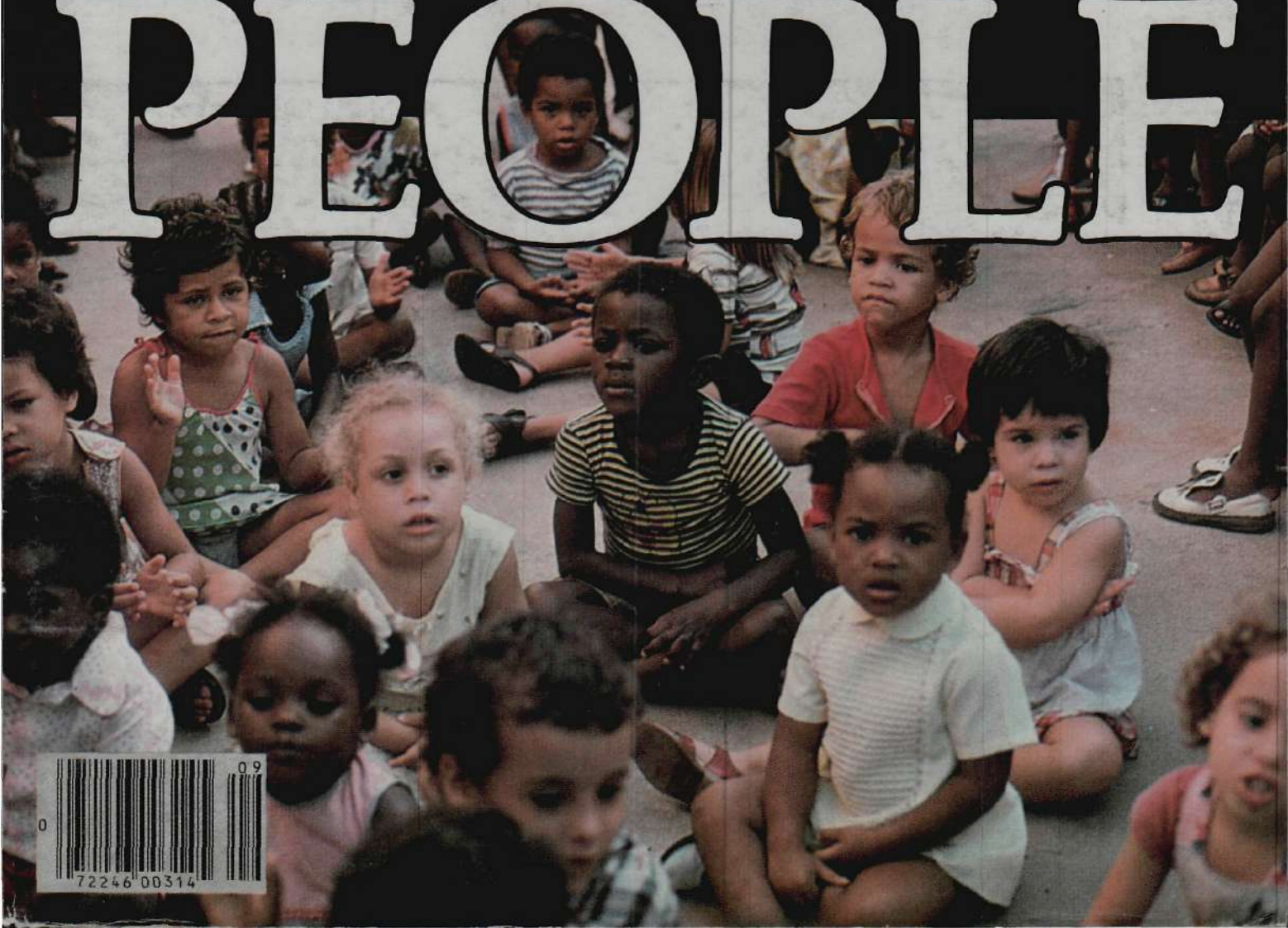

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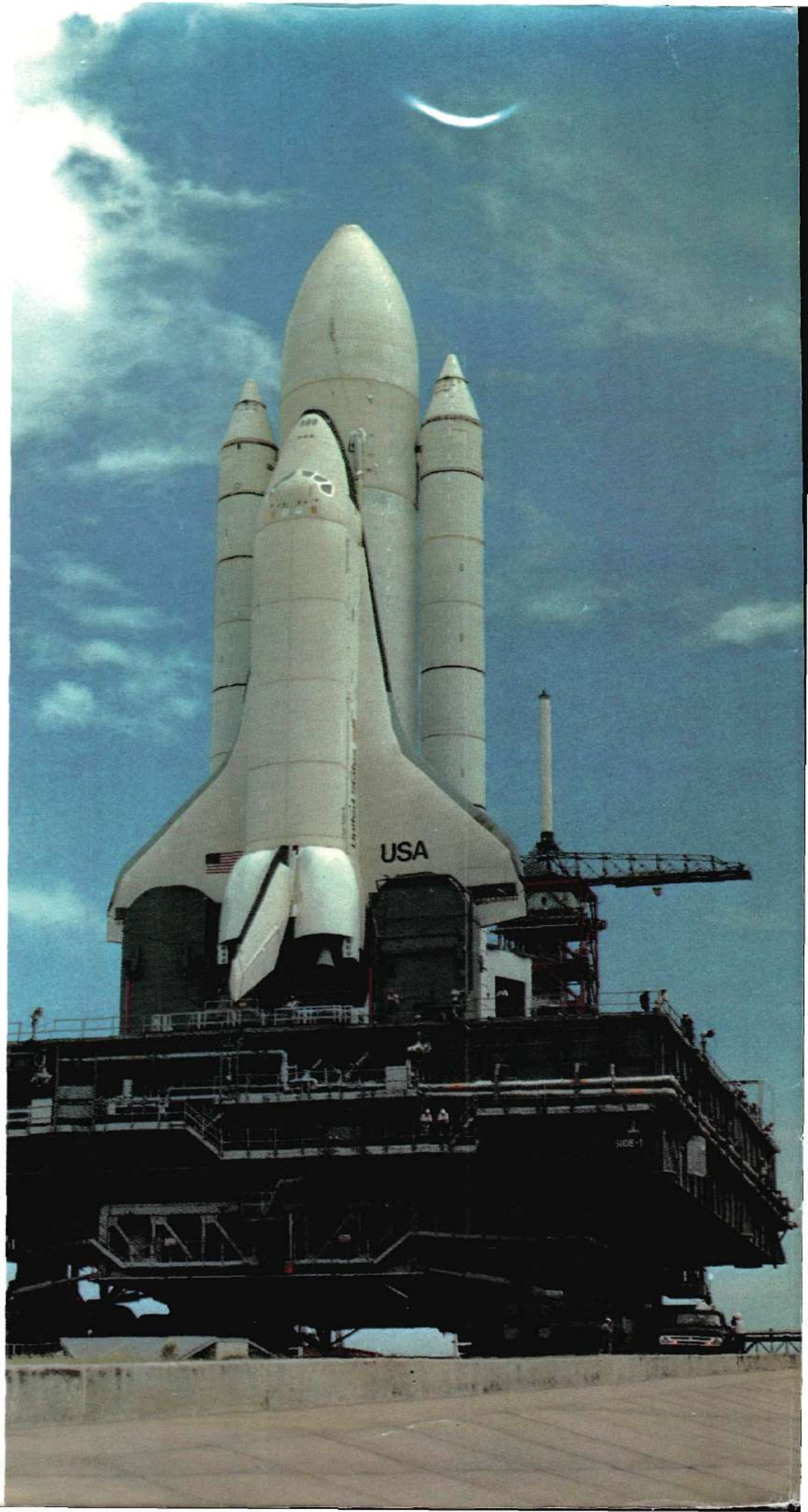

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—*El Heraldo,* Mexico City daily
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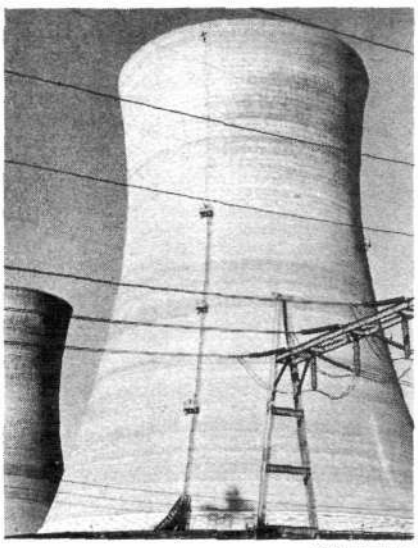
Sygma

The Global 2000 advocates talk about the dangers of overpopulation, but what they don't say is that their dire predictions are based on a deliberate policy of curbing scientific and technological advancement. Here are the facts.



Carlos de Hoyos

This special report gives the facts and figures on how the Reagan administration can accelerate putting 82 nuclear plants on line by 1987—saving more than $100 billion in the cost of electricity production. You can help by sending this report to your legislators and the President.

Features

News

Departments

Carlos de Hoyos

Where do we go next in space? The 24-page Fusion *Special Report, "The Space Program in the 80s: On to the Next Frontier," reviews the history of the space program and outlines the necessary NASA budget to reach that next frontier. The pamphlet is available at 10 copies for $10 from the FEF (minimum order). Shown here is* Fusion*'s Washington editor Marsha Freeman with the Space Shuttle astronaut Robert Crippen.*

From the Editor's Desk

"It is a very odd world indeed in which every time a cow is born, we feel that we are richer, and every time a child is born, we feel that we are poorer." This remark of FEF research director Uwe Parpart (page 56) in the course of his debate with—and trouncing of—Nicholas Yost, an author of the *Global 2000 Report,* typifies the "odd world" zero-growth thinking that this issue of *Fusion* intends to turn around.

The frontier medical research discussed in the editorial (page 4), the real economics of population and resources (page 24 , the nonlinear line of benefits from basic scientific research (page 40) and advanced technology programs like NASA (page 34), the economics of opening up the 82 U.S. nuclear plants now in construction (page 15), and the new frontiers of space industrialization discussed in this month's Viewpoint column (page 13), are weapons for readers to use in the fight to steer the world on a development course.

If you need help in waging the fight for science and growth in your city, state, or national organization, call or write us! We'll put you in touch with local Fusion Energy Foundation members and provide speakers for debates, conferences, and seminars.

Coming in the next issue is a ground-breaking report by Uwe Parpart on how Bernhard Riemann shaped the study of mathematics, physics, aerodynamics, and biology—in short, all modern science.

Fusion skips publication in October, so look for the combined October-November issue in November.

Marjorie Mazel Hecht

Marjorie Mazel Hecht
Managing Editor

FUSION
AT THE FRONTIERS OF SCIENCE AND ENERGY

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

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Medical Science: Key to Our Unlimited Future

"Cheap tricks" is what one of the authors of the neo-Malthusian *Global 2000 Report* called modern medical science. It's easy, he said, to perfect "death control," or life-lengthening, but what we need is birth control.

This vicious statement is as wrong today as it was in 1700s when Benjamin Franklin argued with the British Parliament that the American colonies were overpopulated only if the King continued to impede technology transfer across the Atlantic.

The issue is the same today: Without the rapid advancement of science and its spread throughout the world, there *are* too many people.

If there is world development via the transfer of advanced technology, we will quickly find that there are *too few* people. In this situation, "death control," using modern medicine, precisely because it is so efficient, becomes a primary requirement for world development. A fusion economy requires 10 billion people, many of the highest skill levels. Society cannot afford to have any of these people die before their time; in fact, it must lengthen their lifespan.

The Challenge to Medicine

Unfortunately, medicine and biology are only slowly becoming sciences, rather than a collection of powerful but ad hoc ideas. The life sciences lack a theory. Just raising the question of methodology, or the theoretical underpinnings of the science, is usually enough to send chills up the spines of most research biologists. The problem is that research is always based on the creation of hypotheses, or possible explanations, that are produced by the scientist and that he is continually testing in his research. Scientific research is, after all, the testing of hypotheses. Where, then, does the scientist get his hypotheses? How can the process of generating new ideas become conscious?

The productive biologist has two problems with respect to "theory": First, the prevalent theories are bad; and second, he is only vaguely if at all aware of his own theory. Biologists, more than physicists, find it hard to stomach the idea that all they are studying is collections of molecules. There is apparently qualitative advancement in evolution from a primitive soup to mammals to the human brain, so the reductionist approach is demonstrably inadequate. But healthy-minded biologists are also put off by the "holist" approach, that

says the "whole" organism—or whatever is being studied—determines what is taking place. The holists cannot use their theory actually to formulate specific hypotheses concerning specific problems; it is not "practical," in the sense of expanding knowledge.

The solution to the problem of lousy theories is to come up with another approach. Fortunately there is another approach, most clearly developed by the Leibniz-Riemann hydrodynamics school in physics, that has direct relevance to some of the most central problems in biology today. The problems include how differentiation occurs in the development of embryos, how enzymes work, and how human evolution, particularly human brain evolution, occurred.

The essence of the Leibniz-Riemann approach is that qualitative development does occur in a lawful way, such that qualitatively new physical entities evolve that are governed by qualitatively new laws. The entire universe is dominated by this negentropic tendency, which can be understood as self-development, according to a least-action principle.

A Case Example

Let us take a case example from the area of the embryology of the brain.

In the later stages of the development of the goldfish brain, the eye becomes connected via the optic nerve to the visual center of the brain. Essentially, each of several million light-sensitive nerve cells on the retina of the eye grows a long thread-like extension (an axon) out through the back of the eye, through the channel surrounded by the sheath of the optic nerve, to the visual area of the brain (the tectum). These several million axons, growing like a fiber bundle within the optic nerve sheath, impinge on the flat surface of the tectum, and each of the axons connects to one or several of the millions of brain cells in the tectum. The connection occurs such that neighboring cells on the retina are connected to neighboring cells on the tectum, so that in the developed fish, if a certain visual scene is projected onto the retina, that scene is carried by the axon bundle back to the brain in a faithful fashion with very little distortion. The process is similar to fiber optics as used in industry.

How does this connection occur? What underlying dynamic dictates that organism after organism, generation after generation, each goldfish will reliably develop the appropriate connection between retina and brain?

The reductionist looks at the problem and thinks, "Reduce the problem to the individual nerve cells, the individual axons; somehow each axon knows which brain cell to seek out, possibly based on genetic programming such that each axon is chemically distinct and 'shakes hands' with its chemically distinct brain cell mate, much like the variety and specificity of antibodies to foreign proteins." But this requires millions of genes, and worse difficulties arise concerning the question of evolution, discussed below.

The holist says, "this is part of the whole development of the brain, of the organism; start with the organism, don't get bogged down with individual cells." And this leads nowhere.

Dr. Eric Schwartz at the Brain Research Laboratory of New York University School of Medicine took a different tack.[1] He assumed that the ability of each axon to "know" where to end up on the tectum was only apparent and that the process involves an underlying dynamic determined by a least-action principle in which the *boundary* surrounding the growing axon bundle determines the final placement of the individual fibers. He also assumed that this was combined with a mild repulsive force between the fibers, which tends to keep them evenly distributed, and with a slow growth rate, which avoids the twisting of fibers around each other (the equivalent of turbulent-free fluid flow in hydrodynamics). Schwartz then treated the growing fiber bundle as if it were, in fact, a fluid flowing, guided by the optic nerve sheath as if it were a pipe. He generated a hypothesis appropriate to his model: He cut the fiber bundle in a developed fish and also removed half of the tectum. (Unlike the human, the goldfish optic nerve will regenerate if it is cut.) The result he obtained was that all of the optic fibers crowded onto the remaining portion

Continued on page 6

The Lightning Rod

My dear friends,

It was a fine summer's day, with that notable freshness in the air that comes after a great storm. I was out for my morning constitutional; my steps turned toward the seashore; and, overtaken by a strong impulse to plumb the briny deep, I unbuckled my shoes and plunged into the surf to a comfortable ankle's depth, from thence essaying northward along the shore.

Before I had got more than a dozen paces, I stumbled, almost losing my balance as I encountered an obstacle I imagined to be a rock. But when the foam from that particular wave had receded, I discovered that the cause of my near downfall was a large brown bottle, of the sort once used for the conveyance of those patent elixirs in which distilled spirits have often played an unsung but heroic part.

Drawing it from the water, I noted that although the label had long since washed away, the manufacturer had thoughtfully embossed his glassed container with the legend: "Dr. Friedman's Tonic." As I brought it into the full sun, I realized to my great astonishment that the bottle was not empty, but carried a written message—more than a message, a veritable tract! Its contents I share with you, dear friends, on the instructions of my anonymous correspondent.

* * *

To Whomsover finds this Note: BE FOREWARNED ... BEWARE OF SQUALUS!!!

To my knowledge, I, a night watchman in a long-deserted harpoon factory, am the last survivor of what was once the thriving center of Atlantic enterprise and industry. What horrors

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Editorial

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of the tectum, following the expected "smoothest" pattern possible given the change in boundary conditions of the tectum.

The reductionist would have predicted that the half of the fibers that normally impinge on the portion of tectum that remained would continue to do so, while the rest would not end up on the tectum at all. Not only was Schwartz able to explain the overall features of the new connection, but his model of the boundary-condition determination also accounted precisely for the "smooth" shift of fibers.

A Unique Experiment

Schwartz's work on the visual system is unique in all embryology: It is the first, and so far the only, instance in which the geometry of an embryological development is explained. The field is otherwise very bleak at the moment.

Schwartz's findings are visibly the result of his unique approach using the principle of least-action. In this case, the global boundary conditions combine with dynamics at the local level to produce a final result that minimizes shifting of the fibers as they grow onto the brain surface, producing a unique result that appears, superficially, as if it were guided by a "magic hand." Differentiation is occurring not by some complex summation of simple interactions, but by the higher-order determination of geometric conditions.

This aspect of the visual system can be likened to a complex geometric object that evolves by refolding or shifting in a coordinated way such that changes in one part affect changes in all the other parts. Presumably the boundary conditions themselves depend on genetic content in some way, and genetic changes may change the boundary conditions. But, and this is a big but, the changes that occur are highly coordinated transformations with a better likelihood of functional value than if the components were randomly varied as in the reductionist model. There is recent evidence that many other parts of the embryo develop by similar boundary-condition determination, such as limb buds.

How did a system with such high evolutionary potential itself evolve? It is easy to say that what now exists does so because it evolved better and faster and therefore survived and can continue to survive. How this is possible is another question. The evolution of a boundary-condition or optic fiber bundle determined by the least-action principle is likely to be based on the high potential for evolution of more primitive nervous systems. Recent evidence indicates that in the developing embryo the nervous system develops by boundary condition determination from the earliest stages, including the formation of the neural crest in the primitive embryo.

Thus, the findings of Schwartz are probably not the exception but rather the rule for how the universe basically "works" when it is working well, notwithstanding such degenerate conditions as billiard balls.

Biologists have good reason to run from lousy theories. They have no excuse for avoiding the work of understanding an approach that has already made fundamental contributions to embryology, evolution, and, by implication, to all phases of physiology.

On the practical level, the main tasks ahead for human biology are conquering the afflictions of old age, cancer and cardiovascular disease. If we don't stumble across some simple cure (which is looking less and less likely), then we may have to go the basic science route for quite a while, understanding much about normal differentiation before understanding the dedifferentiation characteristic of cancer, for instance. In this case, the Leibniz-Riemann approach may make all the difference in the world for longevity two generations down the road. It is hardly an academic question.

—Ned Rosinsky, M.D.

Notes

1. Schwartz's work was described in "The Physical Geometry of Vision," by Ned Rosinsky, M.D., in *Fusion*, July 1978, p. 22.

Lightning Rod

Continued from page 5

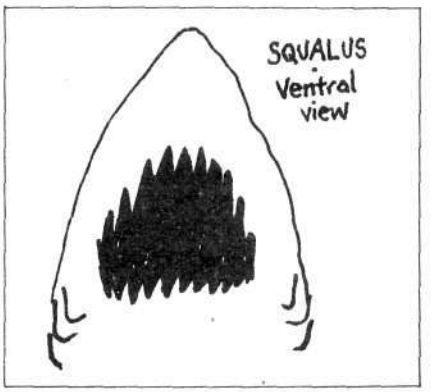
befell my countrymen I shall relate in the little time that may be left to me.

Busy and energetic, if we had a fault, it may be that we were not an overthoughtful people, and no one paid a great deal of attention when the lone SQUALUS first washed up unconscious on our shores, a piece of flotsam more dead than alive.

True, he possessed a wicked looking dorsal appendage and a nasty set of teeth, and when the boy who found him first attempted to revive him with aid of a ham sandwich and a bottle of Dr. Friedman's Tonic, we noticed he was not overparticular about his table manners. He disdained to remove the sandwich wrapper before dining, and swallowed the tonic at a gulp, bottle and all, nearly taking the boy's hand with it. Some were for dispatching him with a harpoon on the spot, but the boy said that since all creatures were equal in God's eyes, we had no right. . . .

And when SQUALUS had recovered a bit, he pressed his own case, presenting us with an impressive set of introductions from the oldest families in Europe, including a letter from a great Queen beseeching us "as your oldest and dearest ally, to accept the assistance of my man SQUALUS, a most dedicated public servant, as I know you are too busy to entirely manage your own affairs. . . ."

SQUALUS was thereupon interviewed by the Wise Men of our commercial community, who issued a public statement afterward commencing, "SQUALUS is brilliantly sound." In private they congratulated themselves on discovering "a real



shark for business." So SQUALUS was taken into our financial community, where he agreed to serve as an adviser providing that he was granted "a free hand and a modest percentage of new ventures."

Time went by, and our community continued to prosper, though perhaps not quite so much as before SQUALUS arrived. It was noted that the sight of SQUALUS at chic cocktail parties, chomping his way through whole platefuls of hors d'oeuvres and a case or two of Dr. Friedman's Tonic, tended to send the other guests away more than a little depressed.

But SQUALUS himself was so highly esteemed by the Wise Men that no one really objected strenuously when he suggested periodically that those wishing to do business should give him just a little bit bigger bite. From 6 percent it went to 7 percent, from 7 to 8, from 8 to 10 percent. By that time SQUALUS had grown into a pretty big fish, although the rest of the economy had stopped growing altogether.

The Wise Men brought SQUALUS to our capital, and beseeched him for advice.

"As I glance around, I see a somewhat bloated and unhealthy look to our enterprises," SQUALUS intoned. "We must fight this creeping inflation."

Then, to encourage everyone to cut back, so he said, SQUALUS announced that henceforth he would take a 15 percent bite "off the top." There were widespread mutterings of complaint, but the Wise Men reminded everyone, "We must respect the independence of SQUALUS," and the President backed up the Wise Men.

Soon, however, it became obvious that giving SQUALUS 15 percent had certain effects many had not anticipated. For one thing, SQUALUS, although his digestion was strong as always, had gotten if anything even less discriminating about where and what he ate. When he swallowed 15 percent of an auto company, it came to the attention of the Congress that SQUALUS, in addition to his usual healthy helping of stocks and bonds, had devoured 50 percent of the assembly lines and diverse other portions of the productive enterprise ac-

tually engaged in producing the cars.

"What do we do about this decline in productivity?" SQUALUS was asked.

"Fight runaway inflation," he replied. "From now on I will take 17 percent."

Even the Wise Men became a bit worried as they subsequently witnessed whole steel plants, farms, and housing developments disappear down the enormous gullet of SQUALUS. Worse, such disappearances were actually showing up in the Commerce Ministry's reports.

One of the Wise Men had an idea: why not sell lottery tickets to commercial enterprises, with the promise that the winners would not get eaten? The plan was put into effect, business was suitably brisk, and the Gross National Product figures grew apace once more.

The Wise Men called a press conference. "Our economy has never been more robust," they announced. "In fact it is overheating just a little bit."

Without being asked, SQUALUS promptly announced that he would "take 20 percent to slow it down."

With SQUALUS's share at 20 percent, the factories emptied and entire neighborhoods vanished overnight with barely a trace. Our citizens became obsessed with fear of getting eaten, and pleaded with the government to act. A new President announced lottery tickets would now be sold to individuals, and promised a tax cut. No one was reassured.

A few brave men dared to suggest that SQUALUS himself was the major problem. "We got along fine before he arrived," they recalled. Why don't we just put him on a strict diet, and if he doesn't like it—get rid of him! After all, SQUALUS is not the only fish in the sea."

"No, no, no," the Wise Men chanted in unison. "We must respect the independence of SQUALUS."

At that point, SQUALUS took 20 percent of the Capitol building "off the top" and the surviving legislators demanded immediate action.

"But we mortals are too stupid to act," said the Wise Men. "We must wait for the Invisible Hand to correct the situation."

So they called the President and the Congress into a seance, and summoned the Invisible Hand to appear. And they were still waiting when SQUALUS devoured the entire West Wing of the Executive building, where the seance was being held, and glided down the street toward the Treasury Department. All resistance crumbled in a matter of hours. The scenes of death and destruction since that unhappy time cannot bear retelling. . . .

I know that even hidden away in this deserted harpoon factory, SQUALUS will find me soon. His appetite is endless. But perhaps this note will survive to warn others that . . . SQUALUS DELENDA EST.

* * *

Something tells me this is one "fish story" we ought to pay attention to.

Yr. obt. svt.,

Benj. Franklin

Letters

Kepler Versus Newton Versus Fusion

To the Editor:

The recent discussions in *Fusion* of the relative roles of Kepler and Newton in defining modern scientific methods are fascinating. I suggest to you, however, that they do not belong in the pages of the magazine. They are not directly relevant to fusion research. . . .

My friends refer to the "Flat-Earthers" at *Fusion* magazine, and the impact of significant articles on fusion are diminished by association with opinionative rather than factual discussions.

I think it is particularly important that young readers should be given a balanced picture of scientific history, rather than one that reflects a personal (and, in terms of common belief, a minority) view of Newton and Kepler. They are not receiving that balanced picture in *Fusion* magazine.

Charles Sheffield
Vice President
Earth Satellite Corporation
Washington, D.C.

The Editor Replies

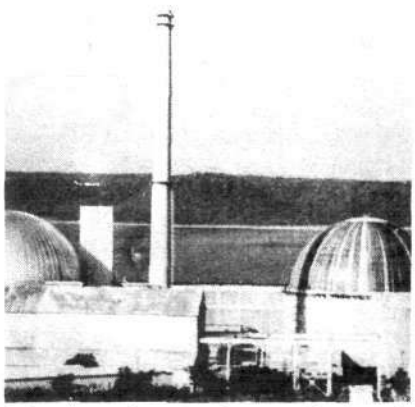
Fusion has repeatedly made the point that the false methodology of Newton and his heirs is crippling modern science, and that only a return to the epistemology of Kepler, Leibniz, and Riemann will make possible the scientific breakthroughs in plasma physics as well as every other discipline to bring about a world fusion economy. *Fusion* prides itself on presenting a definite point of view on a number of crucial issues facing us today that may appear to "common belief" to be one sided. Support of nuclear energy, our constant fight for advanced agricultural technologies, and our championing of pesticide use are examples of scientific issues that would be incomprehensible if presented in an "if/or," "both sides" manner.

Continued on page 12

News Briefs

AIP

The German physicist-mathematician Bernhard Riemann (1826-1866).



Rajasthan Atomic Power Station in India.

PROJECT TO TRANSLATE WORKS OF KEPLER, LEIBNIZ UNDER WAY

The Fusion Energy Foundation launched a project last spring to translate and for the first time make available to a broad audience the numerous neglected works of Kepler, Leibniz, and the Göttingen school of mathematicians, including Karl Friedrich Gauss and Bernard Riemann. FEF research director Uwe Parpart, who is heading up the work, reported in May on his return from a tour of the European archives that the Leibniz archives in Hanover, West Germany contain some 100,000 manuscript pages, only a small number of which have been translated from the Latin and old German script in which they are written.

This collection includes about 20,000 pages on mathematics that will go a long way, Parpart said, toward resolving the Leibniz-Newton controversy over the invention of the calculus. Parpart also reported on the existence of two previously unknown works by Leibniz on political economy and music theory sitting untouched in the Hanover archives. He compared the task facing scientists and scholars today to the work of Erasmus and his contemporaries in the 16th century in restoring the Greek classics for humanity.

Translations of Kepler's *New Astronomy* and *Harmony of the Worlds* and of key papers of the 19th-century physicist-mathematician Riemann are already under way. The FEF is seeking financing for the project. Scholars interested in collaborating in this effort or in establishing parallel projects should write to the FEF at 888 Seventh Avenue, New York, N.Y. 10019, attention Uwe Parpart.

FEF ORGANIZER TOURS INDIA

FEF organizing director for India Ramtanu Maitra toured India last spring, presenting slide show-lectures on fusion and the U.S. space program to general and scientific audiences at universities, research laboratories, and public forums throughout the country. Maitra addressed audiences at the Indian National Science Academy in New Delhi, the Saha Institute for Fundamental Physics in Bangladore, the Indian Institute of Technology in Bombay, the Physical Research Laboratory in Ahmedabad, and other prestitious centers.

The response was universally one of excitement on the prospects for fusion and scientific progress as embodied in the flight of the U.S. Space Shuttle. Maitra reported, further, that the Indian government recently decided in principle to initiate a small-scale nuclear fusion program in India, which will include construction of a research tokamak reactor and work on lasers. Indian plasma physicists are already conducting theoretical work in these areas, as well as experimental work, under the Indian Department of Atomic Energy, on coal-based magnetohydrodynamics power generation.

DEFENSE AND FOREIGN AFFAIRS DAILY CITES CASE FOR FUSION

The *Defense and Foreign Affairs Daily*, a newspaper widely read in defense and industry circles, devoted a full page May 20 to a discussion of fusion power development in the United States, featuring the views of FEF research director Uwe Parpart and noted nuclear scientist Dr. Edward Teller. Reporter John Sanders discussed the efforts of the FEF and Teller to ensure that the Reagan administation's budget cuts do not impinge on fusion power development.

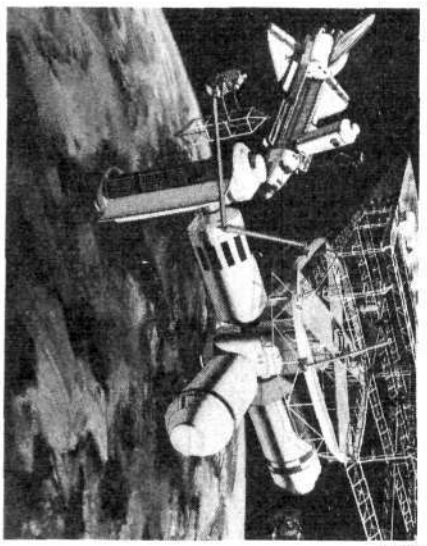
"One criticism being directed at the administration," Sanders wrote, "is that the proposed cuts will reduce government support for a number of high-technology programs which have the potential to ease U.S. energy and national security problems, as well as strategic resource shortages. Fusion proponents like Dr. Uwe Parpart," Sanders continued, "argue that this technology is more than just a more complicated way of producing electricity. By producing extremely high temperatures very cheaply, fusion can improve the entire industrial base."

The article also discussed Teller's argument that fusion will have major military implications as well and warned that the Reagan budget does not live up to the funding mandated by the McCormack fusion bill.

NASA SCIENTIST ASSERTS GOVERNMENT PLACE IN SPACE

Speaking at public forum in New York May 30, Dr. Jesco von Puttkamer, staff scientist of NASA, drew a direct parallel between the programs of the U.S. space agency and the role of the governments of England, Spain, and Portugal in "opening up the sea lanes" in the 15th and 16th centuries, preparatory to full-scale exploration and colonization of the New World. "Only governments have the capability and resources to assume the risks of opening up space for development and colonization," Puttkamer said. Only after programs like those NASA had laid the basis could private interests get involved in exploitation of the resources and special environment of space. Puttkamer emphasized that the development of space will create opportunities and wealth beyond anyone's imagination and that the space program has already provided solutions to problems on Earth. The NASA scientist illustrated his remarks with a parable: A man is standing in a basement rapidly filling up with water. In three hours, the water will reach over his head. How long does he have to live? "Doomsday theorists like the Club of Rome would say three hours," Puttkamer said. "But the obvious answer is, why should he die? All he has to do is walk out of the basement and fix the leak."

Puttkamer later gave a preview of NASA's plans for the future, emphasizing that the next major milestone for the space program must be the construction of a Space Operations Center (SOC). The SOC, he said, will be a permanent laboratory and space manufacturing facility, as well as a platform from which to launch the further exploration of space.



NASA

An artist's conception of the construction of a space station. The Shuttle will carry the materials to the construction site.

KOOP APPOINTMENT TRIGGERS CONTROVERSY

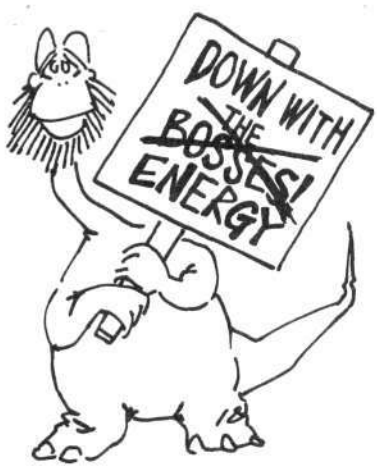
The nomination of Dr. C. Everett Koop, currently surgeon general at the Children's Hospital in Philadelphia, as Surgeon General of the United States triggered a storm of protest from the liberal press when it was announced last spring. The *Washington Post* and *New York Times* ran editorials claiming that Koop is too old and too narrow in experience to hold the post. He has a "Lincolnesque beard," they noted, and, crime of crimes, is progrowth.

Koop's actual credentials, in fact, make him a promising nominee. In the postwar period, Koop was pivotal in turning Children's Hospital into the leader in pediatric surgery in the nation. In addition, he has extensive experience in the international health field. He has set up programs to train U.S. medical students abroad in tropical medicine. Working through MAP International, a relief agancy based in Wheaton, Ill., Dr. Koop has helped set up physician training programs in 83 countries, as well medical, sanitation, nutrition, water supply, and hospital construction projects around the globe. Progrowth observers have commented that as future head of the Center for Disease Control, the Population Research Center, and the National Institutes for Health, Koop would as Surgeon General be in a strategic position to recommend cutting back the U.S. government's world population control and related programs—an estimated budget savings of $3.9 billion.

LOUSEWORT LAURELS TO MR. JANE FONDA

This month's Lousewort Laurels award goes to Mr. Jane Fonda—Jane's husband, Tom Hayden, that is—for his new literary production, *Economic Democracy in an Age of Scarcity*. In this pamphlet, the allegedly reformed Students for a Democratic Society terrorist argues: People must rid themselves of the illusion that industrial and scientific progress are positive; energy growth, particular nuclear power use, is not only "unsafe" but "undesirable" as well; and industrial development is incompatible with democracy. "We live in an age of shrinking rather than expanding resources," Hayden asserts.

Hayden's recent activities have not gone unappreciated by conservative Democrats in California, where Hayden and his caucus, the Campaign for Economic Democracy, are making inroads into the Democratic Party (with unlimited help from Jane Fonda's financial resources). Last April 10, the Orange County Democratic Alliance awarded Hayden the "Rumpus Delicti" (chosen ass) award at a special ceremony, citing his "defoliation of the once lush and fertile vineyards of the Democratic party by depositing his personal brand of toxic waste."



Letters

Continued from page 9

When you have arrived at the point where any advocacy of high technology is unpopular, and mumbo-jumbo must be given equal weight with scientific argument, there is something drastically wrong with your society.

The criterion appropriate for judging the coverage in *Fusion* is that of scientific accuracy. On the Kepler-Newton controversy, we find ourselves historically in very good company, among scientists like Leibniz, Gauss, and Riemann, who shared our judgment of the relative merits of their contributions. Not content with an appeal to historical authority, however, the Fusion Energy Foundation has begun a major research project to resurrect for modern readers the "lost knowledge" of Kepler and his successors.

We are sponsoring a major publishing effort to translate and print the vast amounts of archival material pertaining to science, mathematics, and astronomy by Kepler, Leibniz, and Riemann. Literally hundreds of thousands of manuscript pages by these authors *have not even been cataloged,* let alone translated or published.

Our first effort, a collection of letters by Riemann on mathematical method, will be published in the October-November issue of *Fusion.* We believe that the results of this research will dramatically change the prevailing "common beliefs" about Kepler and Newton, as well as lay the basis for a reinvigoration of modern science.

Budget Cuts Affect the Weather

To the Editor:

I thought your readers would like to know how budget cuts are affecting the National Weather Service (NWS).

The National Weather Service has been directed to reduce 253 full-time federal employees or 5 percent of its total staff. This means losing 10 positions at the Federal Aviation Academy, closing the Las Vegas Nuclear

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Viewpoint

The Buck Stops Here

by Dr. Krafft A. Ehricke

History proves abundantly that any new option—a new environment, technology, or idea—is only as good as man's response, reflecting prevailing attitudes.

Compare Rome to Carthage when the Mediterranean world was at stake. Compare the Vikings who came to America and left (like the Americans who went to the Moon), to 16th-century Europeans who did not leave. Compare the difference in response of the European nations when the New World was at stake and when the industrial revolution arrived. And now, compare the different responses to the nuclear and extraterrestrial options. History shows the winners to be those who embrace the new option with superior reason, who make it their own by committing themselves to it.

For 96 percent of the almost 5,000 years of civilization, the annual economic growth rates stayed under 1 percent and often were negative. Periods of slow expansion and some decline in mortality were followed by shrinkage and mortality peaks often in the order of those expected for World War III. Society after society was caught in Malthusian traps, not because there were true limits to growth, but because no major conceptual breakthrough had occurred since the agricultural revolution.

Eighteenth-century Europe would have been caught in another trap of no-growth incompetence had it not been for an immensely powerful new option, the emergence of industrial, capital-based free enterprise. Beginning in the 1780s, annual production growth rates in England began to reach an unprecedented 2 percent, climbed to 4 percent, and stayed there, on the average, for the next 50 years.

Between 1870 and 1914, the 12 leading industrial nations held an average of 2.7 percent production growth rates, with the United States leading at 4.7 percent. After World War II, economic growth rates of the 12 leading industrial nations soared again to an average of 4.2 percent in the 1950s, with West Germany leading with 7.6 percent.

The free world, dedicated to scientific, technological, economic, and social progress, built itself back up and at the same time started an unprecedented program of supporting the nations of the Third World. After nearly 5,000 years of drifting helplessly in "God-given" misery, a new idea was ready to redeem humanity—one whose power could not be broken even by a succession of history's most destructive wars, one that made winners of victors and vanquished alike, wherever it was applied.

Destruction from Within

But a great civilization is not conquered from without until it is destroyed from within, by altering the mental attitude from which it draws its strength and by cutting its source of power. So, they marched through the system—counterculture, chlorophyll socialism, neo-Malthusianism, and cultural pessimism. They left behind division, confusion, and suggestive guilt—of profits, of production, of technological progress, and apologies for the most successful system known. This system is so successful not only because it is rational and efficient, but above all because it is dynamic, innovative, and willing to improve, socially and environmentally, and because it is strong enough to improve.

When it became apparent that reasonable measures to assure clean air, water, and land would be installed, logic and sense of proportion went out the window. Had today's irrationality and bureaucratic restrictions been in force in the early 19th century, the industrial revolution would never have occurred and, considering the then existing birth control by high mortality, most of today's enemies of industrial free enterprise would not be here today. We would still be crawling in the poverty, the environmental filth, and the almost total absence of freedom inherited from the Dark Ages.

It is supreme irony that now, when for the first time in almost 5,000 years a solution has been found that works virtually without limits, the Club of Rome became busy constructing a problem, a present and future predicament that, by Jove, they'll make sure comes about. Dismantle the free enterprise system. Ridicule progress. Block power plant construction, especially nuclear. Belittle the prospects for useful fusion and space industries. Recommend regression and an inefficient soft technology that is small and beautiful. Whip up nostalgia for a past that never existed; if it had, industrial revolution and free enterprise would have been rejected from the start as historic non sequitors, since our ancestors were not stupid. Create lack of tough resolve by sanctimonious preaching of cultural pessimism. And finally, create in the wake of this pessimism the inability and disinterest in the type of response to new options that makes winners.

Withdrawal into the Womb

In ancient times, philosophy often led the way. Today, it runs behind the conditions created by technology. Therefore, there is no profundity of perception, no coherent conception of the most important challenge of our lives: our world and our place in it. Conse-

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Viewpoint

Continued from page 13

quently, there is flight into the unreal, into mysticism, withdrawal into the womb of Earth. The bold frontier of space becomes a comfy little nest of simulated Earth conditions from 1 g to a murmuring brook, wobbling inertly around L-5. Solar electricity from space offers no relief when it is needed most, in the 1990s and the first decade of the next century. But it is irrelevant to support it just so long as it is not *nuclear* electricity, which is safe, economical, and available *now*. Solar electricity is great space technology, but not in the service of mankind.

We've got to look at the whole picture of needs and options, if space technology is to be truly useful. We need a highly developed nuclear power industry, as recognized by a growing number of countries. The advantages in low electricity cost and early availability to meet the urgent needs for energy and preserve oil for other important purposes, such as food production, are just too great. The prospects for building even better and safer reactors—high temperature reactors, pebble bed reactors, thorium breeders in addition to uranium breeders—are above-the-horizon realities of the late 1980s and 1990s.

If fission and fusion technology are given the support they deserve (and this has to be in view of their much broader potential than just furnishing electricity, but also processing heat, more economical coal liquefaction, other chemical fuels, and material recycling, to say nothing of their enormous importance in developing the space industrial sector, even if solar energy is used wherever it offers objective advantages), then there is a good chance of ample supply of nuclear energy and availability of fusion power plants by 2010. In addition, in the intervening decades, we will have prevented staggering human misery, especially in the Third World.

Space technology does not have to compete with better alternatives. It has too much to offer in vital areas where there is little or no terrestrial competition. This includes the tremendous potential of electronic services for information-transmission; Earth observation; advanced disaster warning, assessment, monitoring, and assistance; orbital manufacturing; orbiting satellite reflectors Lunetta and Soletta; and, last but not least, lunar development. Every one of these is a long-term driver for the industrial space program, a driver for new technologies, jobs, and a vigorous economy, at the same time creating an infrastructure for expanded space exploration.

I advocate a grand synthesis of space, nuclear fission/fusion, and solar energy, each where it is most effective.

I would not split these two goals but rather integrate them. *Going back to what I said initially about the winning way of responding to new options, I advocate a grand synthesis of space, nuclear fission/fusion, and solar energy, each where it is most effective for steering the proven industrial free enterprise system into a cosmic frame of reference, for the benefit of Earth and the accelerated utilization of space.*

Lunetta and Soletta

I do not need to enlarge on the importance of electronic services or of orbital manufacturing, which also prepare lunar industrial development. With the Lunetta system, controlled rural night illumination assists in increasing local food production, providing tens of millions of additional labor hours. Among other unique applications, Soletta yields high net economic/agricultural benefits by hail suppression, precipitation augmentation, or the provision of added sunshine where needed. Modification of weather, even by a small amount at selected places and times, reduces stress and losses and raises the standard of living anywhere.

The Moon provides virtually all the materials needed for the economic construction and deployment of Soletta reflectors and many other products. Lunar industrial development is the greatest and most comprehensive of the four goals I mentioned. It provides important raw materials, among them pure iron, much more titanium, chromium, nickel, manganese in mare sands, and more aluminum in highland sands than in average Earth rocks. It is a natural and protective basis for large-scale, diversified industries, settlements, and the first extraterrestrial biosphere, based essentially on life-giving nuclear energy—the nuclear fire we will carry eventually into the lonely twilight world of the outer solar system.

It is the law of life to grow or die.

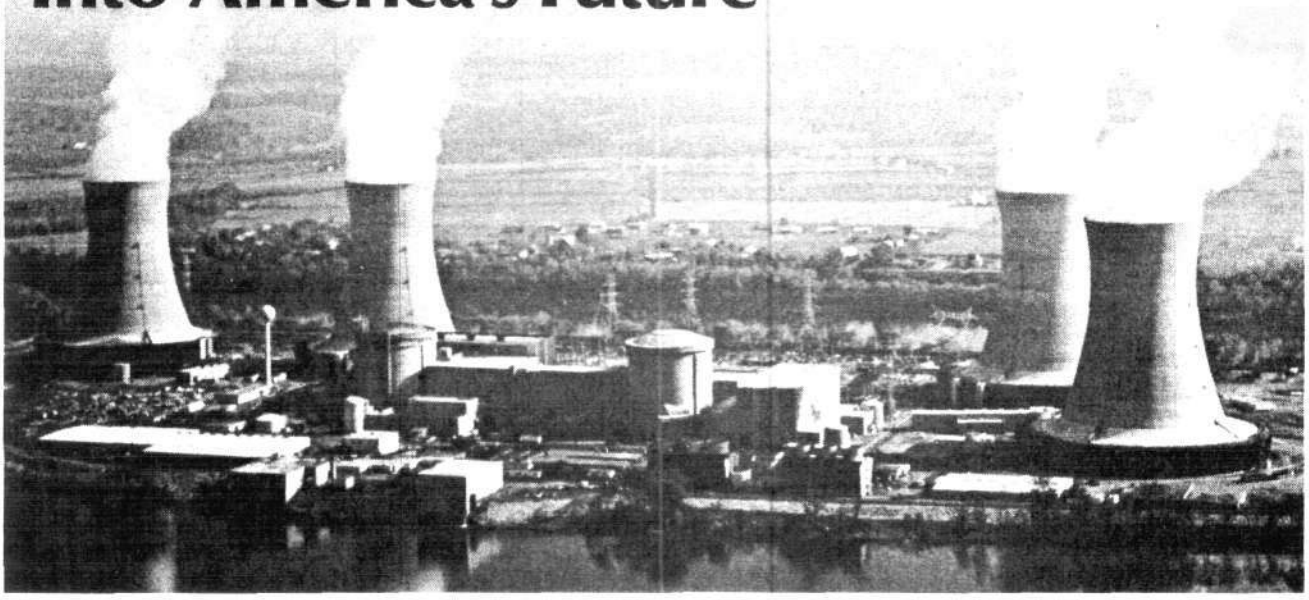
We have changed the world. Can we not change ourselves? Human creativity is unlimited in freedom; the energy-material world is unlimited. Therefore, the notion of limits to growth is a figment of ignorance. All evolution shows that there are no limits to growth, only to mindless multiplication. What we see is a material-mental Universe, capable of limitless quantum leaps of growth in technological creativity and reason—of an ultimately deathless rise into the radiant infinity of space, time, and understanding.

But for now, the buck stops at the human desk.

Krafft A. Ehricke, the president of Space Global, has been involved in the study and development of space technology, exploration, and utilization for 40 years. During the 1960s, he developed the concept of comprehensive space industrialization and in 1970-71, he argued for a reorientation of the post-Apollo effort toward space industrialization as both an essential means to assist global economic growth and as a necessary foundation for a new cycle in manned deep space exploration.

Open 82 U.S. Nuclear Plants

Put Nuclear Back Into America's Future



Metropolitan Edison

Between now and Election Day 1984, nearly 50 of the 82 U.S. nuclear plants currently stalled by delays in construction and licensing could be put on line, saving utilities and consumers of electricity more than $50 billion. By early 1987, by which time all of the 82 nuclear starts could be generating power, the savings would be more than $100 billion, compared with the cost of generating electricity by alternative means.

Despite the antinuclear decade of the 1970s, American citizens are still committed to nuclear power. With a new administration that supports the expansion of nuclear energy, now is the time for action to reverse the wreckage and restore the growth of electric power grids nationwide.

The delays affecting the 82 nuclear plants have been costing U.S. industry and consumers hundreds of millions of dollars per month and are threatening power shortages and failures in the Pennsylvania-New Jersey power grid and in the Northeast. If not reversed, the delays will cost billions more, and they will make recovery from the current economic slump impossible.

Bring Down the Rates

The Fusion Energy Foundation is urging the Reagan administration to take prompt action to lift the regulatory roadblocks and put the U.S. nuclear industry back on a normal construction schedule. If this is done, we can confidently predict that inflated electricity rates will come down and funds will be freed up for investment in the development of advanced nuclear fission technologies and fusion—thus ensuring a future of cheap and abundant energy for the United States.

The situation of the Unit 1 reactor at Three Mile Island near Harrisburg,

What You Can Do

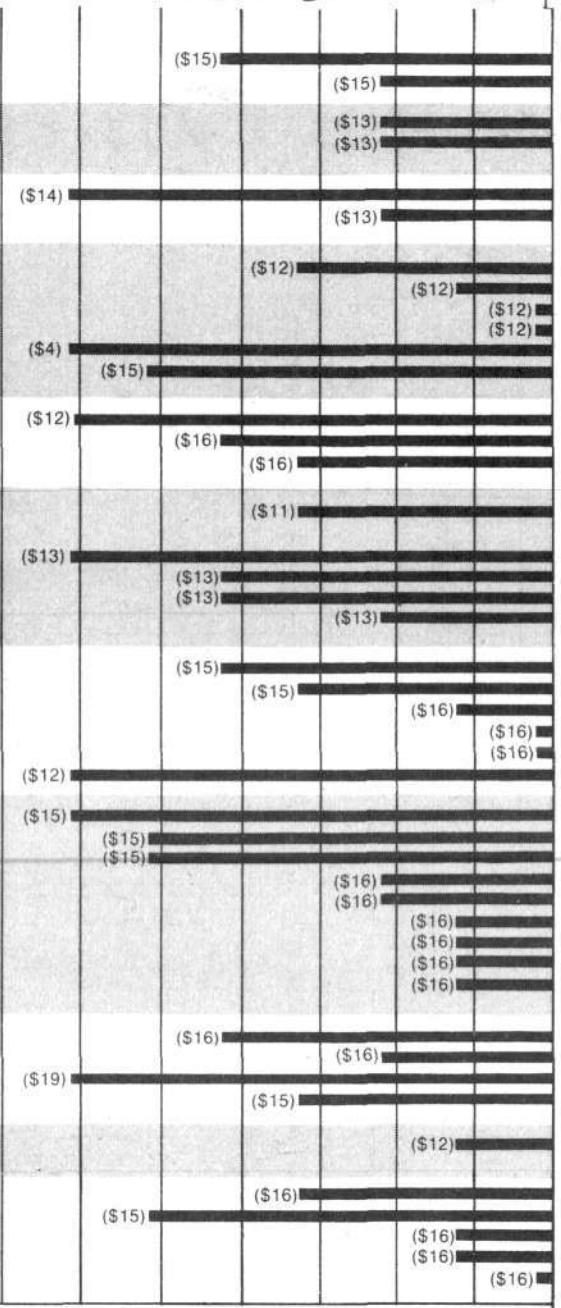
The Fusion Energy Foundation, a nationwide pronuclear group with 18,000 members, has launched a campaign to get Three Mile Island Unit 1 turned back on immediately. As a result, interested citizen groups, labor, and business representatives have organized to put a resolution on the docket of the Pennsylvania State Legislature.

The pronuclear readership of *Fusion*—close to a quarter million monthly—can make this a national campaign that will reverse the nuclear shutdown. Your telegrams, letters, town meetings, and local government resolutions will help remove the obstacles from the NRC policy. With 82 nuclear power plants coming on line in the near future, the United States will have enough energy at lower electricity rates to guarantee economic recovery.

Figure 1
DELAYED U.S. NUCLEAR POWER PLANTS WITH PROJECTED START-UP DATES

State	Plant	Utility	Capacity (MWe)	Percentage Completed	Plant Start-Up Dates			Monthly Savings (in millions of dollars)						
					Original Projection	Current Projection	FEF Projection	1981	1982	1983	1984	1985	1986	1987
Ala.	Bellefonte 1	Tennessee Valley Authority	1,213	75	1977	9/86	9/82		($16)					
	Bellefonte 2		1,213	52	1978	9/84	2/84				($16)			
Ariz.	Palo Verde 1	Arizona Public Service Co.	1,270	81	1981	5/83	5/82		($16)					
	Palo Verde 2		1,270	50	1983	5/84	3/84				($16)			
	Palo Verde 3		1,270	12	1984	5/86	5/86						($16)	
Calif.	Diablo Canyon 1	Pacific Gas & Electric	1,084	99	1972	1981**	6/81	($26)						
	Diablo Canyon 2		1,106	98	1974	1981**	6/81	($29)						
	San Onofre 2	Southern California Edison Co.	1,100	86	1976	12/81**	12/81	($37)						
	San Onofre 3		1,100	64	1977	2/83	2/83			($15)				
Conn.	Millstone 3	Northeast Nuclear Energy Co.	1,150	33	1979	5/86	3/85					($15)		
Fla.	St. Lucie 2	Florida Power & Light	777	59	1979	5/83	5/83			($13)				
Ga.	Alvin W. Vogtle 1	Georgia Power Co.	1,100	17	1978	5/85	5/85					($15)		
	Alvin W. Vogtle 2		1,100	4	1979	11/87	12/86						($15)	
Ill.	La Salle 1	Commonwealth Edison	1,078	99	1975	6/81	6/81	($13)						
	La Salle 2		1,078	81	1976	6/82	5/82		($13)					
	Braidwood 1		1,120	59	1980	10/85	9/83			($15)				
	Braidwood 2		1,120	47	1981	10/86	9/83			($15)				
	Byron 1		1,120	73	1978	10/83	10/82		($15)					
	Byron 2		1,120	59	1979	10/84	9/83			($15)				
	Clinton 1	Illinois Power Co.	950	72	1980	8/83	11/82		($12)					
	Clinton 2		950	2	1983	*	2/87							($12)
Ind.	Bailly Nuclear 1	Northern Indiana Public Service Co.	644	0	1976	12/89	3/87							($9)
	Marble Hill 1		1,130	20	1983	12/86	1/86						($15)	
	Marble Hill 2		1,130	6	1984	12/87	11/86						($15)	
Kans.	Wolf Creek	Kansas Gas & Electric Co.	1,150	70	1973	4/84	1/83			($15)				
La.	River Bend 1	Gulf States Utilities Co.	934	23	1979	4/84	4/84				($12)			
	River Bend 2		934	5	1982	*	11/86						($12)	
	Waterford 3	Louisiana Power & Light Co.	1,165	82	1977	3/83**	4/82		($20)					
Mich.	Midland 1	Consumers Power Co.	522	63	1974	7/84	6/83			($8)				
	Midland 2		807	62	1975	12/83	6/83			($11)				
	Enrico Fermi 2	Detroit Edison Co.	1,093	80	1974	11/83	5/82		($15)					
Miss.	Grand Gulf 1	Mississippi Power & Light Co.	1,250	85	1979	4/82	2/82		($16)					
	Grand Gulf 2		1,250	22	1979	4/86	11/85					($16)		
	Yellow Creek 1	Tennessee Valley Authority	1,285	18	1983	4/88	2/86						($16)	
	Yellow Creek 2		1,285	3	1984	*	* 1/87							($16)
Mo.	Callaway 1	Union Electric Co.	1,150	76	1981	10/82	8/82		($15)					
	Callaway 2		1,150	0	1983	4/88	3/87					($15)		

N.H.	Seabrook 1	Public Service of New	1,150	44	1979	1983	1983		
	Seabrook 2	Hampshire	1,150	8	1980	1985	1985		
N.J.	Hope Creek 1	Public Service Electric & Gas	1,067	24	1975	12/86	10/85		
	Hope Creek 2		1,067	24	1977	12/89	10/85		
N.Y.	Shoreham	Long Island Lighting Co.	854	88	1975	1/83**	12/81	($14)	
	Nine Mile Point 2	Niagara Mohawk Power Corp.	1,080	30	1977	10/86	5/85		
N.C.	Shearon Harris 1	Carolina Power & Light Co.	900	38	1977	3/85	12/84		
	Shearon Harris 2		900	4	1978	3/88	12/86		
	Shearon Harris 3		900	0	1979	3/94	3/87		
	Shearon Harris 4		900	0	1980	3/92	3/87		
	McGuire 1	Duke Power Co.	1,180	99	1976	7/81**	6/81	($4)	
	McGuire 2		1,180	75	1977	6/83	9/82		
Ohio	Zimmer 1	Cincinnati Gas & Electric Co.	810	95	1975	6/82**	7/81	($12)	
	Perry 1	Central Area Power Coor-	1,205	70	1979	5/84	1/83		
	Perry 2	dinating Group	1,205	40	1980	5/88	10/84		
Pa.	Beaver Valley 2	Central Area Power Coordinating Group	833	40	1977	5/86	10/84		
	Susquehanna 1	Pennsylvania Power & Light Co.	1,050	90	1977	5/82**	10/81	($13)	
	Susquehanna 2		1,050	57	1978	5/83	5/83		
	Limerick 1	Philadelphia Electric Co.	1,055	62	1975	4/85	6/83		
	Limerick 2		1,055	28	1977	4/87	7/85		
S.C.	Catawba 1	Duke Power Co.	1,145	68	1979	3/84	2/83		
	Catawba 2		1,145	37	1980	9/85	12/84		
	Cherokee 1		1,280	15	1984	1/90	4/86		
	Cherokee 2		1,280	0	1986	1/92	3/87		
	Cherokee 3		1,280	0	1988	*	3/87		
	Virgil C. Summer 1	South Carolina Electric & Gas Co.	900	97	1977	6/81**	6/81	($12)	
Tenn.	Sequoyah 2	Tennessee Valley Authority	1,148	96	1974	7/82	6/81	($15)	
	Watts Bar 1		1,177	83	1976	11/82	3/82		
	Watts Bar 2		1,177	82	1977	8/83	4/82		
	Hartsville A-1		1,233	31	1980	7/88	5/85		
	Hartsville A-2		1,233	23	1981	4/89	10/85		
	Hartsville B-1		1,233	17	1981	*	3/86		
	Hartsville B-2		1,233	7	1982	*	10/86		
	Phipps Bend 1		1,233	17	1982	2/89	3/86		
	Phipps Bend 2		1,233	5	1983	*	11/86		
Tex.	South Texas Project 1	South Texas Project	1,250	60	1980	82**	8/83		
	South Texas Project 2		1,250	23	1982	84	10/85		
	Comanche Peak 1	Texas Utilities Generating Co.	1,150	87	1980	2/84	12/81	($19)	
	Comanche Peak 2		1,150	50	1982	2/86	3/84		
Va.	North Anna 3	Virginia Electric & Power Co.	907	8	1977	89	9/86		
Wash.	WPPSS 1	Washington Public Power	1,267	38	1980	2/86	12/84		
	WPPSS 2	Supply System	1,093	84	1977	9/83	3/82		
	WPPSS 3		1,240	15	1981	9/86	4/86		
	WPPSS 4		1,267	15	1982	2/87	4/86		
	WPPSS 5		1,240	3	1983	9/87	1/87		



*Utility companies have stopped projecting start-up times for these plants.

**Plants experiencing licensing delays. Total replacement energy costs for these plants are running about $170 million per month, according to utility company estimates. All other estimates of energy replacement costs in this table were projected by the FEF.

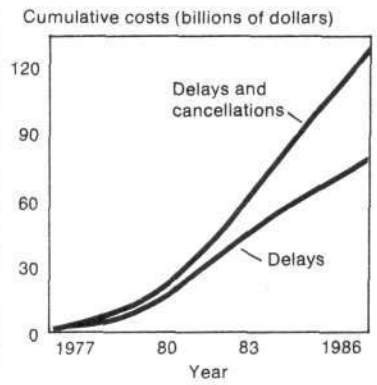


Figure 2
REPLACEMENT POWER COSTS CAUSED BY NUCLEAR PLANT DELAYS AND CANCELLATIONS

SUMMARY OF PROJECTED NUCLEAR PLANT START-UPS AND ELECTRICITY COST SAVINGS

Year	Plant Start-ups (FEF Projection)	Annual Savings in Electricity Costs (billions of dollars)	Cumulative Savings (billions of dollars)
1981	11	5.8	5.8
1982	13	14.7	20.5
1983	13	18.8	39.3
1984	10	13.2	52.5
1985	11	18.0	70.5
1986	15	28.0	98.5
1987 (by March)	9	7.1	105.6

A total of 82 nuclear plants could be put on line by March 1987 saving $105.6 billion. Below, the plant underway at Bay City, Texas.

Carlos de Hoyos

Pa., is a case in point of the prohibitive cost of not reviving the U.S. nuclear program. Last March the FEF launched a campaign to reopen TMI 1, the undamaged reactor that was down for routine refueling at the time of the March 1979 incident at TMI 2. Despite its having met all of the new safety regulations for nuclear plants, TMI 1 has still not been relicensed by the Nuclear Regulatory Commission. As of May 1981, the cumulative cost of this shutdown was $364 million, based on the $14 million per month cost differential between nuclear-generated power and the more expensive replacement power General Public Utilities Company has been buying from outside sources. GPU is the holding company that owns Metropolitian Edison, Jersey Central Power and Light, and Pennsylvania Electric.

These higher energy costs, moreover, have financially strained GPU, slowing down the clean-up work at the utility's TMI 2 reactor.

The FEF review of the national picture showed that regulatory and related delays affecting 82 plants around the country had cost more than $27 billion as of mid-1981. If these delays continue, the cumulative loss will be close to $75 billion by year end 1985 (see Figure 2).

Taking into account nuclear plant cancellations, U.S. industry and consumers have already paid an extra $35 billion for higher electric power costs, and they will pay a total of $115 billion extra by 1985.

Projected Savings

Figure 1 is a grid of the 82 delayed nuclear power plants in the United States, their owners, capacity, original start-up date, and the approximate state of completion of each. We assumed a total project completion time of six years for nuclear plants, including construction, licensing, and start-up, based on the actual completion schedules met in the early 1970s in the United States and other nations.

Our analysis showed that 47 of the delayed plants could be put on line by Election Day 1984, and the remaining 35 plants could be started up over the next two-and-a-half years.

We then estimated the savings in electricity costs, assuming that the nuclear-generated electricity would be replacing a mix of more costly coal and oil-based electricity (80 percent and 20 percent, respectively). In projecting the cost of the replacement nuclear power, we used Commonwealth Edison's estimate of the mills-per-kilowatt-hour cost of nuclear-generated electricity. This estimate includes fuel, operating, and amortized capital costs.

The table shows the savings that can be expected from putting the U.S. nuclear program back on a reasonable timetable: $20 billion by 1982, and $53 billion by Election Day 1984—with 47 new nuclear plants on line by that time.

These savings can be put to work as increased investments in the U.S. energy industry or other productive industries. The savings from reviving the nuclear option in the United States can, in fact, provide a critical margin of economic recovery—comparable to a noninflationary tax cut—which will directly translate into productive investment and more and cheaper energy.

—Jon Gilbertson,
director of nuclear engineering,
Fusion Energy Foundation

Los Alamos CO_2 Laser Promises Breakthrough

A new series of experiments carried out recently by inertial fusion researchers at Los Alamos National Scientific Laboratory on their carbon dioxide gas laser has led to new theoretical target calculations that completely change the near-term prospects for successful fusion experiments on gas lasers.

Although details of the new results and the target designs based on them have not yet been revealed publicly, there is a strong likelihood that a method of converting the carbon dioxide laser light's wavelength, which is too long for achieving fusion efficiently, into shorter-wavelength X-rays may have been discovered. A second possibility is that a means to suppress or utilize the "hot" electrons generated by interactions between the carbon dioxide and the plasma has been found.

In sum, the carbon dioxide laser approach, upon which the Los Alamos inertial-confinement fusion program is primarily based, can no longer be considered a limping dark horse fusion contender.

Although these new results are most welcome, the fusion community has cautioned that the success of the carbon dioxide laser must be used to upgrade the overall funding for inertial confinement fusion, not subtract funds from the mainline glass laser approach.

Gas Versus Glass

Laser-matter interaction experiments over the past several years have demonstrated that to achieve fusion through inertial laser confinement efficiently, short-wavelength laser light would be needed. That is, the absorption efficiency and quality greatly improve with decreasing wavelength. This led the U.S. inertial fusion program to emphasize glass lasers, which produce light at short wavelengths that can be further shortened using known technologies. For example, the ideal wavelength for laser fusion target gains greater than 1 was determined to be 0.69 micron, and the high-power, neodymium-doped glass lasers at present have a wavelength of 1.06 micron. Carbon dioxide lasers, on the other hand, produce light at wavelengths a factor of 10 greater.

Another requirement for laser fusion, however, is an energy intensity of 500 trillion watts per square centimeter. The basic physics of the excited energy state in glass lasers limits the energy density that can be extracted. In order to increase the total energy of the laser beam, the *volume* of the amplifying medium must be increased, which prevents economical scale-up to commercial reactor size. Gas lasers would not have this problem.

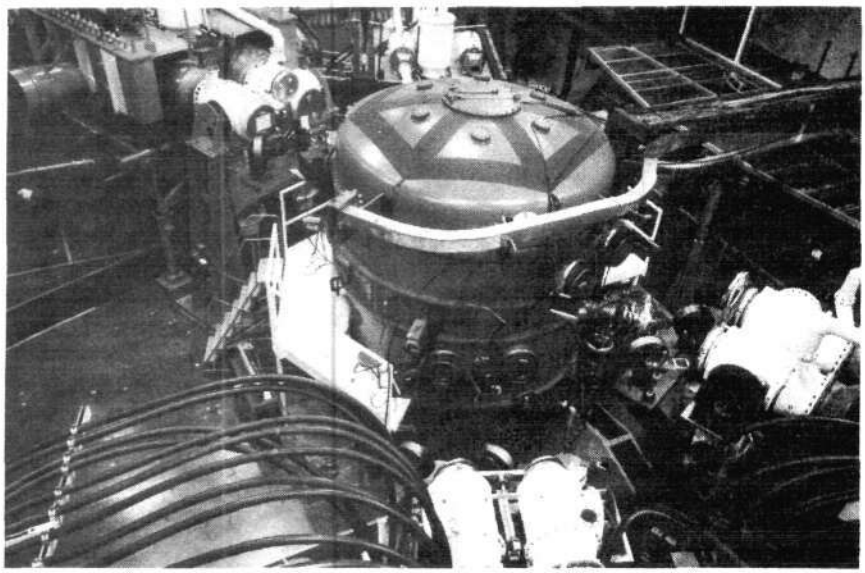
In addition, the operating efficiencies of the carbon dioxide laser are 10 to 20 times greater than those of the glass laser, whose laser light captures less than 1 percent of the incident light energy.

For these reasons, although glass lasers are currently the major research tools, being used successfully to investigate the realm of inertial fusion, it is realized that they are inherently incapable of providing a practical basis for commercial energy applications because of the high cost involved in scaling up.

The problems to be overcome in commercial gas lasers are decreasing the wavelength, increasing the energy density, and extending the excitation lifetime to permit a short, high-power pulse.

Given the revelations at the November San Diego plasma conference concerning the use of soft X-rays, the Los Alamos scientists may have discovered a way to solve one or more of these problems.

The prognosis is that carbon dioxide could demonstrate moderate-gain laser fusion targets in the near future. Since the operating efficiencies and ease of scale-up (not to mention the relative cost efficiency compared to glass lasers) of the carbon dioxide laser make it more suitable as a commercial reactor laser, the door may now be opened for the development of laser fusion reactors to breed fuel for light water fission reactors before the year 2000.



LANSL

The target chamber of the Helios carbon dioxide gas laser system at Los Alamos National Scientific Laboratory. The laser beams are emitted from the eight white pipes surrounding the chamber.

ZT-40 Increases Stability Time

The Los Alamos National Scientific Laboratory's ZT-40 toroidal magnetic fusion experiment has now increased its quiescent times from 6 up to 8 milliseconds, demonstrating once more the promise of this alternative approach to magnetic fusion energy and opening an entirely new horizon of possibilities for magnetic fusion by increasing the understanding of the dynamics of plasma in its most general features.

Researchers at Los Alamos report that their continued success, equaling the accomplishments of early tokamak experiments, is based on using a fraction of the ZT-40's total capability. The earlier successes of the ZT-40 (see *Fusion,* June 1981, p. 18; August 1981, p. 13) were to overcome the problem of wall impurities and transform the plasma into a stable magnetic field-reversed configuration, when the refurbished device was first operated in February. Then in April, the ZT-40 increased the quiescent period to 6 milliseconds.

The First and the Last

The ZT-40 is the same type of magnetic fusion approach that was first explored experimentally in the late 1940s, during the early stages of the worldwide fusion effort. Like the tokamak, the ZT-40 is a donut-shaped (toroidal) magnetic bottle that uses an induced electrical current in the confined plasma both to heat the plasma and to help generate the magnetic bottle. Unlike the tokamak, however, the ZT-40 does not use large external toroidal magnetic field coils to provide the stable confinement structure. Thus a major engineering and economic drawback of the tokamak is avoided for the ZT-40 zeta machine.

The stable magnetic bottle configuration of the ZT-40 is attained through the generation of what is called a reversed magnetic field; that is, part of the magnetic bottle—in this case, an outer shell of the donut—has field lines that are reversed in a direction opposite to the remaining portion. The ZT-40 magnetic bottle can be said to be a "self-generated" structure since this stable reversed magnetic structure is generated from the interaction between the plasma and the original magnetic field at some point in the evolution of the experiment.

The most immediate pragmatic aspect following from this self-stabilizing, self-generated magnetic field-plasma configuration is that high plasma betas can be readily achieved. Beta is a measure of the efficiency with which a magnetic field confines a fusion plasma; formally, it is the ratio of the plasma gas pressure to the magnetic field pressure. Attainment of high beta means that more energy-dense fusion plasmas can be confined by weaker magnetic fields. This greatly enhances the economics and engineerability of these systems as fusion power reactors.

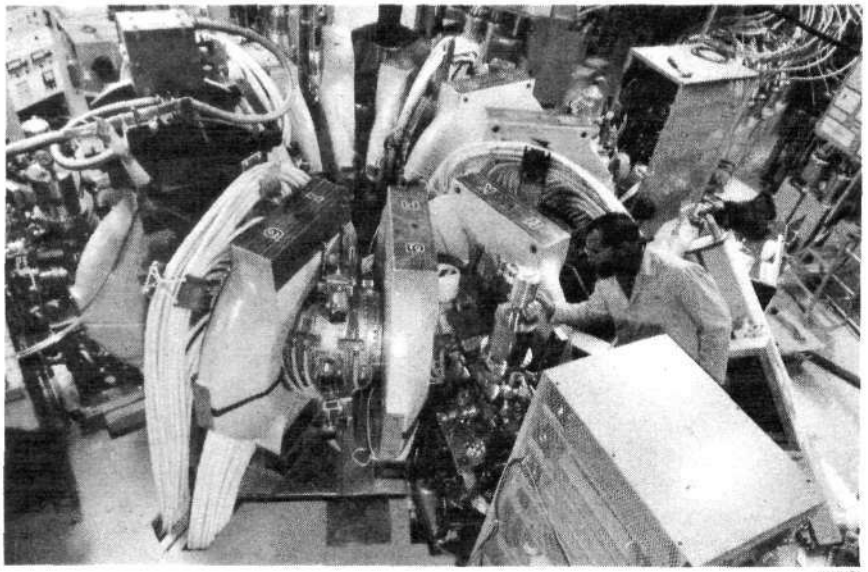
The current ZT-40 experiment have reached betas of 10 to 20 percent, with an apparent upper theoretical limit of 40 percent—tokamaks have reached betas of only a few percent at present. Although these high betas are quite important, the real significance of the ZT-40 is its overall potential for expanding man's knowledge and understanding of fusion physics. For the first time, scientists have produced relatively long-lived, hot magnetic plasmas that undergo a series of dynamic transformations to higher and higher ordered states, with minimal connection to external support structures during their evolution.

For the first time, scientists will be able to explore experimentally the details of the evolution of self-organized plasmas. Although such structures are almost universally observed in plasmas, in the past man-made plasmas have exhibited such behavior only on very short temporal and spatial scales.

A Musical Analogy

The success of the ZT-40 creates a situation not unlike that of the development of the symphonic form compared to the previous simple chamber musical form in terms of the possibilities of advancing composition in general.

With the long-lived, large ZT-40 reversed-field high-beta plasmas, the detailed elements of the evolution of self-organized plasma structure can be experimentally explored. And on the basis of the insights obtained, totally new magnetic fusion approaches can be readily generated.



LANSL

The ZT-40 toroidal magnetic fusion experiment at Los Alamos National Scientific Laboratory. A series of recent successes demonstrates once more the promise of this alternative approach to magnetic fusion energy.

Satellites Link Magnetic Fusion Computer System

The U.S. magnetic fusion program is upgrading its capacity for computer simulations of plasma physics using a new satellite communications system. Since April 1, two satellites have relayed information between the National Magnetic Fusion Energy Computer Center (MFECC) at Lawrence Livermore National Laboratory in Livermore, Calif., to the Plasma Physics Laboratory in Princeton, N.J.

By the end of 1982, similar linkups will be established between the computer center at Livermore and the fusion programs at Oak Ridge National Laboratory in Tennessee, Los Alamos National Scientific Laboratory in New Mexico, and the General Atomic Co. in San Diego.

The satellite communications network replaces a phone transmission system that cost twice as much and ran at half the speed.

A Japanese Link

Edwin Kintner, director of the Department of Energy Office of Fusion Energy, announced May 4 that the Department of Energy is considering linking up with the fusion program in Japan by satellite. The MFECC system, "the brain that ties together the fusion program" in the United States, would then transmit and exchange information continually with Japan's $2 billion fusion program, which is centralized by an equivalent fusion computer center at Nagoya University in Japan.

According to the director of the MFECC at Livermore, Dr. John Killeen, a proposal for such a satellite linkup with Japan has not yet been written. But since a reciprocal fusion agreement already exists between two countries, and since Japan has made a strong commitment to the rapid commercialization of fusion energy, such a linkup is likely at some time in the future.

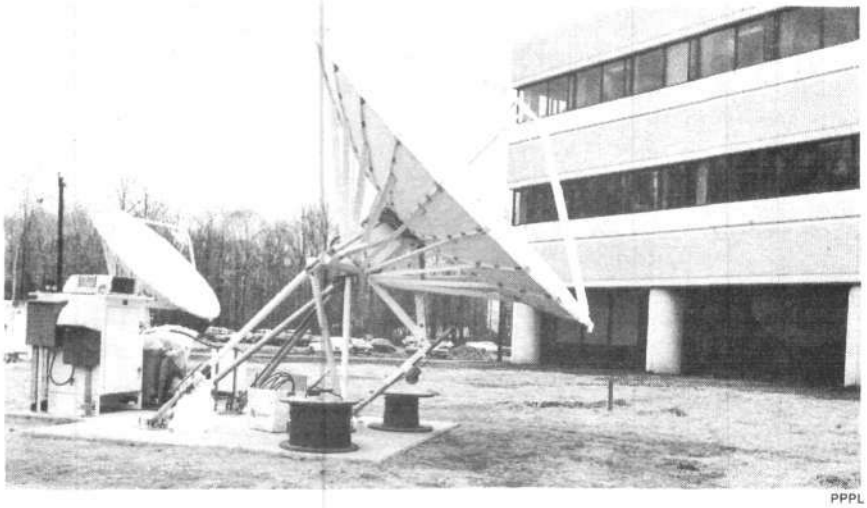
The Fusion Energy Foundation has proposed a similar satellite linkup with Mexico as part of an oil-for-technology agreement between the United States and that country. This would make the U.S. fusion program available to leading scientific institutions in Mexico. It would not be a mutual exchange of fusion information, as the United States has with Japan, but a part of a larger political and educational commitment to transfer the most advanced U.S. technologies, as they develop, to our rapidly industrializing southern neighbor.

Such a political agreement would also commit the national laboratories here to an intensive effort to train Mexican scientists and to collaborate in establishing advanced science education programs in Mexico.

According to Killeen, the satellite communications system is part of a larger program to upgrade the MFECC program, which handles all the large-scale computer link-up needs of the DOE magnetic fusion program. The program started with a Control Data 7600 program and then graduated to a Cray Computer that is five times as powerful. By summer 1981, MFECC will add still another computer to meet its expanding needs.

Aside from being less expensive and far more accurate, the satellite communications linkup has the advantage of including a substantial capacity for handling the much larger volume of information the MFECC program will need as it expands.

—Carol Cleary



PPPL

A new satellite communications system links up the National Magnetic Fusion Energy Computer Center at Lawrence Livermore with the Plasma Physics Lab at Princeton. This is the first of a number of planned linkups that will enhance the U.S. magnetic fusion program.

Roser Nominated As DOE Asst. Sec.

Herman E. Roser, current manager of the Department of Energy's Albuquerque operations office, has been nominated by President Reagan as DOE assistant secretary for defense programs. This department is responsible for the production and development of nuclear weapons as well as the inertial fusion research effort. Currently Roser supervises the work of Sandia and Los Alamos National laboratories.

A native of San Marcial, N.M., Roser joined the Atomic Energy Commission at Los Alamos in 1961. In 1968, he transferred to Washington, D.C., as assistant director of the Division of Military Applications, a position he held until his return to New Mexico in 1972.

AIF Conference Report

Will the U.S. Move Ahead with Fusion?

The future of nuclear fusion as a source of unlimited energy was debated at a nuclear industry conference sponsored by the Atomic Industrial Forum (AIF) in New York May 3-6. What emerged at the meeting is that while the Japanese and Europeans are strongly committed to developing an operational fusion reactor by the 1990s, the U.S. program is jeopardized by the Reagan administration's commitment to pare down the budget.

The world fusion community had optimistically expected a strong U.S. fusion program to lead the world fusion effort after the passage of the McCormack bill, the Magnetic Fusion Energy Engineering Act of 1980, last October, which commits the United States to develop an engineering fusion reactor by 1990 and a commercial prototype reactor by 2000.

Instead, the fight in Congress is to restore the cuts made in the Department of Energy's fusion budget, sliced from the $525 mandated in the legislation to $460 million in the Reagan budget for fiscal year 1982.

DOE Disagreement

At the conference, dissension was evident between those in the DOE who favor an Apollo-style development program and the "cost-benefit" budget cutters who say the R&D emphasis must be on relatively low-technology conventional military weaponry instead of on basic scientific research.

DOE Fusion Director Edwin Kintner expressed the former position, while DOE acting director of the Office of Energy Research, Dr. N. Douglas Pewitt, stated the latter.

Kintner noted that with the budget cuts, fusion progress would be "less dramatic or rapid than we had hoped."

"Fusion is unique," Kintner said. "It is a test of the ability of society and the government to marshal resources for a long-term program that has no military justification."

Summing up the results of the U.S. magnetic fusion program in the past year, Kintner said, "It's difficult to see this kind of progress and conclude that it can't be done."

Pewitt, on the other hand, urged a "go slow" approach. The proposed Center for Fusion Engineering, to be run by industry for the DOE according to the 1980 fusion legislation, "will not be considered until all the information is available or until it is absolutely necessary," he said.

Pewitt's view was challenged by nearly all the speakers at the three-day conference. Dr. Harold K. Forsen, president of Jersey Nuclear Isotopes and Exxon Nuclear, for example, stressed that fusion is a "national commitment. . . . This is a $20 billion program over 20 years." Fusion people should report to someone on the assistant secretary level."

A Chance for World Peace

Former congressman Mike McCormack, the chief sponsor of the 1980 fusion legislation, expressed the hope that the 100 fusion industry and science representatives present would "commit themselves to work enthusiastically for the year 2000 goal of commercial demonstration of fusion, the same as Jack Kennedy did for the goal to reach the Moon."

"Fusion is of paramount concern for our nation's security, stability, increasing economic health, and the security and stability of the world," McCormack told a luncheon session of the conference.

"This is a fundamental chance for world peace. We have a moral obligation to future generations to hold for them their share of the world's precious hydrocarbons."

Fusion, whose fuel, hydrogen, is derived from water, "will bring us abundant supplies of energy, of water, of minerals not now worth developing. It is not responsible to wait," he said, to implement the fusion bill. "We are in critical danger of

Continued on page 61

Hirsch Fusion Panel Reconvened

The House Subcommittee on Energy Research and Production is reconvening the scientific panel commissioned in 1979 by former congressman Mike McCormack to help Congress plan a more aggressive magnetic fusion program.

Rep. Marilyn Bouquard, the Tennessee Democrat who replaced McCormack as chairman of the subcommittee, has reconvened the advisory group to help ensure that the accelerated fusion development program mandated by the 1980 fusion law is not derailed by the administration's budget cutting. Of particular concern to the subcommittee is to keep the fusion program on the timetable specified in the law for designing and building the Fusion Engineering Device (FED) by 1990.

The fusion legislation mandates a $525 million fusion budget, which is adequate to begin the engineering phase, but the Reagan administration has cut this budget to $460 million.

The panel, named after its head, Dr. Robert Hirsch, a former director of the U.S. magnetic fusion program, includes 12 of the the nation's leading scientists and industry representatives in fusion. Its expert opinions were used in drafting the McCormack fusion bill, which was passed by Congress and signed into law Oct. 7, 1980, as the Magnetic Fusion Energy Engineering Act of 1980.

The 1980 law clearly states that the policy of the United States is to "achieve at the earliest practicable time, but not later than the year 1990, operation of a magnetic fusion engineering device based on the best available confinement concept."

In order to perform the necessary design and technology development work for this Fusion Engineering Device, the law says that the secretary of energy "shall develop a plan for the creation of a national magnetic fusion engineering center for the purpose of accelerating fusion technology development via the concentration and coordination of major magnetic fusion engineering devices and associated activities at such a national center."

The law then states that "no later than July 1, 1981," the secretary of energy shall submit a report to the House Committee on Science and Technology and to the Senate Committee on Energy and Natural Resources "characterizing the plan and setting forth the steps necessary for implementation of the plan" for the Center for Fusion Engineering (CFE).

'Helping' the DOE

There is not a clear agreement in the Department of Energy (DOE) itself, however, on the detailed steps that must be taken to meet the law's timetable. Although the DOE Office of Fusion Energy is ready to begin serious design and technology work on the center, Acting Director Dr. N. Douglas Pewitt of the Office of Energy Research, which oversees the fusion program, is not.

Speaking at a forum on fusion sponsored by the Atomic Industrial Forum in early May, Pewitt stated that the July 1 report to Congress "would not be very long" and that a decision on where and how to organize the new CFE should not be made "until all the information is available or until it is absolutely necessary."

Bouquard and many other committee members feel that Pewitt's attitude or plans do not comply with the spirit, nor the letter, of the fusion law. They are thus reconvening the Hirsch panel to consider ideas from the industrial community, which should manage the CFE, on how the work should proceed. Questions yet to be answered include the kind of industrial management the CFE should have, its relationship to the existing fusion facilities at the national laboratories, and the content and deadlines for the design work.

House Reaffirms Support for Fusion

Final action on the fusion budget for fiscal year 1982 was taken by the full House Science and Technology Committee May 14, when the committee added on $5 million to the Reagan administration budget request of $460 million. Rep. Marilyn Bouquard (D-Tenn.), chairman of the committee's subcommittee on Energy Research and Production, had tried unsuccessfully to increase the magnetic fusion budget to nearly $475 million, which is still $50 million less than the figure mandated in the 1980 fusion legislation.

In its authorization report on the fiscal year 1982 Department of Energy budget, the committee states that it "reaffirms its commitment that the Center for Fusion Engineering be established during FY82" and directs that the DOE give highest priority to initiating work on the Fusion Engineering Device or FED.

During the first quarter of fiscal

Continued on page 61

Rep. Marilyn Bouquard (D-Tenn.), chairman of the House Subcommittee on Energy Research and Production, led the fight to increase the magnetic fusion budget.

The World Needs 10 Billion People

A Scientific Refutation Of Global 2000

by Dr. Steven Bardwell

The infamous Global 2000 Report *concludes that there are too many people, not because there are too many people but because its authors have chosen a policy of continued underdevelopment in science and technology. In fact, the population requirements for a fusion-based economy show that the world is largely underpopulated today and will remain so for decades.*

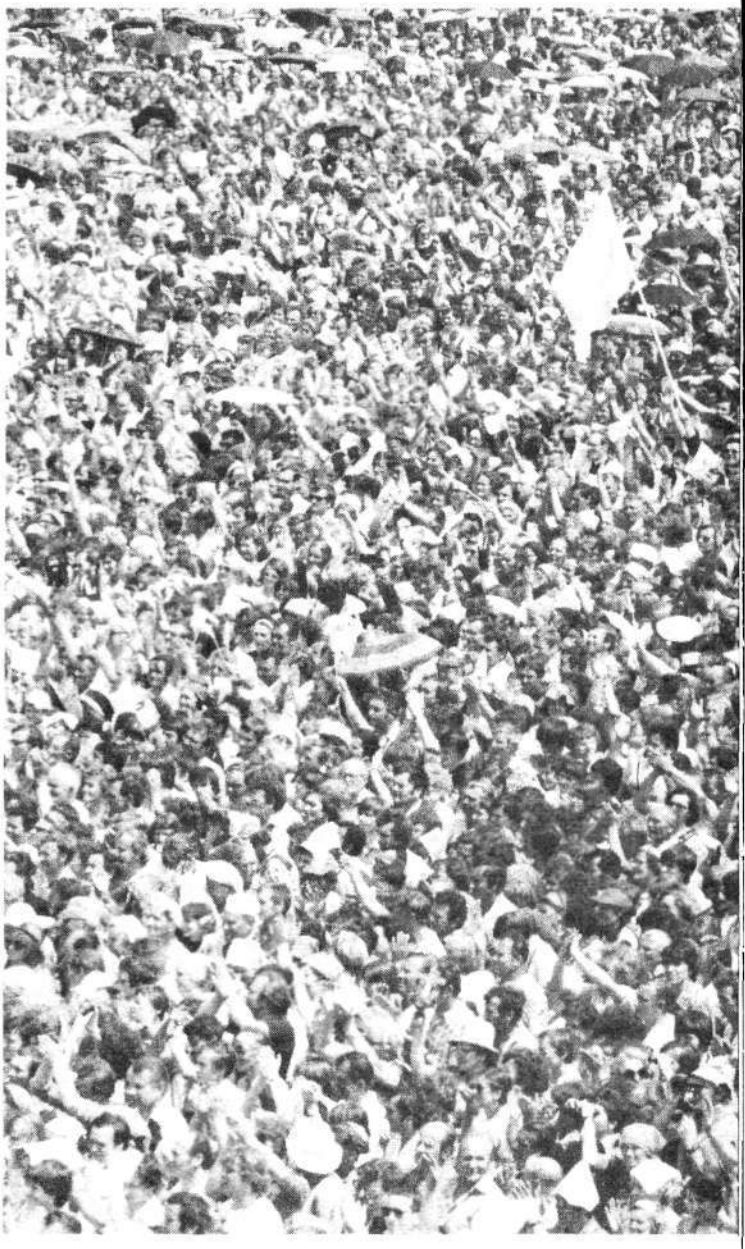
There are too many people in the world who believe that there are too many people in the world. It is not just the rabidly antigrowth minority, the Negative Population Growth organization, or their Malthusian cothinkers who subscribe to this view. Many well-meaning Americans who support nuclear energy, an aggressive space program, and industrial growth sincerely believe that parts of the world are overpopulated and that population control is an essential part of world development.

In fact, the world—especially the poorest parts of Africa—is underpopulated! The world needs more people if it is to successfully make the transition to a fusion economy.

Of course, the solar-powered rural paradise proposed by the soft-technology advocates does not require more people; if that is man's future, the world is severely overpopulated today. But, a nuclear-powered, high-technology human civilization that is capable of colonizing the solar system cannot function with fewer than 10 billion of us.

The unspoken premise of the population debate is one of development and technology policy. If you believe that growth and technological innovation are dangerous, the inevitable consequence is that there are too many people. On the other hand, if you know that mankind has an unlimited future, a future accessible through the creative development of new technologies, then, whether you know it or not now, there are not enough people to accomplish this dream.

This policy question is usually hidden by the zero population growth advocates, who have managed to hornswaggle even progrowth Americans with scare stories of finite resources and starving hordes in the Third World. The latest and most talked-about attempt to justify population control, *The Global 2000 Report to the President,*[1] however, is more blunt. Commissioned by President Car-



ter and compiled by the Council on Environmental Quality and the U.S. State Department, the *Global 2000* authors show that their political decision to restrict investment in technology development and industry is the sole cause of the overpopulation they predict.

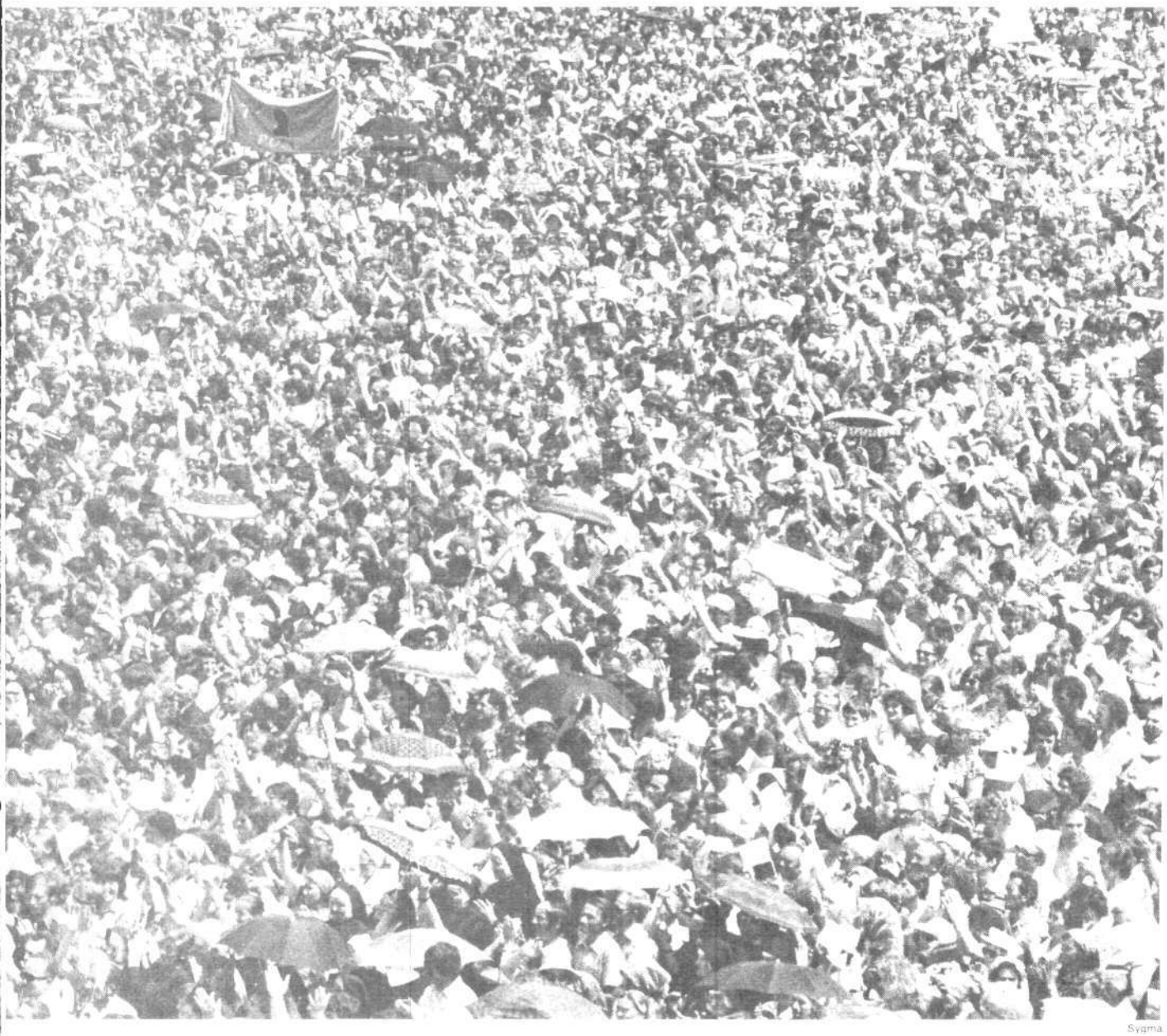
In other words, the authors of the *Global 2000 Report* chose population control as the option for our future. They chose population control because they chose not to develop new technology.

No one should be fooled by the rhetoric of the widely quoted 40-page summary of the *Global 2000 Report* and its forecast of 170 million deaths in the Third World. This is not the inevitable consequence of scarcity, but a deliberate, criminal policy chosen by U.S. government officials who know that the problems of world development are solvable but have chosen not to solve these problems.

The *Global 2000* authors have dropped any pretense of science in looking at man's history and future. Instead, they have approached the problem as though the Earth were an animal preserve and they were the park rangers keeping the preserve's population down to the size they desire—a strategic conception taken from one of the leading advocates of population control, Gen. William Draper, Jr. (see box).[2]

In this sense, the *Global 2000 Report* is methodologically different in a fundamental way from previous tracts expounding the same Malthusian worldview, like the Club of Rome study, *The Limits to Growth*.[3] Many such studies have gone to great lengths to convince the population that progress, growth, and technological development were temporary fluctuations in man's history, that the eventual and natural state of mankind is a "steady-state" in equilibrium with nature.

That these studies were fraudulent, shoddily done, and ideologically motivated[4] is a secondary point. Primary is that they attempt to argue from necessity (a false one, to



Syama

decreases in absolute terms by OPEC suppliers.) The primary impact of this policy determination to maintain high oil prices for the less developed sector is an increasingly negative balance of payments.

Once these policies are assumed, however, the *Global 2000 Report* describes in ghoulish detail their economic consequences. For example:

> It was assumed that not all LDCs could experience optimal circumstances simultaneously. . . . Several LDCs are likely to experience negligible per capita economic growth and possible decreases in per capita consumption over the 1985-2000 period. This would be in contrast to recent historic trends, as well as to LDC expectations and might produce severe social and political tensions, which are also not represented in the model [Vol. 2, p. 526].

Table 2, taken from Table 3-5 of the *Global 2000 Report,* shows the conclusions concerning economic growth that follow from these economic and financial policies. Major sections of the world have static or declining consumption levels. The nations of Bangladesh, Pakistan, India, most of central Africa (sub-Sahara and non-OPEC) all will be consuming less per person in 20 years than they do today. Countries that today have a per capita income of less than $200 will be no better off in 20 years than they are today.

Is this catastrophe necessary? Absolutely not, and the authors of the *Global 2000 Report* do not claim that it is. It is simply the result of the financial and growth policies that the *Global 2000* authors deem necessary. Put differently, anyone who proposes, as the authors of *Global 2000* do, that the advanced sector must lower its consumption levels and slow down economic growth is proposing a policy that means stagnation and worse for the less advanced sector. Even the simplistic economic model used by the *Global 2000 Report* shows that slow growth in the more advanced sector means economic death for the less developed sector.

Rates of Technological Change

In many places in the *Global 2000 Report,* the authors note the importance of technology and technological innovation. However, in keeping with the thrust of their policy statements, they systematically exclude fundamental changes in technology. They explicitly rule out, for example, the development and implementation of nuclear fusion (Vol. 1, p. 7), major breakthroughs in agricultural technology (Vol. 2, p. 547, Figure 6-1), and dramatic improvements in industrial technology (Vol. 2, p. 68). These assumptions reflect the policy tendencies in the advanced sector that are cutting back research and development spending, investment in basic science, and advanced education.

It is true that the economic development of the world over the next 20 years can be accomplished even without major technological innovation.[6] Several studies have shown that a carefully structured investment program can take a country as large as India and successfully industrialize it using only off-the-shelf technology. A well-conceived development policy, however, should count on qualitative breakthroughs occurring in technology, although these cannot be quantified in the same sense that the penetration of existing technology can be quantified. In other words, qualitative innovations in technology must be planned on but cannot be planned for. In spite of this difficulty, these studies have given an existence proof for the possibility of industrial development using only the productivity improvements that can be confidently forecast from the spread of existing technologies.

The *Global 2000 Report* rules out even this possibility. In the areas of energy, agriculture, and industrial production, the less developed sector continues to suffer from inadequate and inappropriate technology. The *Global 2000* technology transfer forecast for agriculture shows this policy in its most grim detail. The basic policy dictate the *Global 2000* authors formulate is one of insufficient investment:

> All three alternatives [for agricultural investment] indicate that projecting food balances to the 2000 is a question not of capacity alone but also of private and public cost. The projection results . . . suggest that the world's productive capacity is more than adequate to meet the largest foreseeable increases in demand to the end of the century. However, real food prices are projected to increase even if the price of inputs from outside the agricultural sector remain constant. . . . A number of recent studies conclude the earth's physical resources and expanding technology can sustain a 4-6 percent rate of growth in food production. Realizing even the 2.1 percent growth to 2000 . . . however, will entail higher real costs and increased pressures on the world's resource and environmental balance. . . . The environmental difficulties likely to be associated with the projections outlined above appear to be manageable in theory. Management options within the agricultural sector are wide enough, particularly if supplemented with environmentally sensitive technology, to solve the problems inherent in using a larger proportion of the world's resources in an increasingly intensive manner to produce food [Vol. 2, pp. 96, 100, 101].

In other words, there are no technical or "natural" impediments to increasing food production much faster than population, yet, the policy described by the report provides for a miniscule increase in global food per capita.

In fact, the *Global 2000* authors actually intensify the inequalities and insufficiencies of agricultural production. Table 3, taken from Table 6-15 of the report, shows *Global 2000's "optimistic"* projections for fertilizers, where areas suffering most from underinvestment continue to be preferentially penalized. Central Africa, potentially one of the richest agricultural areas in the world, has investments in fertilizer growing only slightly faster than the world average, and slower than Canada and Australia.

At the end of the period of projection, Central Africa uses only about 4 percent of the fertilizer per hectare that is projected for Japan's intensive production. The authors summarize this situation and its consequences in the second volume:

With regard to improvements in per capita LDC food consumption, even Alternative II's combination of optimistic supply and demand assumptions suggests gains are likely to be small and poorly distributed. Annual gains in per capita consumption for the LDC's as a group average less than 0.5 percent but range as high [sic] as 1 percent and as low as declining per capita consumption. Given Alternative III's pessimistic assumptions, LDC per capita levels do not grow. While increase in the high-growth regions slows somewhat, per capita consumption levels fall below substandard benchmark 1969-71 levels in low-growth South Asia and Central Africa. . . . The effect of production constraints—be they limited agricultural resources, inadequate agricultural infrastructure, outdated technology, institutional constraints, or any combination thereof—are obvious in countries such as Mexico and Egypt. . . . The regions showing the smallest improvements through 2000, however, are those with severe supply *and* demand problems. The typical agricultural economy in both South Asia and much of Sahelian and Central Africa will be hard pressed to produce an additional 5-10 kilograms of grain per capita over the next 10 years; their consumers, however, are also likely to be hard pressed to demand an added 5-10 kilograms [Vol. 2, pp. 90-95].

The result of these policies, according to the report, is astounding: an *18 percent decline in food consumption* in large parts of Africa and Asia. These declines are not global; over the same period food consumption in the United States increases by 30 percent. The declines in consumption affect only those areas of the world already most deficient in food. Furthermore, these devastating results are not because of limits of arrable land, water, fertilizer, or energy; even the authors admit that such environmental considerations are manageable. The starvation is solely a result of the *Global 2000* investment policies.

Infrastructure Development

Infrastructure development—transportation networks, communications, health care delivery, water and sewage systems, and energy delivery—traditionally has been the most expensive, problematic aspect of world development. Infrastructure is especially critical for urbanization, an absolutely necessary demographic shift from rural to urban areas. The long pay-back times inherent in these investments, the indirect nature of the benefits they provide, and their nonexportability have made the rate of infrastructure development torturously slow.

In countries where such investments were made, however, like South Korea, subsequent economic growth has paid back the investment many times over.[7] But South Koreas are possible only where long-term credit is available; a 10 to 20 year maturity on credit for infrastructure development is critical for its success.

The *Global 2000* authors foresee the opposite investment strategy for the less advanced sector. They prescribe policies that will actually lessen the delivered services in these countries:

Table 2
PROJECTED ANNUAL GROWTH RATES OF PER CAPITA GNP, 1985-2000

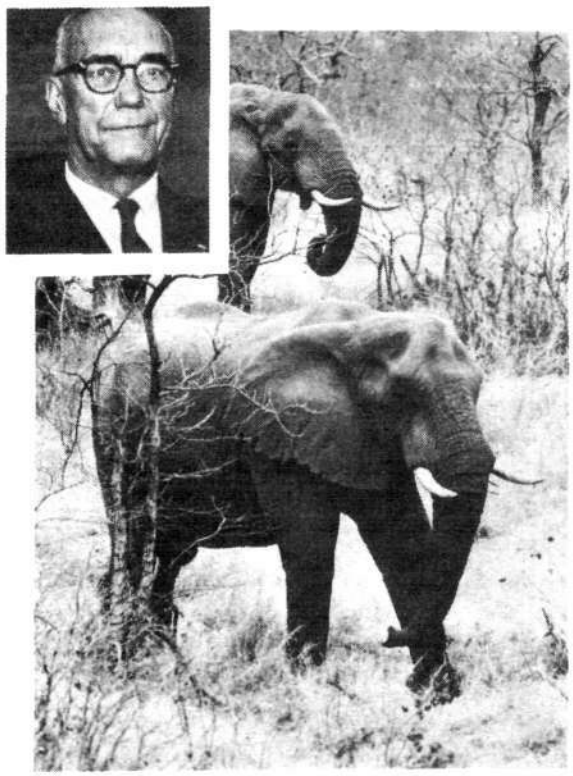
	Average Annual Growth Rate 1985-2000		
	High	Med.	Low
People's Republic of China	3.81	2.30	0.85
India	1.36	0.84	−0.04
Indonesia	4.82	3.07	1.98
Bangladesh	0.69	0.11	−0.45
Pakistan	0.42	−0.09	−0.63
Philippines	3.16	2.27	1.41
Thailand	3.07	2.15	1.29
South Korea	3.44	2.70	1.83
Egypt	3.31	2.22	1.33
Nigeria	3.51	2.15	0.98
Brazil	2.29	1.58	0.72
Mexico	2.52	1.34	0.52
United States	3.42	2.54	1.55
Soviet Union	2.53	2.06	1.59
Japan	3.26	2.49	1.81
Eastern Europe	2.60	2.16	1.73
Western Europe	3.38	2.66	1.97

Source: *Global 2000 Report*, Table 3-5.

Table 3
FERTILIZER CONSUMPTION PER ARABLE HECTARE, ACTUAL AND PROJECTED
(Kilograms per arable hectare)

	1971-75	1985	2000
Industrialized countries	100	145	210
United States	85	135	190
Other major exporters	35	55	100
Western Europe	195	255	355
Japan	355	420	635
Centrally planned countries	70	120	185
Eastern Europe	180	315	440
Soviet Union	55	95	145
People's Republic of China	45	75	150
Less developed countries	20	40	80
Latin America	30	55	125
North Africa Middle East	20	45	95
Other African LDCs*	5	15	25
South Asia	15	35	70
Southeast Asia	15	50	85
East Asia	50	90	170
World	55	90	145

*LDC stands for less developed country.
Source: *Global 2000 Report*, Table 6-15.



"Who will be the Park Ranger for the Human Race?" Gen. William Draper, Jr. (inset), one of the fathers of the U.S. population movement, formed the Population Crisis Committee in 1965. In the background is a view of Kruger National Park in South Africa.

The 'Park Ranger' Strategy

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

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

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

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

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

be sure) that human population and economic growth must be halted.

The *Global 2000 Report* admits that it is possible to introduce investment policies that would provide for population growth—but it chooses instead to institute those policies that will cull the poorest populations from the Earth.

The Policies of Global 2000

A scientific analysis of the world economy shows that the fundamental dynamic of economic change in a system made up of two sectors of vastly different levels of productivity, living standards, and economic scale is determined by investment decisions affecting three areas of economic activity: growth rates in the advanced sector, rates of technological change, and infrastructure development in the less advanced sector:[5]

(1) *Growth rates in the more advanced sector.* The growth rate for the world as a whole is determined primarily by the growth rate of the sector producing *reinvestable profit at the greatest rate. This dominance is* greater, the greater the difference between the sectors. In the world today, the growth rate of the industrialized nations overwhelmingly shapes the potential of the entire world to grow in the next 20 years.

(2) *Rates of technological change.* The rate of technological change enters into the determination of world economic processes in two ways, each with a distinct time scale and effect. In the simpler sense, the spread of existing technologies from the advanced sector to the underdeveloped sector has immediate consequences in the productivity and efficiency of the underdeveloped sector. Indeed, it is the transfer of technology primarily in its already existing form that transforms the less developed sector into a developed sector. Second, and in the longer term more important, is the creation of qualitatively new technologies.

The creation of a new resource base, new energy sources, the colonization and industrialization of space, and the qualitative upgrading of mankind's cognitive abilities all depend on the rate at which qualitatively new technologies are developed and implemented. As we shall see, this second rate of technological change is the primary determinant of the population potential of the Earth at any given time, and it is the only rigorous basis for discussing population size.

(3) *Infrastructure development in the less advanced sector.* The ability of the less advanced sector in this two-sector world economy to develop (increase its productivity, population, and living standards) depends immediately on a large set of investments that appear to be uneconomical. It is characteristic of economic change that the introduction of new technology, be it the spread of existing technologies or the implementation of new technologies, requires a large, initially unproductive investment in "infrastructure."

The introduction of electricity depends on a delivery system (transmission cables, wiring in buildings, maintenance of back-up sources of power, and so forth) that is expensive, redundant from the standpoint of existing power networks, and capital intensive. This same problem

confronts the would-be development strategist for the less advanced sector—huge investments are required for irrigation, public health, energy delivery, and transportation in almost every less advanced country, but these investments will not "pay off" until these countries reach a considerably higher level of economic advancement, a process requiring at least one generation. In the first 20 years, at least, this investment must be made on an interest-free basis (from the standpoint of global economics). It turns out, to be sure, that these projects return many times their initial costs, but from a short-term financial or credit evaluation , they are losses.

The *Global 2000 Report* specifies policies for each of these areas. It does not claim that the policies chosen are unique or necessary; it claims merely that they are the policies to be implemented by the powers that be.

Recognizing the central role played by the assumed growth rates of the advanced sector, the *Global 2000* authors estimated these growth rates knowing that the short-term possibilities for world development rise or fall with these growth rates (Vol. 2, pp. 524-25).

Table 1, which appears as Table 16-3 in the *Global 2000 Report,* dramatically shows the sensitive dependence of the growth rates of the underdeveloped sector on the growth rates projected for the more developed sector (Vol. 2, p. 530). Thus, the projection of advanced sector growth rates chosen by the authors of the *Global 2000 Report* predetermines the overall parameters of world development. What projections did they make? They chose growth rates for the advanced sector lower than the already low growth rates assumed by the World Bank and other such studies:

> In both scenarios, all GNP growth rates were reduced by roughly 20-30 percent for the period 1985-2000 . . . to take into account the future impact of declining population growth rates on GNP growth. . . . It should be noted that the WAES [Workshop on Alternative Energy Strategies, the source of the *Global 2000* GNP statistics] high-growth case corresponds approximately to World Bank midlevel projections for the 1976-1985 period [Vol. 2, pp. 521-2].

The assumption of low rates of growth in the more advanced sector is combined in the *Global 2000 Report* with a set of related policy statements on financial and credit requirements for the less advanced sector:

First, economic development in the less advanced sector is decoupled from the advanced sector: "[In the model] LDC [less developed country] economic growth rates have no impact on the growth rates of the industrialized nations, which, in turn, are not projected to have any impact in the ability of the industrialized nations to invest in the LDCs" (Vol. 2, p. 525).

This policy statement thus prescribes that there is no economic rationale for investment in the less developed sector—it cannot possibly pay for an advanced sector nation to invest in a less developed nation if the successful realization of that investment will have no "impact in the ability of the industrialized nations to invest in the LDCs."

Second, there will be no change in the financing and credit relations between the two sectors. As the *Global 2000 Report* says:

> The model thus implicitly also assumed (1) that the existing economic system and associated financial institutions and facilities are fundamentally sound, . . . These assumptions may seem to imply that the recent demands of the LDCs for a "new economic order" will not be met: SIMLINK [the model used by the Global 2000 Report], however, was not designed to analyze this issue. Such a new economic order would involve major changes in the structure of world industry, a new international division of labor, and a dramatic shift in the relative influence of the Western world on the international economic system [Vol. 2, p. 526].

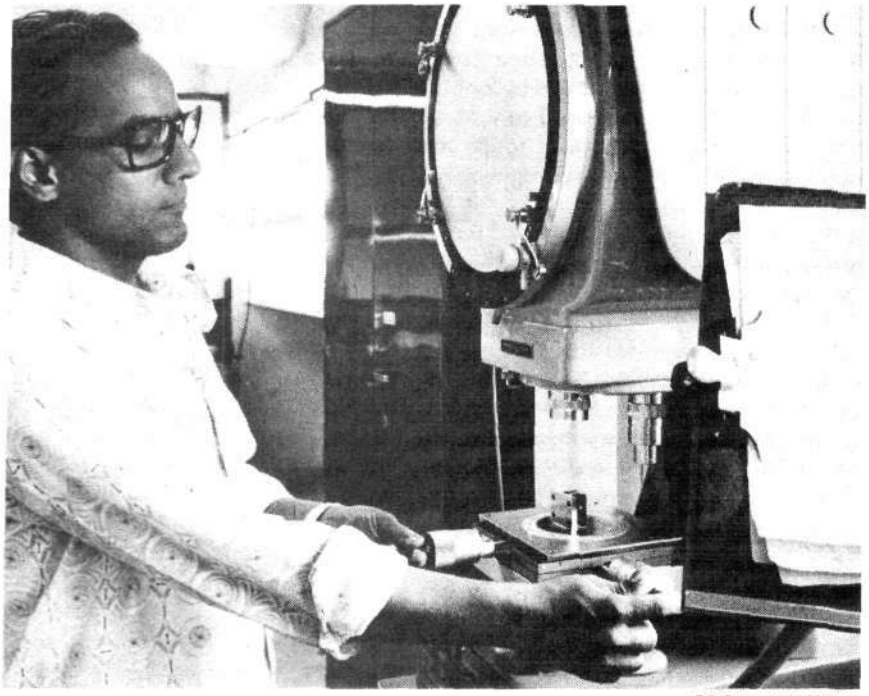
Third, the report projects low prices for raw materials and unprocessed exports from the less developed sector. The *Global 2000* authors consistently assumed that the low growth rates projected in the study would result in stable or even declining prices for the major exports of the less advanced sector (Vol. 2, p. 530). The combination of the more advanced sector's price policy and low import demand policy is, of course, a dramatic drop in the purchasing power of the less advanced sector.

Fourth, the report prescribes high energy prices. Although there is no economic or technical basis for the assumption of rising energy prices, given the demand and consumption pattern assumed by the report's authors, the report assumes a 5 percent annual rise in the price of petroleum. (In fact, recent data show that over the last six months the effect of a significant drop in petroleum exports has resulted in a glut on the world oil market, a steady fall in the oil spot market price, and official price

Table 1
PROJECTED AVERAGE ANNUAL REAL GNP GROWTH FOR THE HIGH, MEDIUM, AND LOW GROWTH CASES, 1977-85
(Percentages)

	High	Med.	Low
Western industrialized countries	4.8	4.1	3.3
Socialist countries	6.0	6.0	6.0
LDC* groups			
India	4.3	3.8	3.4
Other South Asian countries	5.8	5.0	4.0
Low-income Africa	5.3	4.8	4.5
Lower-middle income	7.6	5.6	4.5
Middle income	8.3	6.4	4.8
Upper-middle income	5.8	4.5	3.4

*LDC stands for less developed country.
Source: *Global 2000 Report,* Table 16-3.



T.S. Satyan/United Nations

"If man were primarily a consumer, God would have given him two mouths and only one hand. Instead the producers always outnumber the consumers 2 to 1." Here, an Indian technician at the Institute for Design of Electrical Measuring Instruments in Bombay.

There is reason to question whether the needed improvements in sanitary and environmental conditions will occur. By the year 2000, sanitary conditions in some areas may even deteriorate. This situation [will be] worsened by increasing scarcities of food and energy in poorer regions. . . . The largest impacts on LDC health, however, may occur in the urban areas. Over the last quarter of this century the urban population of the world is projected to increase from 39 percent to almost 50 percent. The largest increases will occur in LDC cities. Mexico City is projected to increase from 10.9 million in 1975 to 31.6 million in 2000, roughly three times the present population of metropolitan New York City. . . . Altogether it is projected that 1.2 billion additional persons—roughly a quarter of the present total world population—will be added to LDC cities, and the most rapid growth will be in uncontrolled settlements where populations are now doubling every 5-7 years. Financial resources are not likely to be available to the poor in uncontrolled settlements or to their city governments, even for providing safe water. Sewage facilities will be limited at best. Fecally related diseases can be expected to increase. The forestry and energy pojections suggest that warm, dry, uncrowded housing will be even less available than now—a condition that will foster the transmission of contagious diseases [Vol. 2, pp. 249, 426].

There is no doubt that if the financial and investment policies projected by the *Global 2000* authors are implemented, these horrendous conditions will prevail in the less advanced sector, ensuring pestilence, disease, and death. Again, the authors make no claim that these results are caused by anything but lack of investment. Population growth, land area, and technology are not determining factors; it is purely a question of policy.

At this point in their argument, the *Global 2000* authors note with some surprise an unexpected consequence of the decay of infrastructure in the less developed sector: Population growth slows dramatically! They remark on this in the summary volume:

> [There is] new data suggesting that fertility rates in some areas have declined a little more rapidly than earlier estimates indicated. The new data indicate that fertility declines have occurred in some places even in the absence of overall socioeconomic progress. Between 1970 and 1976, for example, in the presence of extreme poverty and malnutrition, fertility declines of 10-15 percent occurred in Indonesia and 15-20 percent in the poorest income classes of Brazil. . . . [New data exist showing] that in recent years declines in mortality have not been as great as those anticipated by the United Nations in certain countries, especially LDCs. In most cases, these revisions have been reviewed by the United Nations, and future U.N. projections are expected to reflect the slower progress in mortality reduction encountered in recent years [Vol. 1, p. 12; Vol. 2, p. 513].

Stated in plain language, the authors of the *Global 2000 Report* say that their policy projections mean that people will die younger. They note with clinical interest that the fall in fertility rates is the result of higher infant mortality, lower conception rates, and less frequent intercourse that accompany "extreme poverty and malnutrition." The increase in mortality rates, or shorter life expectancies, results from their projection of insufficient investment in health care. This decline in life expectancies using pessimistic projections of health care is shocking: The lifespan of an average Indian decreases by 6.5 years; of an average Pakistani by 4.2 years; and of an average Mexican by 2 years.[8]

The revisions in the vital statistics of the less developed sector made a significant change in the projected population of the world by 2000. The original estimate of 6.35 billion people was decreased to 6.18 billion. This drop of 170 million people represents 10 percent of the projected population increase between the present and the year 2000 (Vol. 1, p. 12).

In other words, the authors of the *Global 2000 Report* project policies whose *minimum* impact is the unnecessary death of 170 million people. The policy makers know and describe the investments that could be made to save these people, and they explicitly reject them. They do not claim that the food could not be grown, that health care could not be provided, that housing could not be built; they simply reject policies that might provide these necessities. That 170 million people die as a result is an unfortunate by-product, but a necessary consequence, of policy.

Six months after the *Global 2000 Report* was issued, the Council on Environmental Quality published another volume devoted to their policy recommendations for the problems analyzed in the *Global 2000 Report*. Called *Global Future: A Time to Act,* this volume completes the study began by the *Global 2000 Report*.[9] *Global 2000* purports to be an "impact study"; *Global Future* is a set of policy alternatives.

Global Future addresses the basic causes of world problems implicitly making the same assumptions about the world's financial and credit structure as *Global 2000*. Nothing changes in the three determining areas of advanced sector growth rates, technology transfer, or infrastructure development. In fact, *Global Future* explicitly cautions against high growth rates in the advanced sector (it lauds conservation and wise consumption by the greedy and rich more advanced sector); it warns about the dangers of nuclear proliferation, and strongly recommends the "appropriate technology" strategy of technology control; it advocates only the most minimal investments in health care or other infrastructure development.

Global Future instead prescribes population control. There will be too many people by the year 2000. Population growth is outstripping our ability to grow food or provide housing or health care. Mankind is "threatening the balanced environment for all other animals." The solution, the CEQ says, is to stop population growth.

The reader must be absolutely clear on the structure of the argument: Both *Global 2000* and *Global Future* begin by assuming the necessity of the policies of low growth, technology control, and lack of infrastructure—policies they have supported and implemented for at least a decade. Once these policies are taken as given, of course the world faces a population crisis.

Either people are prevented from multiplying too fast by an aggressive program of sterilization, contraception, and abortion, or they will die violently.

The solution proposed by the *Global 2000* authors is population control by any means necessary.

The viciousness of the *Global 2000 Report* was identified by Benjamin Franklin some 200 years ago.[10] Franklin pointed out that population size was entirely dependent on the level of technology. The colonies were fully populated by indigenous hunters when the first Europeans arrived, he said. The Europeans, however, lowered the population density (or, more exactly, raised the population potential) because they brought agricultural technologies with them. This new technology meant that perhaps 1 one-hundredth as much land was then required to support a person in the colonies compared to the previous hunting economy. Franklin argued that the same decrease in effective population density (or increase in population potential) could occur with the development of manufacturing in the colonies.

At that time, the British East India Company and its policy arm, the Parliament and King of Great Britain, were implementing the same policies of low growth and technology control taken for granted by *Global 2000*. As Franklin saw, if the British had enforced these policies in the colonies, they would have been very quickly overpopulated.

Franklin's insight was the basis for an elaboration of the LaRouche-Riemann econometric model on the question of population.[11] The basic fact of demography is that human beings are *not* primarily consumers; they are primarily producers and only secondarily consumers. A human society's mode of production and reproduction determines the particulars of the relation between production and consumption, but mankind in general has the unique ability to create absolute profit or surplus—a real addition to material means of continued human existence.

If this fact were not true, man's progress up to this point

Investment in People

Julian Simon, professor of economics and business administration at the University of Illinois, has devised a useful population model that concentrates on the actual relation between people and production. Writing in *Science* magazine June 27, 1980 he said:

> Additional persons, instead of being a permanent drag, lead to an increase in per worker output starting 30 to 70 years after birth. . . . Babies do not create knowledge and improve productivity while still in their cradles. And though the family bears most of the cost, society must also unpurse to bring the baby to productive adulthood. This means that if you do not look as far ahead as the next 25 years, the knowledge benefits of someone else's baby born today do not interest you, and that baby therefore appears to be a poor social investment for your taxes. But if you feel some interest in, and obligation for, the longer-run future . . . then you will view the knowledge produced by today's children as being of great benefit to you.

In short, economic theory that includes key elements left out of previous models, together with the empirical data, suggests that additional children have positive long-run effects upon the standard of living.

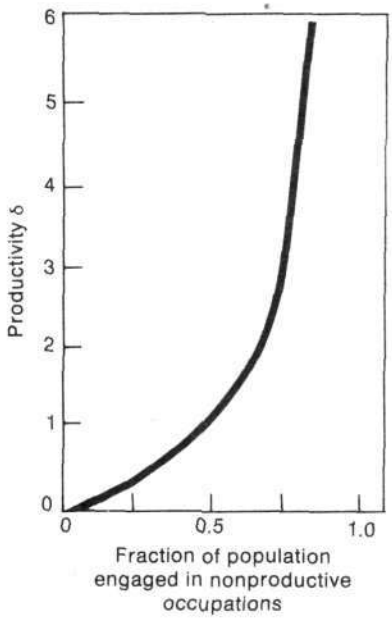


Figure 1
RELATIONSHIP BETWEEN PRODUCTIVITY AND NONPRODUCTIVE POPULATION

The parametric relation between productivity (y axis) and a given nonproductive fraction of the population (x axis) is shown here. At 0 productivity, the productive workforce is able only to reproduce itself, with no net surplus produced. This point is shown on the extreme left end of the curve. As the fraction of the population engaged in nonproductive activities (those who do not produce tangible goods) increases, the productivity of the productive workforce must increase dramatically. On the scale shown here, the productivity of a modern industrial society like the United States is approximately 6. Note that the figure shows the minimum possible productivity required to support a given population, with no production of net surplus; that is, a lower bound on the productivity.

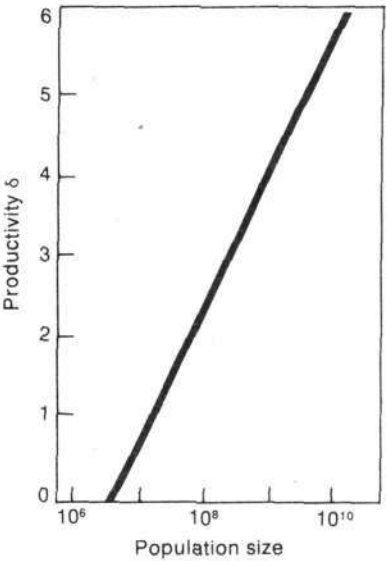


Figure 2
RELATIONSHIP BETWEEN PRODUCTIVITY AND POPULATION SIZE

The causal relation between population size (x axis) and potential productivity (y axis) is shown here. As the size of the population increases, the division of labor increases, along with an increase in the intensity of conceptual ferment and velocity of spread of new ideas. These qualitative changes in the production potential of the population are reflected in increasing productivity. The approximately logarithmic dependence shown here reflects a twofold property of economic systems: More people are required for complex technologies, and those complex technologies can support many more people.

could have occurred only as the result of a depletion of nature, a one time, irreversible process. Similarly, if this fact were not true, man would have overpopulated the earth at the point that the first humanoid ape walked on two feet. If man were really a consumer, the richest countries would be those with the smallest populations. If man were primarily a consumer, God would have given him two mouths and only one hand; instead, the producers always outnumber the consumers 2 to 1.

Man's ability to produce this surplus or profit is quantified in the LaRouche-Riemann model with a measure of productivity, δ, that is defined as the ratio of profit or surplus in the total economy to the total consumption of the productive workforce. (This workforce's tangible production, of course, is part of the surplus.)

The total fund of tangible goods produced by that workforce must provide for four different kinds of consumption; replacement of capital (depreciation) and raw materials used in the production of this output, consumption of the productive workforce, consumption of the so-called nonproductive workforce (the young, the aged, and those who do not directly produce goods), and reinvestment in a change of scale or quality in the economy. The last two categories are both paid out of the *gross profit*, the funds of goods left after the costs of production have been paid.

Given this framework, there is a simple relationship between productivity, δ, and the fraction of the population, designated as θ, that is not engaged in productive activity (productive in the narrow sense of producing tangible goods):[12]

$$\delta > (\theta/1-\theta) \quad (1)$$

This relationship is shown graphically in Figure 1. Most striking is the astronomical increase in productivity re-

quired to support nonproductive fractions of the population in excess of 75 percent. If, for example, we wanted to increase the nonproductive fraction from 75 percent to 85 percent, productivity would have to double!

This algebraic relation reflects economic reality only as a constraint, not as a causal relation between productivity and population. However, we can unravel the causal relations underlying the determination of productivity by using Franklin's insight that productivity depends on absolute population size. Empirically, there is a very definite numerical relationship given by this equation:[13]

$$\delta = 2 \log_{10} P - 12 \qquad (2)$$

This equation describes in a rough way two corollaries of the fundamental fact of demography: First, productivity depends on the level of technology; second, the division of labor required to sustain a level of technology increases as the technology becomes more complex. That is, there is a reflexive relationship between population size and productivity. A certain minimal population is required for a given technology and, conversely, there is a maximum population density sustainable by a given level of technology. For the equation above, a rough average of these two characteristic populations has been used.

Figure 2 actually shows a sequence of technologies more than an algebraic relation between productivity δ and population P. It illustrates a "geometric" (rather than parametric) property of human economic production. The maximum productivity attainable in a purely agricultural mode is approximately 2, and the world population sustainable by that mode of production is less than 100 million. Similarly, a simple industrial economy requires a division of labor that can be provided only by a population of at least 500 million people. For an advanced industrial society, whose highest average productivity is approximately 6, at least 1 billion people are necessary.

The logarithmic dependence of δ on P means that each succeeding leap in technology requires many times more people than the preceding leap. There are several reasons for this: First, man's economic progress continually faces one serious shortage—imaginative new ideas and their translation into economic reality. However, as economists have known for many centuries, each new consumer is also a producer of new ideas. The human body almost always accompanies a human mind that is at least potentially capable of creating new technologies. The more people there are, the greater the number of ideas produced and the greater the speed with which they can be implemented and perfected.

Second, an increasing population and technological level is associated with an increasing proportion of nonproductive people—nonproductive in the sense that they are not directly goods producing. Higher living standards require more service employment, and higher technological levels require a larger proportion of white collar, technical, and scientific labor. None of these people produces tangible goods, although such people and professions are absolutely necessary in more advanced economies.[14] Thus, higher technology raises the productivity of the productive workforce in part out of necessity; to support a more productive work force requires a larger nonproductive population.

Third, economists have long realized the importance of economies of scale and the economies of an increasingly fine division of labor. Such economies of scale and division of labor require more people.

The simple fact is that higher technological levels require a growing population. The qualitative change in an economy produced by technological innovation goes hand-in-hand with population growth.

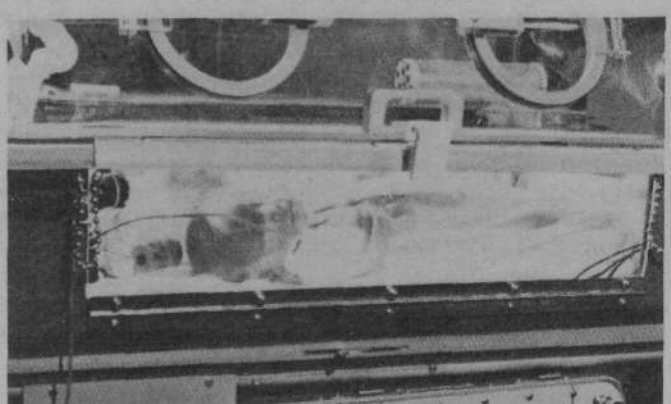
The immediate implication for world development today is that we need more people! The transition to a world economy based on fusion will generate a productive apparatus with a productivity conservatively estimated as 8 on the scale in Figure 2 (using the LaRouche-Riemann model). This productivity and the associated percentage of required scientists and technicians means that we cannot make the transition to fusion successfully without a minimum of approximately 10 billion people. The division of labor required by fusion technology, the number of highly skilled people, and the high living standards required by a population producing at this level are possible only if we have more people.

In fact, the world is underpopulated today compared to the tasks that we face, and the world will still be underpopulated in the year 2000 even if the hideous *Global 2000* policies are stopped. The world needs 10 billion people!

Steven Bardwell, editor-in-chief of Fusion *magazine, has directed the FEF work with the LaRouche-Riemann economic model.*

Notes

1. *The Global 2000 Report to the President: Entering the Twenty-First Century*, Gerald O. Barney, study director, Vols. 1 and 2, Washington, D.C.: Government Publication Office, 1980.
2. In 1965, Draper launched the Population Crisis Committee, which introduced the theory of population control in the United States.
3. The *Limits to Growth* study was commissioned by the Club of Rome and authored by J. Forrester and W. Meadows (New York: Universe Books, 1974).
4. For example, see the Club of Rome annual reports; J. Simon, *The Economics of Population Growth*, Princeton University Press, 1977; or W. Paddock, *Time of Famines*, 1976.
5. See S. Bardwell, *Fusion*, June 1981, p. 25.
6. See, for example, the program for the development of Mexico in *Fusion*, July 1981, p. 24.
7. See S. Bardwell, *Executive Intelligence Review*, Feb. 17, 1981, p. 8.
8. Comparisons of Bureau of Census Special Series P-23, No. 79, "Illustrative Projections of World Populations to the 21st Century," Jan. 1979. Also revisions contained in letter IDDC/MROOF/m-a/5/15/80 from S. Baum of Bureau of Census to L. Corsa, Office of Technology Assessment, May 15, 1980.
9. *Global Future: Time to Act, Report to the President on Global Resources, Environment, and Population*, Washington, D.C.: Government Printing Office, 1981.
10. Benjamin Franklin, "Observations Concerning the Increase of Mankind and the Peopling of Countries," written in Pennsylvania, 1751.
11. S. Bardwell, *Fusion*, June 1981, p. 25. The LaRouche-Riemann economic model was developed by the Fusion Energy Foundation staff in collaboration with the *Executive Intelligence Review*.
12. This equation follows from equating the total consumable production with the total consumers, and assuming an approximately equal level of consumption in both productive and nonproductive parts of the population.
13. Empirical data gathered by the *Fusion* staff.
14. This is of course different from the much-heralded postindustrial society or the sunset-sunrise controversy.



Photographs courtesy of NASA

Few of the millions of Americans who were thrilled by the flight of the Space Shuttle Columbia realize that in building the Shuttle, NASA was also creating new technologies that have a direct life-enhancing impact on the world population.

NASA's Life-Enhancing Spinoffs

by Catherine Caffrey

If the world is to achieve the population density required for establishment of a fusion economy and the sustained colonization of the solar system, the health and longevity of the population must be increased as well. Fortunately, the very process of developing fusion and exploring and colonizing space "spins off" the technologies and equipment to help solve the problems of illness and aging.

Speaking of the payback of the space program to the whole economy, one astronaut said, "People complain about the billions spent on the space program, but they forget that those billions were spent right here on Earth!" Knowledgeable sources estimate a return of some $30 for every $1 invested in NASA. For example, a May 1977 report commissioned by NASA from the Denver Research Institute, titled "NASA Tech Briefs Program: Cost Benefit Evaluation," estimated a return of $11 for every $1 spent by NASA's Technology Transfer Division in publishing *NASA Tech Briefs* to spread the new product ideas and technologies developed in the space program throughout nonaerospace industry. Yet the method used in the study was to do a random survey of "potential users," including industries that have not taken advantage of NASA technology, to arrive at a conservative lower-bound figure.

If we limit our survey to the field of medicine and take into account not only the direct technologies developed by NASA but also the medical technologies built on earlier NASA work, the economic benefits are incalculable—and the benefits to the health of the population are off the scale.

For example, Parker Hannifin of Cleveland, Ohio, an aerospace firm that specialized in building precision miniaturized hydraulic systems for the space program, has now formed a medical products division in Irvine, Calif. to handle their many new products being developed from NASA spinoffs. One of these products, which will have a dramatic effect on the entire field of medicine, is a microdelivery pulsatile pump, called IPIP, for use in "PIMS," a preprogrammable implanted medication system developed by NASA at Johns Hopkins' Applied Physics Laboratory.

This miniature electronic device can deliver precise programmed amounts of medication to the body and is therefore a prime candidate for treating many disorders. Although other implanted devices to deliver insulin to diabetic patients have been developed, NASA's PIMS promises to be vastly superior in terms of applicability to various diseases, flexibility, miniaturization, precision, and reliability. Flexibility, to take one feature, is critical in insulin administration because the intake of sugar and requirements for insulin vary over the day. PIMS can be safely reprogrammed by the patient to meet these daily variations, yet the physician establishes the baseline medication and the upper safe limits. PIMS also has a unique fail-safe redundancy override to prevent accidental overdosing through patient error or instrument failure.

PIMS can deliver programmed quantities of any medication a patient must take regularly, from insulin for diabetic patients; chemotherapy for cancer patients—which could be delivered precisely at the tumor, minimizing side effects to the rest of the body—to the vast array of medications now taken orally by patients with asthma, heart disorders, hypertension, brain disorders such as epilepsy, and other chronic diseases. In the case of children and very old people, who cannot be trusted to take their medication regularly, PIMS will minimize labor-intensive medication administration.

Parker Hannifin's role in developing PIMS came from its work in NASA's Viking search for life on Mars, where a method for measuring liquid volumes at the level of less than one-half millionth of a liter (0.1 drop) had to be developed. Now this same precision is being applied to the medical field. Precision is extremely important for implant technology because a long-term supply of a medication must be put into the implant and dispensed in very small, highly concentrated doses. In addition, slightly more of a medication may be toxic while slightly less may not work.

Technology Transfer

NASA's Technology Transfer Division was set up to fulfill the congressional mandate of the National Aeronautics and Space Act of 1958, which directed that NASA pursue "the potential benefits to be gained from . . . the utilization of aeronautical and space activities for peaceful and scientific purposes." As Donald Vargo, manager of rehabilitation and physical sciences in the division, noted in an interview, "When the space program was created, it was the first time in history that people realized in advance the useful benefits from technology for all of society. Although wars had tended to have this same effect on the economy—for example, analog computers were developed from the World War II need to aim guns—this is the first time technology was recognized as a resource and a conscious effort was made to plan for the assimilation of new technologies into the economy. . . . When technology moves, everything else moves with it."

The concept of "spinoff" is the idea that once a technology has been developed, for example, in the space program, it can be transferred to uses different and often remote from the original application. In 1978, Louis Mogavero, then director of NASA's Office of Technology Utilization, reviewed the success of the technology transfer program since 1958:

> In the past 20 years, there has been exceptional acceleration of technology transfer, due in great measure to NASA's aerospace research programs. To meet the goals of space exploration and aeronautical advancement, NASA and its contractors have of necessity developed innovations in virtually every field of science and technology. This storehouse of knowledge provides an extremely broad technical foundation for the stimulation of secondary applications.
>
> The range of spinoffs that have resulted from reuse of aerospace technology is extraordinary; in fact, it is difficult to find a facet of everyday life wherein spinoff has not penetrated. . . .
>
> NASA provides the catalyst with its Technology Utilization Program, a dedicated effort which seeks new opportunities to reapply the wealth of knowledge in the national technology bank and to gain thereby a bonus return on the tax-paid investment in aerospace research and development.

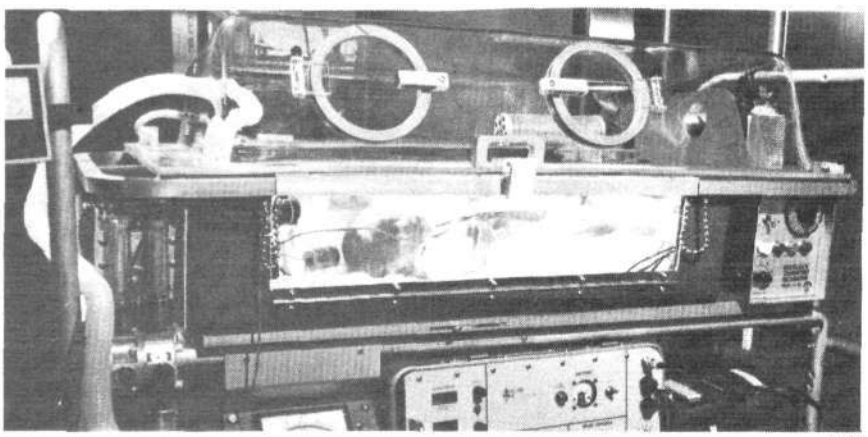
Robert Frosch, who recently retired as administrator of NASA, confirmed this view of the success of the Technology Transfer Program, saying that "Among other areas of benefit, NASA's space science program has provided a wealth of new scientific knowledge, immensely valuable in its own right and additionally important because it serves as a base for tomorrow's practical applications."

According to Floyd I. Roberson, the current director of the Technology Transfer Division (formerly the Technology Utilization Division), there are three ways in which technology transfer from NASA to U.S. industry and the public is accomplished. Brief descriptions of innovations and new technologies that have been developed by NASA are published quarterly in their *NASA Tech Briefs*, which is provided as a free service to engineers and other interested persons.[1] If a product or technology seems to fill the needs of the reader, he can request the more detailed material provided in a Technical Support Package for the particular product or process.

In addition, NASA maintains a network of centers around the country to disseminate information through an interactive computer system, which has access to some 10 million documents of technical data. The nine dissemination centers, located at universities throughout the country, are supported by 33 percent NASA funding, 15 percent matching funds from the universities, and 52 percent fees from industrial and other users.

Finally, NASA works directly as a broker on specific problems brought to its attention in the areas of health care and public safety and welfare. Generally, the problem is brought to the attention of the Technology Transfer Division by a federal, state, or city agency, or some other party interested in public welfare, such as a university hospital.

For example, when the NASA project to develop a nuclear-powered airplane was dropped in the early 1970s, the cyclotron at Lewis Research Center in Cleveland, Ohio, used to test the strength of materials under neutron bombardment, was no longer needed. Dr. James Blue approached other NASA officials with the idea of using the cyclotron for neutron bombardment of cancer tumors. As a result, Cleveland Clinic Hospital Foundation, with National Cancer Institute help, now operates the cyclotron to treat cancer tumors, one of only four such facilities in the country.



NASA

This incubator, specially designed to remotely monitor the vital data of premature and critically ill infants while they are being transported to a specialized medical center, is a spinoff from monitoring astronauts in space.

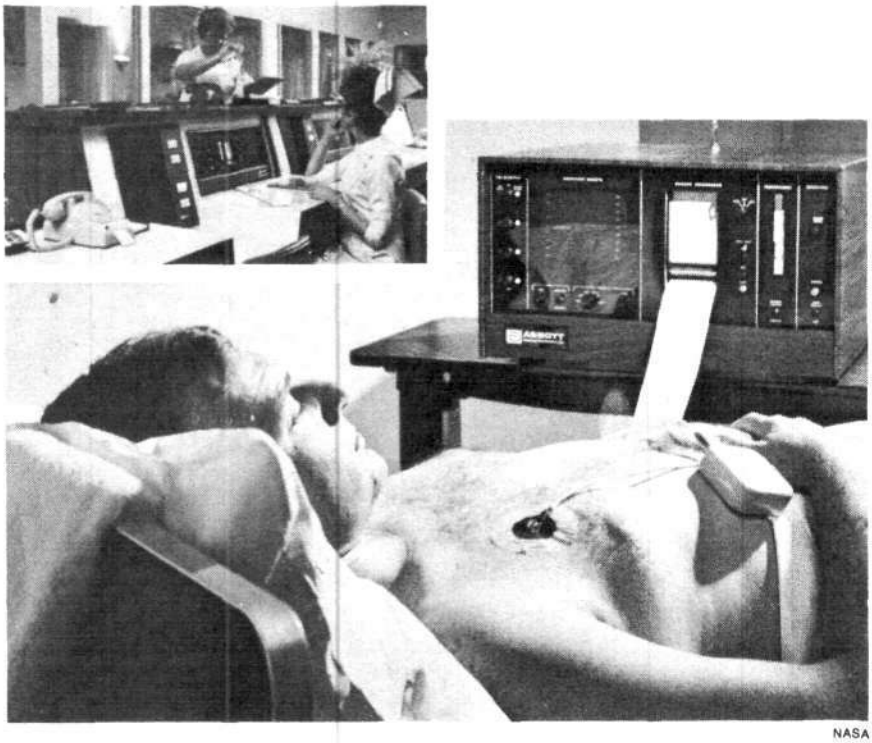
Once a problem has been identified, a market assessment is done to make sure the NASA project will not compete with some other process being developed by industry. Then a statement of the problem is circulated throughout NASA for ideas, until someone says, "Yes, I'm working on something that might work in this area."

NASA then conducts a preliminary analysis to test the project's technical feasibility and advertises for industries to form a joint venture in developing the new product or process. Companies are selected on the basis of management organization, technical competence, and experience. In effect, NASA acts as the broker, bringing together the federal or public agency with the problem, the NASA engineering, and the industrial development facilities, with as little investment of NASA funds as possible. In this way, the timidity of private industry to risk money on new technologies is minimized by a sharing of the risk.

A good example of how this process works is the case

of the rechargeable pacemaker. In the 1970s, Johns Hopkins University asked NASA to use its technological expertise to help solve the pacemaker's problems. At that point, pacemakers—implanted electrical devices that stimulate or regulate the heartbeat—were bulky, unreliable, and had to be replaced through surgery every two years because of the short lifetime of the nonrechargeable batteries used. The doctors wanted to use rechargeable nickel cadmium batteries, but these would deteriorate rapidly at body temperature.

NASA was then working on the problem of enabling spacecraft to fly very close to the Sun, using nickel cadmium batteries recharged with solar energy. The problem of battery deterioration under high temperatures had to be solved. NASA developed battery separator materials to keep the batteries stable at higher temperatures, plus shielding technologies to protect the batteries from much of the intrusive heat. Thus, NASA solved the problem of battery lifetime—the new batteries last for 20 or more years without surgery, provided shielding materials for the pacemaker, and miniaturized the entire package.



NASA

The telemetry technology developed for the Saturn launch vehicle and the Apollo spacecraft, as well as the communications technology developed for the Shuttle, are the basis for this remote control monitoring system used in intensive care units.

Another aspect of NASA's work enabled it to develop Programalith, an advanced cardiac pacing system, which permits the physician to reprogram the implanted pacer without surgery. Using the experience of sending coded instructions or queries to remote satellites and spaceships, Programalith fine tunes the electrical impulses emitted by the pacer to best suit the changing needs of the patient over time. Six different heart-stimulating functions can be reset, and there is also feedback on how effectively the heart is being paced, with warnings of possible problems and of how much life remains in the battery. Another advantage of the system is its use of shielding and pulse code modulation to avoid interference from electrical noise or microwave ovens—the pacer will accept only properly coded instructions.

The "Speaking" Wheelchair

One interesting wheelchair that has been developed through the NASA Technology Transfer Program is a wheelchair that speaks. A spinoff from a NASA project called the "cockpit voice," this chair can provide a speaking voice for patients who are otherwise mute or who have trouble coordinating their speech, such as cerebral palsy victims. To solve the problem of aircraft pilots falling asleep at the wheel or equipment problems not being noticed immediately, NASA sought to have a system in which a voice would say "Pull up!" if the pilot went off course, for example.

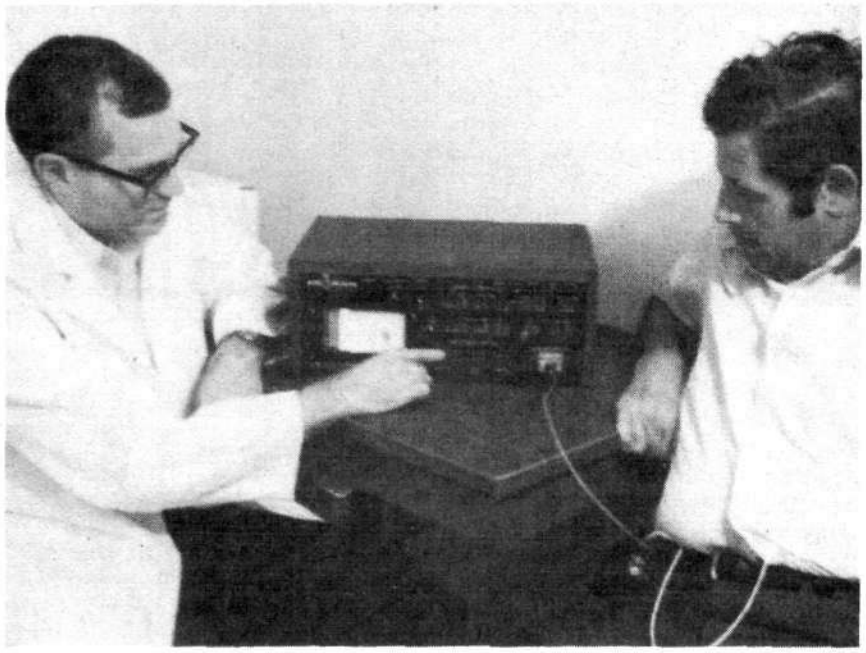
NASA had to solve the problem of inflection—the units of sound that make up a single word or sentence sound different depending on their context—and speed. The system now in use allows the patient to select from a number of preset phrases and sentences, as well as form new sentences using phonemes and algorithms. A patient who can move only one finger can have a simple on-off switch with a small TV camera to display the choices. The same system is adapted to a more mobile patient through use of a typewriter keyboard.

In a similar development, NASA is working on eyeglasses to help deaf patients hear. The glasses contain a miniature computer that flashes symbols on the glasses to help the patient lip-read.

Relief from Pain

Perhaps the most personally devastating health problem for many people is living with constant pain. NASA has a truly remarkable development in this area, a human tissue stimulator. Even the ancient Egyptians realized some connection between electrical activity and pain and used electric eels to shock the patient and temporarily override the electrochemical pain messages coursing through the nervous system. Johns Hopkins University again approached NASA, and NASA decided it was similar to sending electronic commands to spacecraft.

The tissue stimulator developed by NASA is implanted in the patient's skin and emits preprogrammed electrical impulses to override the nervous system and relieve the



NASA

An implantable automatic pulse generator called AID™ that monitors the heart continuously is one of many spinoffs from miniaturized space circuitry. Shown here are the external recorder worn by AID patients and a physician's console to display data stored by the recorder. Opposite are the AID system microcomputer, power source, and two electrodes that sense heart activity. AID recognizes the onset of ventricular fibrillation and then delivers a corrective electrical shock.

pain. Now in the clinical evaluation stage, this new technology by NASA will have a dramatic and immediate effect on the lives of millions with all types of painful chronic diseases, allowing them to live normal lives.

NASA's Unique Role

NASA's Technology Transfer Program is unique in that it is the only program in the country to spread actual technologies. As Leonard Ault, chief of the dissemination and analysis branch, put it, "I'm concerned with process technologies, the problems faced by design engineers and lathe operators. The scientific community has all sorts of vehicles to spread their knowledge, from journals to scientific conferences. NASA serves this role for the technical and engineering community. When you come right down to how do you actually build something to do the job, that's where you really affect productivity. That's how a program like this really makes a fundamental impact on the economy."

Especially in the field of medical science, grants are not usually aimed toward research in hardware, and private industry is often reluctant to take the risk of investing in an unknown technology. The NASA results have been dramatic, and they show the potential for such broad-based research to solve the technical problems encountered in mastering controlled fusion energy, for example, and to produce spinoffs for every area of life.

However, as *Fusion* has reported, Office of Management and Budget Director David Stockman initially proposed to slash the fiscal year 1982 budget of the Technology Transfer Division from $14.6 million to $4.6 million. Although the Senate and House authorization committees have now restored $8 million, to bring the total up to $12.6 million, the importance of fully funding this program for reversing the current economic depression is still not apparent to Congress and the Reagan administration.

An early victim of the Stockman rescission for fiscal year 1981—the budget of the Technology Transfer Division was cut by half, losing $5 million—was a project with the National Science Foundation to develop sensory aids for the blind. Using technology developed for the Rover robot to roam and explore the surface of Mars, NASA was supplying ideas and technical assistance to a NSF grant recipient to use two cameras and a computer to tell a blind person that an object is in front of him. Without NASA, the project would have started from scratch. Now, however, NASA has withdrawn from the project for lack of funding.

The price of cutting back on NASA's Technology Transfer Program will be steep. A look through the *NASA Spinoff Annual Reports* indicates the tremendous sweep of life-enhancing technologies that NASA has already returned to the economy.

Medical Spinoffs

In the field of cardiology, NASA spinoffs have been extremely important. In addition to the pacemaker, they include the implantable heart aid to defibrillate hearts that have developed erratic heartbeats. Death or brain damage results in minutes when an attack occurs, unless the heartbeat can be stimulated to resume normal functioning. The AID device is a spinoff from miniaturized space circuitry and can save thousands from death each year, according to NASA officials. It monitors the heart continuously and delivers a corrective electrical shock at the onset of an attack of ventricular fibrillation. An external recorder worn by the patient provides the physician with a record of attacks, to help him treat the patient.

Also in the area of cardiology, NASA's direct accomplishments include a computerized cardiopulmonary data-acquisition system to control stress tests and display real-time physiological data, a microprocessor-based cardiotachometer to measure heart rate with an accuracy of less than 1 percent error, a cardiology mannequin that simulates 40 heart disease conditions with a high degree of realism for use by medical students, and an automatic

NASA

blood pressure checker for use by patients themselves.

In a related area, it is NASA technology that is keeping patients alive in intensive-care units throughout the country. Patient monitoring uses telemetry to transmit electrocardiograms and other information to a remotely located nurse. This technology is a spinoff of the technology developed for the Saturn launch vehicle and the Apollo spacecraft, as well as the instrumentation technology developed to monitor heartbeat, blood pressure, and sleep patterns of the astronauts. Mass spectrometers developed in the space program to collect and analyze the atmosphere of Mars are now used to measure eight components of a patient's breath and emit a signal when any one falls below a critical level.

Similar technology is used in the field of neonatal care, making it possible to save the lives of babies born prematurely or with serious illnesses. In 1938, for example, the infant survival rate for babies born to diabetic mothers was 54 percent. Now it is 90 to 100 percent. Many of the technologies used are offshoots of NASA's work—for example, the monitoring systems, ultrasonographic measurements, and the radiant warmers to maintain a neutral thermal environment so that the baby's system can maintain stable functions.

In fact, the concept of the "clean room" was developed by NASA in attempting to establish a completely clean and sterile environment for space experiments. This technology has had a tremendous impact on hospital surgery rooms throughout the country, and newer hospitals being built are designed using basic NASA technology with positive air pressure and ultraviolet air cleaning to keep the atmosphere as sanitary as possible.

In a spinoff of importance for both hospitals and patients, NASA has also developed the multi-module AutoMicrobic System to detect and identify disease-producing microorganisms in the human body automatically. Specimens are exposed to microbe nutrients for the nine most common pathogens, and as they incubate an electro-optical scanner monitors each specimen until growth reaches a certain level. The computerized system then enumerates the pathogens and tells the technician not only their types but often the most effective treatment. The total time for identifying the particular disease organism is thus cut by 50 to 80 percent, with a minimizing of error and increase in precision.

NASA is currently considering a project with the National Cancer Institute on heating cancer tumors to stop their growth. The various experiments in this field have suffered from a lack of control over exactly how much heat is actually delivered to the tumor. NASA is involved in designing a machine that would have precise control of the heat and its delivery to the tumor. Only in this way can the possible therapeutic effects of heat treatment of cancer tumors be properly evaluated.

The list could go on, from the infrared scanners and television display screens used to diagnose breast cancer, to the Lixiscope—NASA's handsize portable X-ray camera—to the imaging technology for developing medical X-rays. In fact, if one looks closely at any example of modern medical technology, it is not difficult to trace the connection back, directly or indirectly, to the NASA space program and its Technology Transfer Division.

In testimony before Congress in 1979, Robert Heinlein of science fiction fame testified that after he had a stroke, he investigated and discovered that NASA had saved his life, that all of the technology used in his treatment, from the CAT scanner to the intravenous equipment, had been developed directly or indirectly using NASA technology.

The connections can be traced in the areas of organ transplants, renal dialysis, neonatal care, microsurgery, artificial limbs, and all the various medical equipment making use of computers and telemetry.

Similarly, the entire field of cryogenics (low temperature technology) would not be where it is today if it weren't for NASA. This brings up the important point that it is not enough merely to know, "theoretically," that such and such a thing is scientifically possible. By this argument, lasers should have been invented as soon as Einstein did his work on stimulated light emission in 1916. In the real world, economics is the science of technology; that is, the economic necessity and impetus must be provided before that theoretical knowledge can be translated into process technology. This is the role that NASA has played, in creating a need for development of a technology that might otherwise never have left the ground.

Catherine Caffrey, managing editor of The Young Scientist, *has taught high school science and mathematics and developed curricula for the University of Nebraska Extension Division.*

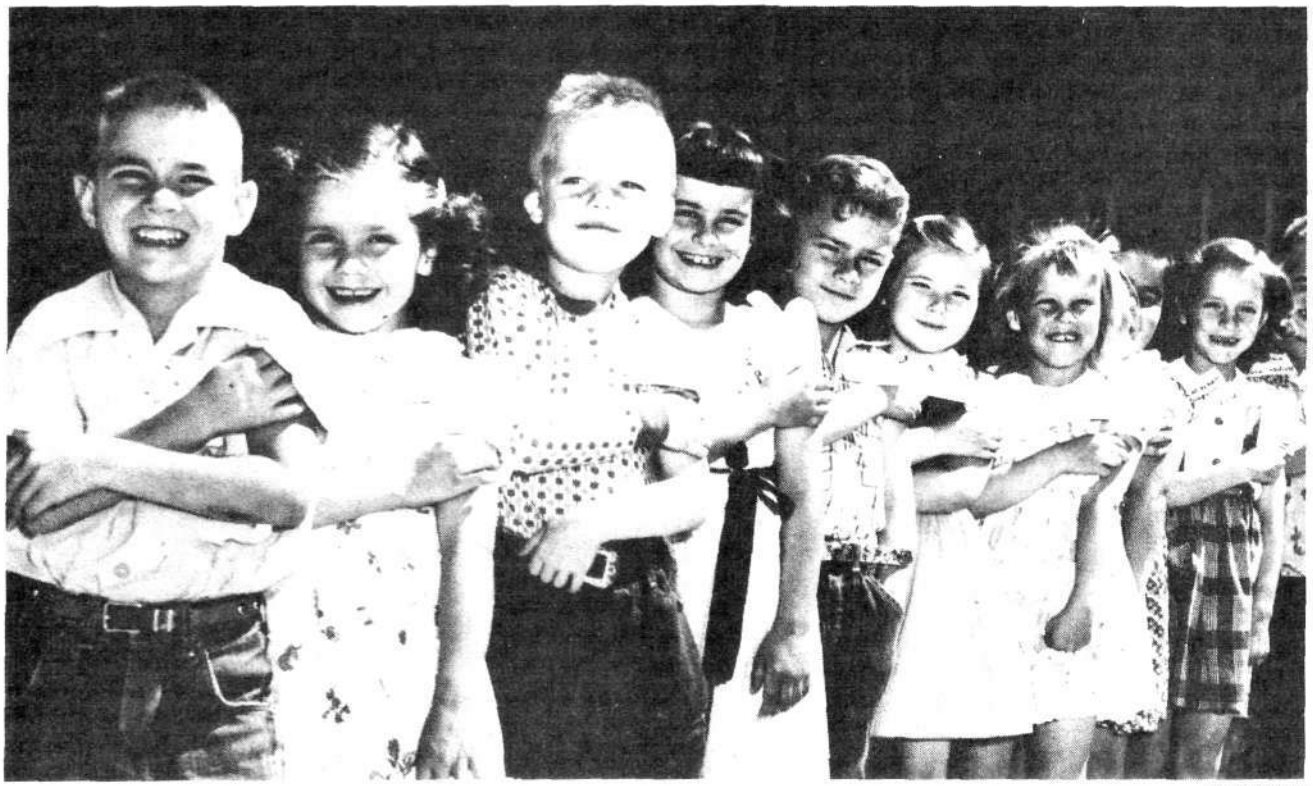
Notes

1. *NASA Tech Briefs* is published quarterly and distributed free to engineers and scientists in industry to encourage commercial application of space technology developed by NASA. *NASA Spinoff Annual Reports* are available free to the public. For information on publications and services available from NASA's Technology Transfer Program, write to the Director, Technology Transfer Division, P.O. Box 8757, Baltimore/Washington International Airport, Md. 21240.

Viral Research And the Conquest of Polio

U.S. Health Depends on Basic Science

by Carol Cleary



March of Dimes

Cutbacks in basic medical research have slowed down the process by which crippling diseases like polio were conquered in the past and by which billions of dollars have been saved every year on disease treatment.

Had funds been awarded according to today's Office of Management and Budget criteria back in the late 1940s in the fight to conquer polio, we might now have the world's best respirator; polio, however, would still be crippling 12,000 to 20,000 children a year.

Fortunately, the U.S. government did not then have the shortsighted, negative view of the benefits of long-term medical research that today's OMB has. Basic research was allowed to thrive, often producing miracle cures to diseases that were not even the main object of the research. The conquest of polio, which came only after some crucial breakthroughs in work on viruses, is just such a case of serendipity in medical science.

In the 1970s, however, Caspar Weinberger, then secretary of the Department of Health, Education, and Welfare, began dismantling the country's biomedical research capability. Weinberger applied the same cost-accounting criteria that Robert McNamara had imported into the

Defense Department from the Harvard Business School—with well-known results in the Vietnam War.

The effect of reducing spending on basic medical research in a period of galloping inflation has been a quieter catastrophe. It is impossible to say exactly what breakthroughs might have occurred had medical research continued at its previous pace, or whose lives would have been saved.

But the fiscal and moral irresponsibility of cutting basic medical research as an unnecessary expenditure is clearly documented by the following statistics. Even a straight cost-benefit analysis of basic and applied biomedical research shows that the benefits of general research—measured in terms of reduced hospital costs, earnings saved, and so forth—exceed the costs by 20-fold. The ratio is 100 to 1 for research on immunology funded by the National Institute of Allergy and Infectious Disease, the institute whose funding awards have been the most thoroughly analyzed.

For research on polio, the ratio was still greater. The attempt to produce a vaccine for polio began at Rockefeller University (then Rockefeller Institute) in 1910, but it was unsuccesful until Drs. Enders, Weller, and Robbins found a means of growing viruses outside the human body, at a cost of approximately $100,000 for this basic research. Subsequently, the full cost of polio research, including vaccine development and field trials, was only $41 million. The savings in hospital costs, medical bills, and lost earnings caused by disability was $6 billion during the first seven years of polio vaccination alone.

But the greatest payoff was the number of lives saved. From the 1920s through 1950s, 1 person out of every 100,000 died of polio each year in the United States. Individual communities lost up to 1 person out of 20 in polio epidemics (Trueta 1956). In many epidemics, at least 10 times as many people were permanently crippled by the polio virus.

The Role of Research

The history of the conquest of polio illustrates an essential point about medical discoveries: Basic medical research—research not directed toward any immediate, applied end—has proved crucial in the conquest of most major medical problems. In the case of polio, a crash program to conquer the disease initially failed because too little was known about viruses; it was only after the basic research had been done on virus growth in vitro—outside the human body—that it was possible to develop an effective vaccine for polio.

The poliomyelitis virus is the smallest pathogen known to kill man—about 10 microns in diameter or one-hundredth of the thickness of a sheet of paper. The viruses are remarkably resistant to a wide range of temperatures, acid-base conditions, and detergents; they even survive drying, particularly in the presence of organic matter. Heat and oxidizing antiseptics are used to disinfect polio-contaminated material that cannot be incinerated. Yet, in spite of their amazing resistance to destruction, the viruses are most exacting in their requirements for multiplication: They reproduce only in certain monkeys and man.

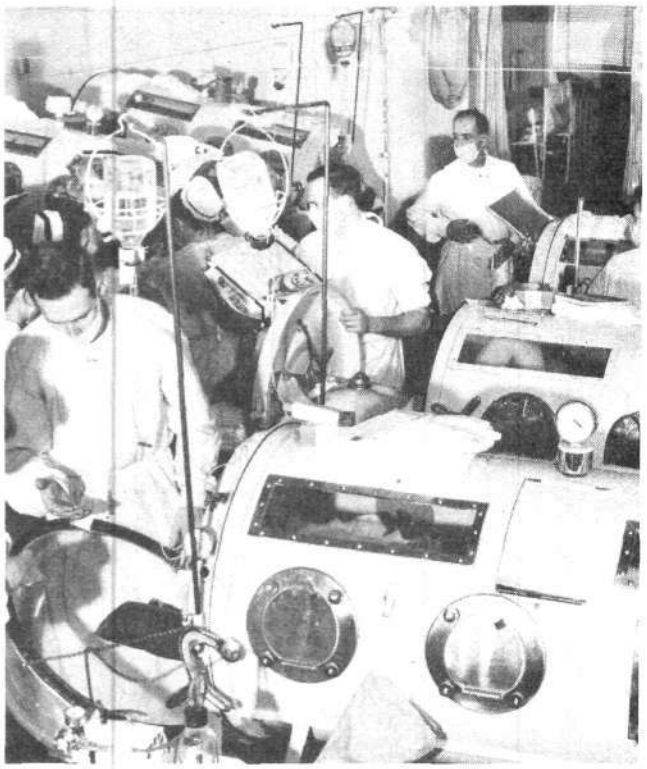
Polio was slowly investigated from the turn of the century, but without success until 1949 when it was shown that viruses could be cultivated in monkey kidneys. But too little was known about the nature of viruses, and polio research in monkeys was so difficult and expensive that no progress occurred until later. Even the crash program of the National Foundation for Infantile Paralysis failed to produce a practical solution to the disease.

A major obstacle to developing a vaccine was the inability to cultivate poliomyelitis viruses in sufficient quantity to study them thoroughly.

Then in 1949, the research team of Drs. John F. Enders and Frederick C. Robbins at Harvard University was successful in cultivating viruses in a laboratory. This work, together with the discovery of the structure of DNA in 1955, opened up an entirely new era in the study of all viruses, including poliomyelitis. This fundamental work on viruses laid the basis for the development of the first polio vaccine just one year later in 1956.

Early Experiments

In 1938 when the National Foundation for Infantile Paralysis was formed, the science of "virology" was barely in its infancy. Previously, poliomyelitis had been treated experimentally as if it were a bacteria, one that could be cultured not in a culture medium like ordinary bacteria but in living monkeys. Early experimentation revealed that if blood serum (blood spun down to remove the cells) from monkeys convalescing from polio, who had devel-



March of Dimes

Investment in basic medical research more than pays for itself over the long run. The research that led to the production of an effective vaccine for polio relegated artificial respirators (iron lungs) like the ones shown above to the annals of medical history.

oped an immunity to the virus, was mixed with polio virus emulsion and injected intracranially into monkeys, the animals did not contract polio. Control animals, on the other hand, injected with a mixture of ordinary monkey serum and polio virus, did contract the disease.

By 1935, vaccine trials were attempted using polio viruses that had been inactivated with Formalin, a solution of formaldehyde with some methanol (Paul 1971). The hope was that the immunity formation demonstrated in the serum experiments on monkeys could be reproduced in man. However, the work prior to 1937 suffered seriously from inadequate numbers of experimental monkeys and imprecise quantization of the amounts of viruses and antibodies used.

As a result of the restrictions on the research effort, several misconceptions about polio became established among researchers: that it was a single type of virus; that it entered the body through the nose; and that it reproduced only within nerve cells (Weaver 1953).

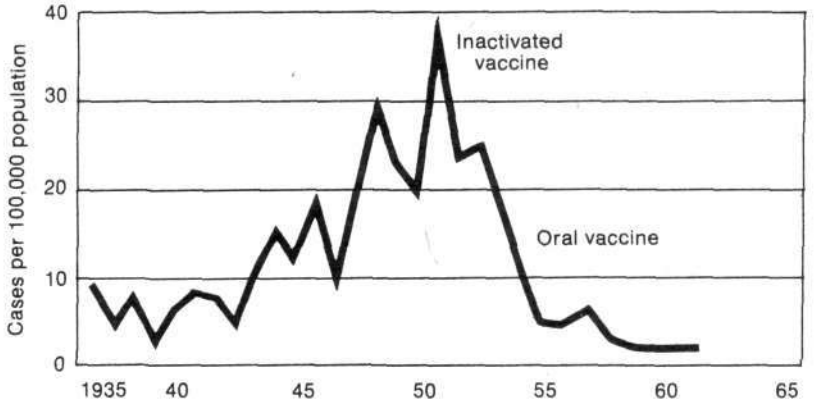
During the first decade of its existence, the National Foundation for Infantile Paralysis established a monkey conditioning center, which housed 3,000 monkeys at a time and delivered 20,000 properly conditioned monkeys to polio researchers annually.

A major cooperative effort among researchers over three years established that polio is actually three separate virus strains: "Brunhilde I," "Lansing II," and "Leon III." This time-consuming effort to isolate the virus strains, necessary to establish a competent epidemological approach to the disease, cost $1.4 million. In the same decade it was established that the digestive tract is the portal entry and exit of the polio virus (Weaver 1953).

Methods of treating polio also improved notably during the 1950s; mortality rates and the extent of paralysis from the disease decreased significantly. Affected individuals were enabled to utilize the motor nerve cells that had escaped paralysis to the fullest extent possible, partially compensating for their destroyed motor nerve cells (Weaver 1953).

Extensive research was done during this decade on the possibility of using injected polio antibodies, or gamma globulin, to prevent paralysis in human beings exposed to polio virus. However, the effectiveness of gamma globulin was less than six weeks, and it had to be obtained from the blood of human beings who had acquired an immunity to the virus. Logistically, the use of gamma globulin for polio prevention was impossible. Some

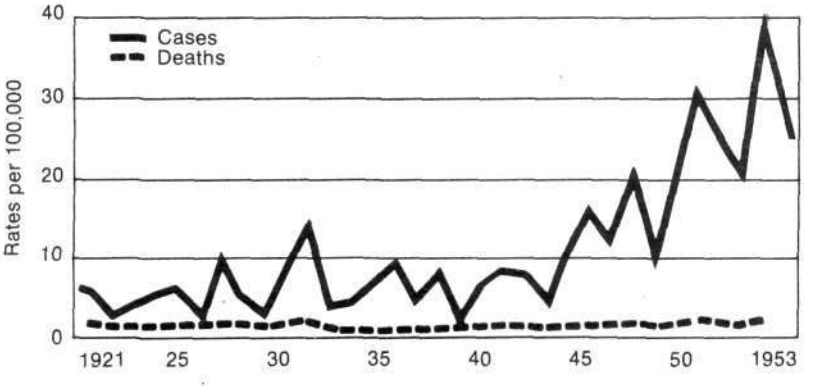
THE IMPACT OF VACCINATION ON POLIOMYELITIS INCIDENCE
United States, 1935-1964



The introduction of a vaccine for polio had a dramatic effect on the annual rate of polio incidence in the United States and disease treatment costs. The total savings in hospital costs, medical bills, and lost earnings caused by disability was $6 billion during the first seven years of polio vaccination alone, compared with a cost of $41 million for the research that produced a polio vaccine.

Source: John R. Paul, *A History of Poliomyelitis*, New Haven, Conn.: Yale University Press, 1971, p. 439.

POLIOMYELITIS CASES AND DEATHS IN THE UNITED STATES
1921-1953



The sharp increase in the incidence of polio after World War II was related to rapid urbanization, in the absence of a vaccine for the disease. Following the pattern of infectious epidemic diseases, polio was spread by personal contact among people living close together in urban areas.

Source: Joseph Trueta, et al., *Handbook on Poliomyelitis*, Oxford: Blackwell Scientific Publications, 1956, p. 2.

kind of vaccine against the three polio virus strains was needed (Weaver 1953).

Production of an effective vaccine was at the time equally problematic. Since polio viruses would reproduce only in living monkeys and human beings, there was no method sufficiently uniform for producing large quantities of them. In addition, the viruses that could be produced were generally contaminated with small quantities of substances from the monkey nerve tissue they were grown on. When injected into a human being under certain conditions, such impurities could precipitate the destruction of the recipient's brain tissue.

Working on the theory that polio virus would reproduce only in nerve cells, Drs. A. B. Sabin and P. K. Olitsky at the Rockefeller Institute in New York attempted to grow the virus in human embryonic nerve tissue. They chose embryonic tissue because early work in tissue culture had been most successful using the undifferentiated cells of an embryo. By 1936, Sabin and Olitsky had succeeded in their goal. However, monkeys were still required to test whether the viruses had been successfully grown in the tissue culture. And the culture of polio virus in human embryonic nerve tissue excluded the possibility of large-scale commercial production. The possibility of vaccine production was still at zero (Paul 1971).

The crash effort to conquer polio had faltered. No vaccine was imminent. Virtually nothing was known about the chemical and physical configuration of polio virus particles. Further research was blocked by the inability to produce large quantities of polio virus (Weaver 1953).

Breakthroughs in Virology

Fortunately, after World War II the Harvard research team of Drs. John F. Enders, Thomas H. Weller, and Frederick C. Robbins was able to realize its late 1930s ideal of maintaining a tissue culture laboratory for viruses for research and diagnostic purposes. By March 1948, the team had developed a successful technology for cultivating viruses in vitro, using cell tissue culture. They developed rolling culture tubes, changed the nutrient fluid every three to four days, and used penicillin and streptomycin to control bacterial contamination. First mumps virus was cultivated in vitro, then varicella, or chicken pox virus, and the Lansing strain of polio virus in human embryonic skin-muscle tissue. Between 1948 and 1950, the team succeeded in growing all three strains of polio virus in nonneural human tissue cultures both of embryonic and nonembryonic origin. In addition, the researchers noted that polio viruses produce distinct changes in infected cells, which are readily observable under a light microscope. Hence, monkeys were no longer needed to confirm the successful multiplication of polio virus (Paul 1971).

The initial results of the Enders team were first published in *Science* magazine in January 1949. (The team received the Nobel Prize for this and other crucial viral work, including Enders's development of a measles vaccine.) Polio research was totally transformed. Research using tissue culture techniques could be conducted in one quarter of the previous time, without the hazards and expense of dealing with live monkeys. Polio and other viruses could be produced in virtually unlimited quantities, purified and available in accurately quantized amounts, which are necessary for dosage control. The stage was finally set for the development of an effective and safe polio vaccine (Weaver 1953).

Through the early 1950s, a team at the University of Pittsburgh headed by Dr. Jonas Salk led the development and trial use of a killed polio vaccine, using viruses cultivated in monkey kidney tissue. Convalescent polio patients who had developed antibodies to the virus were utilized in the first clinical trials to minimize risks. The killed vaccine was safer for initial development, but it required repeated injections to establish full immunity. Its widespread use, beginning in 1956, was later superseded by the development of the live oral vaccine of Dr. A. B. Sabin. The oral vaccine, first used on a large scale in 1962, took longer to develop, since it involved a search for and development of avirulent variants of each of the three strains of polio virus (Sabin 1955).

Polio had finally been conquered, but only through the added impetus provided by the basic research of the Enders laboratory.

The incidence of polio in the United States dropped dramatically thereafter, as did the cost of treating polio, the amount of wages lost due to disability, and the intangibles—the number of lives lost or shortened by the disease.

In addition, the breakthrough work on culturing viruses that had allowed the development of a polio vaccine was now put to use in developing vaccines for other deadly and expensive diseases—measles, pneumonia, and *hemophilus influenza, meningitis, and other middle ear* infections that can lead to deafness.

Carol Cleary, a Fusion Energy Foundation staff member, holds an AB degree in biochemistry from Bryn Mawr College and did neonatal respiratory research in the department of physiology at the University of Pennsylvania. This article was written from materials prepared by H. Hugh Fudenberg, M.D., chairman of the department of basic and clinical immunology and microbiology at the Medical University of South Carolina. He recently received the Carl Newberg Medal of the New York Academy of Sciences for his outstanding reasearch and his work in training numerous independent researchers.

References

Fudenberg, H. Hugh and Melnick, Vijaya L., eds. 1978. "Informing the Public: Fiscal Returns of Biomedical Research," *Biomedical Scientists and Public Policy.* New York: Plenum.

Paul, John R. 1971. *A History of Poliomyelitis.* New Haven, Conn.: Yale University Press.

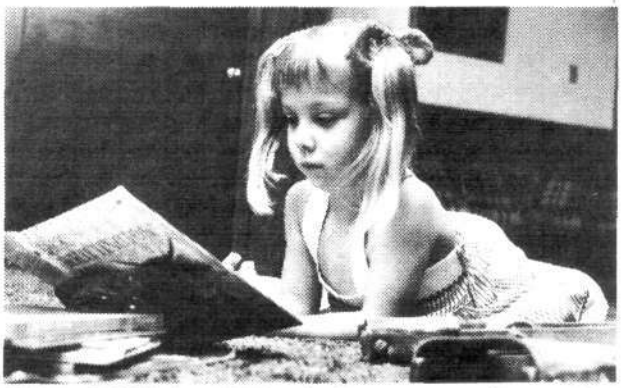
Sabin, A. B. 1955. "Immunity in Poliomyelitis, with Special Reference to Vaccination." *Poliomyelitis.* Geneva: World Health Organization.

Trueta, Joseph, A. B. Kinnier Wilson, Margaret Agerholm. 1956 *Handbook on Poliomyelitis.* Oxford: Blackwell Scientific Publications.

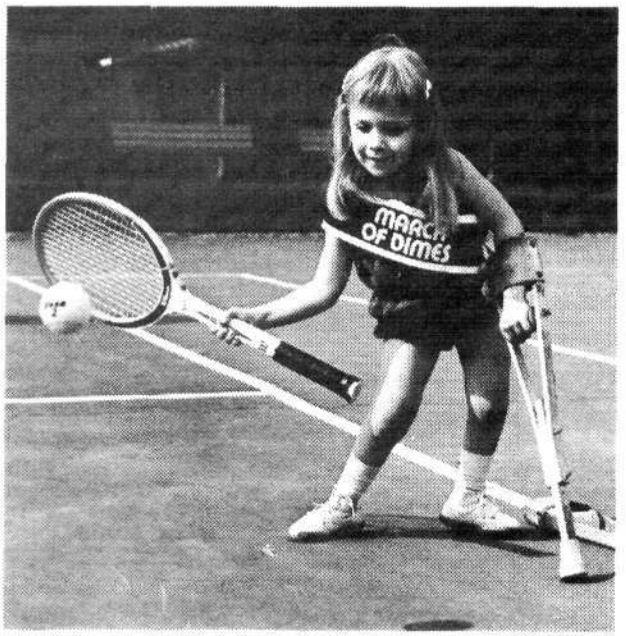
Weaver, Harry M. 1953. "Poliomyelitis Research: Four Eras of Progress." Address to the Board of Trustes of the National Foundation for Infantile Paralysis. New York.

POSTER CHILD-AN ACTIVE LIFE

As 1981 March of Dimes National Poster Child, Missy Jablonski of St. Louis, Mo., represents more than a quarter-million children born every year in the U.S. with birth defects. Missy, 5½, was born with open spine and uses crutches to get around. But she loves to play, exercise, practice ballet and has all the lively curiosity of her age.



READING IS FUN for 1981 March of Dimes National Poster Child Missy Jablonski. After a year of pre-school, Missy, who enters kindergarten this year, already loves school. The 5½ year old from St. Louis, Missouri, represents more than a quarter-million children born each year with birth defects.



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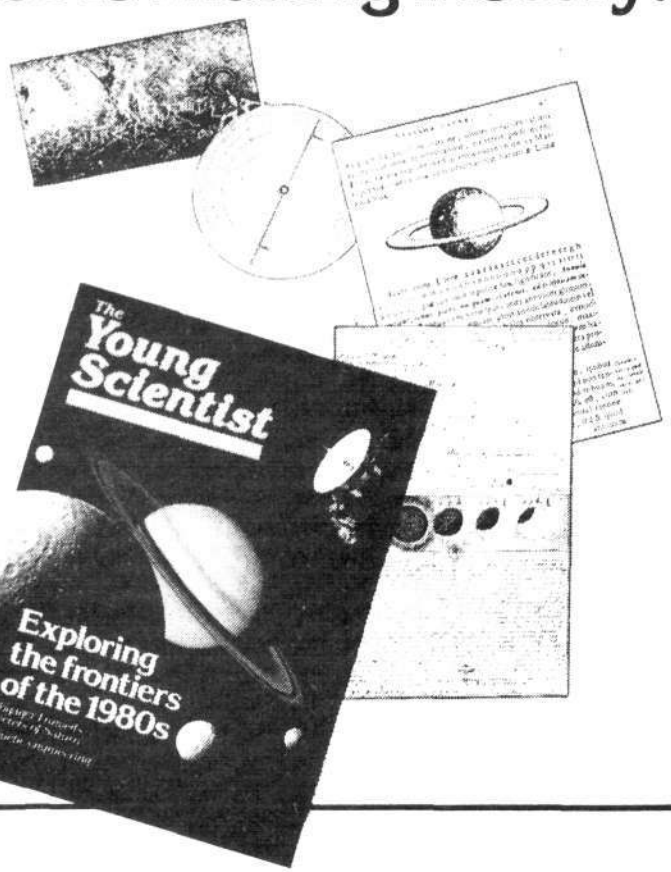


Second Flight Date For Shuttle Moved Up

The Space Shuttle orbiter Columbia performed so well on its maiden flight April 12-14 that NASA announced it is moving up the timetable for the second scheduled launch from Oct. 18 to Sept. 30. NASA officials report that the schedule acceleration was made possible because the damage inflicted on the orbiter during the first flight was so minimal that there was no need for 17 of the tests that had been planned.

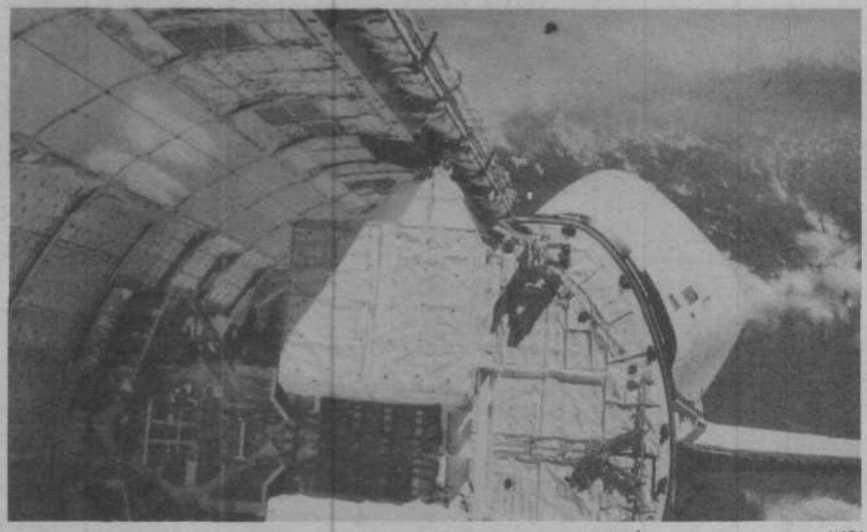
One modification in the postflight procedure has been the decision not to remove one of the three main Shuttle engines from the Columbia to evaluate its performance. Although the removal procedure is relatively simple, it is now thought to be unnecessary, and the engineers will examine the engine while it is still mounted on the orbiter.

The one tile that fell off during the maiden voyage will be replaced, along with 12 others that were clearly damaged. Although NASA had planned to replace about 600 of the 30,000 thermal insulation tiles if necessary, the actual count is about 100, including any that might show signs of wear and tear. It is surmised that much of the tile damage upon launch was caused by frost and debris falling from the insulation of the large external fuel tank attached to Columbia.

The thermal tiles on the three other orbiters under construction are being strengthened and tested, in light of the Columbia experience, and NASA has also budgeted $20 million over the next few years to develop an alternative heat-protection system.

The performance of Columbia's thermal-protection system, however, exceeded all projections. The Columbia arrived at the orbiter processing facility at the Kennedy Space Center in Florida needing only 50 minor repairs. By the end of May, more than 20 of these had been completed.

NASA is anxious to reduce the turnaround time for each orbiter between launches in order to move the Space Shuttle into an operational mode by 1982. This would require operation procedures similar to those of commercial airlines, where checkout and repairs are done routinely. To cut two weeks off this first turnaround, NASA engineers and industry technicians are working on a seven-day, three-shifts-a-day schedule during this vehicle-modification period.



NASA

A photo of the Space Shuttle Columbia's huge cargo bay taken from inside the Shuttle on its maiden voyage last April. In the background, the planet Earth.

When this phase is completed and the vehicle testing begins, leading up to the launch, Kennedy Space Center will go on a six-day, three-shifts-a-day schedule. Kennedy Shuttle Launch Director George Page has described the current schedule as "success-oriented."

—Marsha Freeman

Nuclear Power Could Save U.S. $1.5 Trillion

U.S. consumers would save an estimated $1.5 trillion in energy costs over the next 25 years if the development of nuclear power were reinstated, according to a study by researchers at Virginia Polytechnic Institute. The study, headed by Dr. L. A. Rapoport and titled "Evaluation of Environmental Protection Policy Impacts on National and World Energy Supplies," was presented to the Society of Petroleum Engineers-AIME's Ninth Hydrocarbon Economics and Evaluation Symposium in Dallas, Tex.

The estimates of cost savings are based on the assumption of a continuing de facto moratorium on U.S. nuclear starts and a stagnating capacity at approximately 65 gigawatts through the year 2000, versus a reinstatement to the technically attainable level of 390 gigawatts by the year 2000.

Even this modest 390 gigawatts compares unfavorably with the 1,000 gigawatts projected for the year 2000 by U.S. national policy in 1973.

The Rapoport study calculates that removal of environmental constraints on nuclear, coal, and synthetic fuels could result in a combined potential savings of "about one third of the total cost of energy for the 1978-2002 period under study, expressed in constant 1978 dollars."

Inside Energy

Westinghouse Predicts Electricity Shortfall

Westinghouse Electric Company estimates that electricity demand will grow three times faster than demand for other forms of energy but notes with alarm that, because of inflation, the high interest rates of Volcker's Federal Reserve System, and regulatory problems, the electric utilities nationwide have postponed or canceled capacity growth. By 1983, Westinghouse predicts, utilities will realize that their current growth expansion will be insufficient to carry them into the 1990s.

The Westinghouse assessment corresponds with a recent study from the Electric Power Research Institute, which projects a possible electric generating capacity shortfall ranging from 170 to 485 gigawatts-electric. This range depends on anticipation of a GNP growth rate between 1.0 percent and 3.3 percent to the year 2000.

New Mexico Rolls Back Uranium Tax

New Mexico Governor Bruce King, who ordinarily opposes tax reduction, has signed into a law a bill to roll back the severance tax on uranium sold in New Mexico. The measure is an indication of the severely depressed state of the uranium industry in New Mexico, which in 1978 produced almost 50 percent of all domestic uranium.

A number of large uranium mining operations have closed in the state as well as in Colorado as a result of the successful environmentalist onslaught on the nuclear industry and on the mining itself. The low number of nuclear plant starts and the large number of plant closings have caused utilities to stockpile uranium fuel, plunging the price of uranium to below actual production costs for many mines.

Under the new law, effective for three years, New Mexico will assess its severance tax on only 60 percent of the sale value of the uranium.

The Nasty Politics Of Electricity Demand Forecasts

by William Engdahl

A recent advisory report to Congress issued by the U.S. General Accounting Office reveals the shocking fact that our nation's electric utilities have canceled 184 electricity generating plants—80 nuclear and 84 coal-fired among them—from 1974 to 1978. And since that time, 15 additional nuclear reactors have been canceled. In fact, not one new nuclear reactor has been ordered by any U.S. utility since 1978.

The primary reason the utilities cite for the cancellations is the precipitous drop in projected electricity demand to the end of the century. Yet, the incompetence of these demand projections is staggering, as I shall show.

Among the spate of recent U.S. energy forecasts, there is an identifiable cluster appropriately dubbed the "conservation mafia," one of the unfortunate by-products of unregulated government and foundation grants to antigrowth researchers in recent years. This group's studies include the National Audubon Society's *National Energy Plan*,[1] a mammoth unpublished study done by the Solar Energy Research Institute,[2] the Carnegie-Mellon Energy Productivity Center's *Least Cost Energy Strategy Revisited*,[3] and *Our Energy: Regaining Control* by Marc Ross and Robert Williams.[4]

All advocate what's called "low-energy growth path" studies. In the the case of Ross and Williams and in the SERI study, which Williams coauthored on the request of former deputy energy secretary John Sawhill, the studies are actually "negative energy growth paths."

Audubon: For the Birds

According to the Department of Energy, total domestic energy consumption in 1980 was 80 quads (1 quad or quadrillion Btu's is roughly equivalent to the energy of 500,000 barrels of oil/day/year, or the output of three 1,000-MW nuclear plants). Now it doesn't take much to recall that 1980 was a year of economic stagnation and recession. Yet the Audubon report promises the nation that in the year 2000, we can "produce the goods and services of a traditional 122 quad economy with an expenditure of only 80 quads."

In addition to proposing that the world's most advanced energy-intensive industrial nation stand still at an energy steady-state for 20 years, Audubon Society suggests that we invest some $700 billions into various forms of energy conservation in order to stay where we are.

Audubon's Russell Peterson, the former governor of Delaware who headed the Council on Environmental Quality under President Nixon, proudly advocates such sustained stagnation, along with phasing out nuclear generation and reverting to ecologically damaging and energy inefficient wood-burning and windmills. These 16th-century technologies will give us 25 percent of that 80 quads by 2000, Audubon says—while stripping the national forests and dressing up the land by dropping about 50,000 windmills across the Western Plains states.

Such a gross shift of our advanced industrial economy into this lower or "least cost" [sic] mode, we are told, can be relatively painless "without significant lifestyle change. . . . It is by no means clear that rapid and drastic changes in lifestyle are inevitable if solar energy is allowed to develop to its full potential and population growth is controlled."

What the Audubon's social engineers, masquerading as "energy ex-

perts," do not emphasize is that they are planning for an almost totally hermetic or autarchic U.S. economy with few or no export links with the rest of the world. The last major industrial economy to try a sustained hermetic economy was Germany in 1933. That experiment exploded less than six years later when Panzer Divisions rolled into Poland, France, and Yugoslavia.

Both the SERI and the Ross and Williams projections would send us back deeper into the Dark Ages. Using the bugaboo of U.S. dependence on "vulnerable" energy sources, Ross and Williams call for "negative energy growth" down to a level of 64 quads by 2010, phasing out nuclear generation and cutting oil, gas, and coal to 50 percent of the 1975 level. This they assure us, can happen with only "minor lifestyle changes."

Not surprisingly, the SERI study, which was conducted by the DOE at the request of rabid zero-growther Rep. Richard Ottinger, projects a similar 25 percent energy cut by 2000. The study has been wisely embargoed by the present administration as a waste of taxpayer dollars.

Demand Trap

All this quad estimating could be dismissed as academic babblings—if the situation were not so serious in terms of America's future energy supply. It's not just that the conservation mafia's projections are getting front-page coverage nationwide as somehow authoritative on the energy question.

The real problem is that the more reputable energy groups, and the Department of Energy itself, are projecting lower and lower energy demand for the year 2000.

In 1972, for example, the Atomic Energy Commission projected 160 quads for the year 2000, while the Department of Interior projected 191.9 quads.[5] Two years later, the AEC's successor, the Energy Research and Development Administration, projected only 124 quads by 2000. *This year, in April, the DOE changed its official projection down to 102 quads,* while the Edison Electric Institute, the most optimistic of various private studies, predicts a pathetic 117 quads. (In 1974, EEI predicted 160 quads).

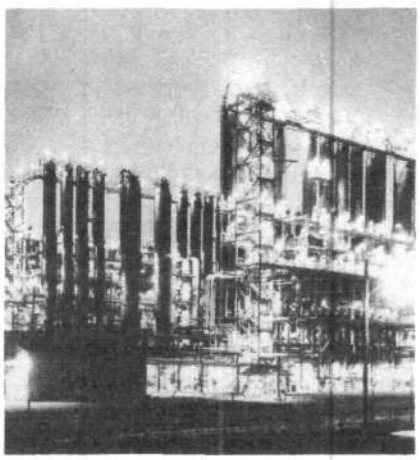
To get a sense of the political fraud involved in what should be a serious determination of need, note that Amory Lovins, the antienergy guru who makes the Audubon projections seem optimistic, back in 1972 projected 125 quads for 2000, while the Sierra Club projected 140.

Political Fraud

The point is that in all these "projections" by partisans at Audubon, SERI, and elsewhere, the numbers are merely data massages of predetermined policy decisions taken at higher political levels. The projections of U.S. energy demand in the year 2000 are going down because political strategists in the top policy-making levels decided a decade or so ago to impose deindustrialization instead of development and depopulation instead of growth. Had the decision been made to go with industrial development, the energy demand by *the year 2000 would be at least 10* times the present 80 quads.

For the growth-oriented who don't buy the windmill lifestyle, the more weighty "decoupling" explanation was devised: Energy growth has nothing to do with economic growth, the myth goes. This myth was first promoted by Ross and Williams in a study they did in 1977 for Sen. Kennedy's Subcommittee on Energy.

The utilities that downscale their construction plans because of such fraudulent demand forecasts are basing a critical national decision on outright political lies. This has put the nation on the brink of a potentially disastrous shortfall of electric power capacity.



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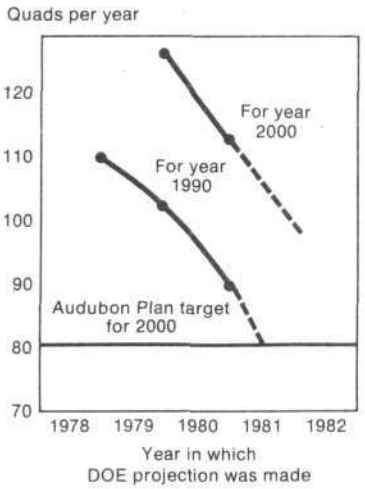


PROJECTIONS BY DOE OF U.S. TOTAL ENERGY CONSUMPTION FOR 1990 AND 2000

The Audubon study shows the DOE projections for energy demand in 1990 and 2000 converging on its own steady-state projection. Projections like these are cited to justify the phaseout of nuclear power. Here, the heavy water plant at Aiken, S.C.

Source: Audubon Energy Plan

Notes

1. *The Audubon Energy Plan; Technical Report.* April 1981. Russell W. Peterson, et al. National Audubon Society.
2. Solar Energy Research Institute (Department of Energy). Unpublished 1,000-page study.
3. *Least Cost Energy Strategy Revisited.* May 1981. Roger Sant. Carnegie-Mellon Productivity Center.
4. *Our Energy— Regaining Control.* 1981. Marc H. Ross and Robert H. Williams, New York: McGraw Hill.
5. *United States Energy Through the Year 2000.* 1973. U. S. Department of the Interior. Washington, D.C.: Government Printing Office.

Mexico Marks Several Development Milestones

Since 1977, when news of Mexico's enormous oil reserves made world headlines, the challenge for Mexico has been to invest its new oil wealth wisely for the takeoff of the rest of the economy.

Three years of solid investment are now reaching the maturation stage, and the picture is impressive.

At the end of April, President José López Portillo inaugurated Latin America's largest petrochemical complex at La Cangrejera in Mexico's southeast. This giant undertaking, involving seven separate facilities, was finished in record time. The majority of the engineering and all the construction was Mexican. Its initial output will be 3 million tons of petrochemicals per year, valued at $1 billion. La Cangrejera, moreover, is expected to help boost Mexico into the role of a petrochemicals exporter in a few years time.

A week later, the president presided over an extraordinary cabinet session that not only endorsed the substantial progress made toward building four new industrial port cities—which will have a combined population of more than 5 million by the year 2000—but mandated feasibility studies for three more such projects.

And a week after that, the president flew to the northern state capital of Saltillo for the inauguration of four new auto parts plants. Nationwide, the auto industry is now growing 10 percent per year.

As underscored in the Fusion Energy Foundation-Mexican Association of Fusion Energy 20-year program for Mexican development (see July *Fusion* cover story), these are the kinds of investments that can lead to growth rates of 10 to 12 percent per year and the emergence of Mexico as a fully industrialized power by the year 2000.

A weak spot in the picture, however, is nuclear. Though Mexico has an ambitious program on the drawing boards to build 20 nuclear plants by the year 2000, a stalemate in high policy circles continues to delay implementation.

Part of the problem is the still unresolved debate over whether the next set of reactors should be of the heavy water Candu type or the light water technology of Mexico's first generation of reactors at Laguna Verde, scheduled for completion in 1983. Some government officials are deluded into believing Mexico's plentiful oil reserves mean that Mexico does not need nuclear at all.

Complicating the situation is the emergence of an environmentalist movement, which is focusing its attention on stopping construction of a training reactor complex on Patzcuaro Lake west of Mexico City.

Progress in the Superports

"We are convinced that a country that deserves to be a country, a country that wishes to be viable, must conceive of itself in the long term," López Portillo said, as he summed up the recent ports evaluation session. "The industrial ports are an important and audacious way to do this."

These are the highlights of the progress report:

- Work has begun on all four of the port projects announced in 1979, Altamira and Laguna de Ostion on the Gulf Coast and Lazaro Cardenas and Salina Cruz on the Pacific. Altamira and Laguna de Ostion involve port and urban infrastructure built from scratch.
- By the end of 1982, at the end of López Portillo's term, the first phase of the program will have been concluded at a cost of $1.8 billion.
- By 1990, the ports will have adjoining them four new steel plants, an aluminum plant, giant petrochemical facilities, and a food processing industry.

Stuart Lewis

The Reagan-Portillo summit in June set the tone for an era of oil-for-technology exchange between the United States and Mexico.

The director of special development projects, Julio Moctezuma Cid, announced that the surge of port activity will convert the Gulf of Mexico into a "true Mediterranean."

What this can mean for U.S. producers and shippers is underlined by Mexico's project to build a "landbridge" container rail link across the narrow Isthmus of Tehuantepec, with savings in time and cost from the passage through the Panama Canal. The required port facilities and rail link are scheduled for operation late in 1981.

The Presidential Succession

The question on many Mexico observers' minds is "Will this extraordinary development perspective continue beyond López Portillo's term in office?"

Some influential publications, such as *Business Week* and *The Economist* of London, predict future instability and impediments to further economic growth in Mexico. But the dynamic of growth and self-confident mastery of advanced technologies has taken on a momentum of its own in the country. López Portillo is intent on passing on the current boom to a successor who will follow the same path, and the chances look good that he will succeed.

—Timothy Rush

Brazil Doubles Nuclear Budget

The Brazilian government doubled the country's budget for nuclear energy to $1 billion this year, making the energy sector the one exception to the austerity conditions that prevail throughout the rest of the economy. The government is making every effort to keep Brazil's nuclear program on schedule, despite complaints from international bankers and local environmentalists that the country is too poor to continue such an ambitious program.

One important impetus for the budget decision came from the continuing Iran-Iraq war. Until last year, when the war broke out, Brazil had been getting 43 percent of its petroleum from Iraq. Brazil has had little trouble building up its stockpiles to record levels since the war by purchases from other sources, but government policy makers are nervous about continued dependence on Middle East oil supplies.

The Hydroelectric Alternative

Although some planners have proposed hydroelectric power as an alternative for Brazil to fossil fuels and nuclear, there are real limitations to the hydroelectric option. Recent regional droughts in southern and southeastern Brazil, where urban life is concentrated, have highlighted the danger of total dependence on hydroelectric power, which already provides over 80 percent of Brazil's electricity.

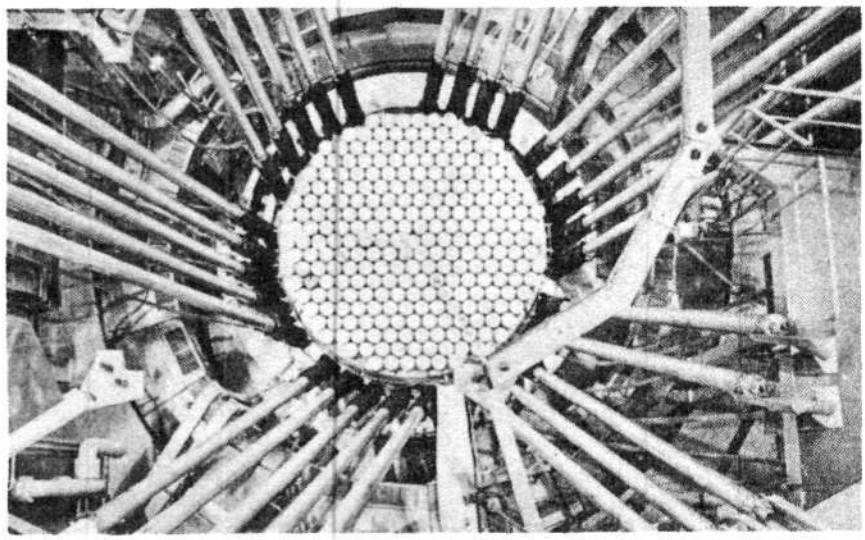
In addition, new dam sites in that region would have to be developed by 1992. And though Brazil already has over 100 gigawatts of hydroelectric capacity in the Amazon basin, the costs and risks involved in stretching wires for 2,500 kilometers are substantial.

A compelling reason for going with nuclear rather than more hydroelectric power is Brazil's even vaster uranium resources. Brazil's 193,000-ton reserves would be sufficient to produce 10 times the country's entire hydroelectric potential for a period of 49 years.

The various elements in the deal Brazil signed with the West German nuclear company KWU in 1975 for a complete fuel cycle are gradually taking shape—after many delays stemming from the U.S. opposition to the deal. The West Germans are now scheduled to complete the transfer of technology by 1990, even if completion of the actual eight plants and the enrichment facility is drawn out to 1995 or 2000 by Brazil's financial difficulties.

- Training programs for Brazilian engineers are almost completed.
- Nuclep, Latin's America's most advanced engineering facility, is already turning out components for Brazilian and Argentine nuclear power stations.
- Brazil's pilot enrichment plant will go on line in 1983.
- Yellow cake concentrate and fuel plants are nearing completion.

The big question mark hanging over the program is whether Brazil will be able to finance continued industrial growth and therefore increased energy consumption.



The core of the Atucha I reactor in Buenos Aires, Argentina, built by the West German nuclear firm KWU.

Argentina Defends Nuclear Independence

Assistant Secretary of State for Science and Technology James Malone ended a visit to Argentina in May promising a "new policy" toward Argentina's nuclear program. However, the Argentine government is apparently not sanquine about a policy change in Washington toward Argentina's desires to develop the complete nuclear fuel cycle. The Reagan administration has continued to block shipments of enriched uranium for test reactors and to press Argentina to sign the Nuclear Nonproliferation Treaty.

Vice Admiral Carlos Castro Madero, head of the country's atomic energy commission, declared after the Malone visit that Argentina no longer seeks assistance in nuclear technology from the United States.

Argentina's next nuclear plant is being built by West German suppliers, with the reactor vessel manufactured in Brazil. A Swiss company will supply Argentina with a fuel enrichment facility in 1983, which will give Argentina control over the full fuel cycle, within the International Atomic Energy Agency's safeguards.

In the meantime, the Soviet Union is supplying Argentina with 500 tons of heavy water and enriched uranium—fuel blocked by the Carter administration and now by the Reagan administration.

Satellite Data Show New Class of Thunderstorms

A recent development in the understanding of thunderstorm dynamics has already paid off in an increased reliability of storm forecasting as well as in a profound reevaluation of the conventional theories of energy transfer and storm formation in the Earth's atmosphere.

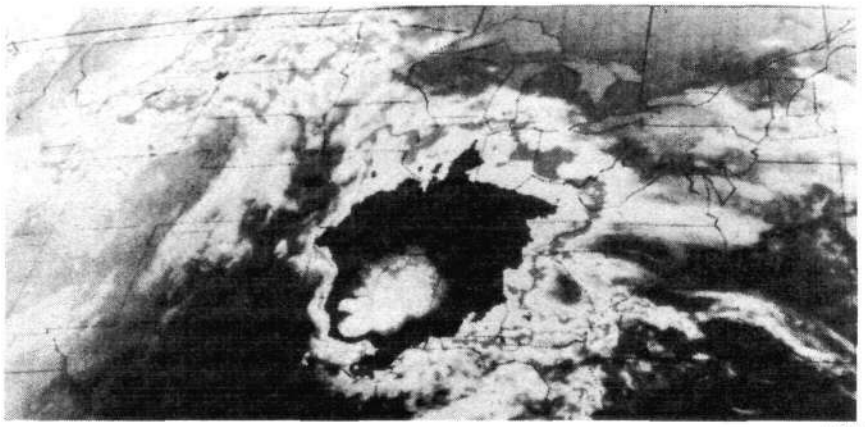
Writing in the *Journal of Applied Meteorology*, J. Michael Fritsch and Robert A. Maddox, scientists from the National Oceanic and Atmospheric Administration, announced the first clear empirical evidence of "mesoscale convective complexes," organized groups of thunderstorms clustered in structures approximately 1,000 miles in diameter.[1] These complexes were discovered from infrared satellite photographs taken of the United States that showed intense emissions of energy in the area of the storm complexes. One such complex over the Midwest during summer 1980 is shown in the figure.

The conventional wisdom about storm formation begins with the assumption that storms are small-scale (50 to 100 miles), localized phenomena whose overall dynamics are determined by high velocity upper air winds. This theory of thunderstorm formation has made the prediction of storms difficult. It has also greatly impeded the development of computer models that are able to predict storm formation and evolution, because the theory required such fine detail to describe the weather.

The new data taken from the satellite photographs, as interpreted by Fritsch and Maddox, show a dramatically different picture: The most violent and widespread storms are not local phenomena; instead they are frequently organized into large-scale, roughly circular complexes of storms.

These complexes form as the energy transfer from the release of latent heat from an initiating storm causes a chain reaction of storm formation in a wide area around the first storm. The resulting intense atmospheric activity, called a "mesohigh," can change the usually dominant high velocity jet stream. As Maddox describes it, "This interaction is an important finding since the traditional viewpoint has been the other way around—that convective storms are regulated by the upper-air patterns."

These new dynamics are being incorporated in a set of computer models of the atmosphere in an effort to apply the new physical interactions to weather prediction. The initial results, using "backcasts" of previous weather, show a dramatic improvement in both the prediction of amount of rain and the duration of storm activity.



NOAA

Infrared cloud pictures taken by NOAA satellites have identified a new class of huge thunderstorm clusters like the system above, one of the largest so far detected, centered on Mississippi.

Theoretical Implications

In early 1978, researchers at the Fusion Energy Foundation theorized that such middle-size organized storm phenomena must exist in order to account for the dynamics of tropical precipitation and its action as the power source for the Earth's atmosphere. Dr. Steven Bardwell and Eric Lerner of the foundation's scientific staff developed a computer model of the interaction of these organized structures (which they called quasi-geostrophic vortex formations), the highly dense areas of vegetation, and the energy transfer from these structures into the atmosphere.

The resulting highly nonlinear model was successful in explaining the abnormal winter weather of 1978 and provided some valuable insights into the interaction of tropical rainfall and northern hemisphere weather. Specifically, Bardwell and Lerner predicted that the deforestation of the Brazilian rain forest had been responsible for the destabilization of normal circulation patterns in the northern hemisphere because these rain forests are the power source for the medium-scale weather systems.

Maddox and Fritsch have independently theorized along similar lines. But the question of the exact relation between the mesoscale convective winds and the Earth's rotation, required to replicate the geostrophic features seen in the FEF model, is still under study by the NOAA team.

It is clear, however, that these middle-scale structures are important in determining the evolution of the tropical rain storms, which produce as much as 90 percent of the tropical precipitation. Also clear is the importance of these structures in shaping the global, longer-term circulation.

—Dr. Steven Bardwell

Note

1. *Journal of Applied Meteorology*, Jan. 1981, p. 9 and p. 20.

U.S. Urged to Develop Advanced ABMs

Development of advanced technologies over the past decade, such as computer chip technologies and new infrared sensors, gives the United States a potential today for developing effective antiballistic missile (ABM) defense systems that would be economical and not as likely as present systems to trigger nuclear war. As Dr. Robert Kupperman, director of the Georgetown University Center for Strategic and International Studies, and Dr. Donald Kerr, director of the Los Alamos National Scientific Laboratory have noted in their proposal for an advanced ABM system, the argument over the MX Multiple Protective Shelters that is raging in the media would become academic if the United States were to develop advanced ABM technology.[1]

The joint initiative by Kupperman and Kerr, if successful, could help turn around the disastrous policy of arms control through a total ban of technological progress in weapons research and development that has strangled our defense capabilities, especially during the Carter years. In particular, the current Department of Defense policy of emphasizing development of "in-width," near-term procurement of existing defense systems would be transformed into an "in-depth" development of qualitatively more advanced defense systems.

In more immediate terms, adoption of a positive ABM approach could lead to the scrapping of the proposed Multiple Protective Shelter (MPS) "racetrack" basing mode for the new MX missile system.

ABMs Can Work

Kerr and Kupperman's urging of advanced ABM development is based on their analysis of a series of Los Alamos National Scientific Laboratory studies (Reports La-UR-80-1578, LA-8632) that reassessed the feasibility of ABMs in light of technological advances of the past 10 years, demonstrating that existing and near-term technologies have progressed to the point where active defense can become more economical and efficient than offense in terms of nuclear warfighting strategy.

The new ABM system proposed would involve a combination of two different missile defense systems: long-distance interception of incoming warheads in space and low-altitude defense systems (LOADS) in the immediate vicinity of the warhead's target. These two systems would be combined into a layered defense.

For hardened targets such as missile silos, this layered defense would be extremely effective and could be implemented in stages. With only a single stage of the layered defense actually engaged, the survivability of the targets would be greatly enhanced. The long-distance intercept system would use nonnuclear destruction of incoming warheads, either through simple collision with the warhead or a small conventional explosive. Only the LOADS would use small nuclear warheads. In an accidental launch situation, therefore, activation of the long-distance ABM defense layer would not commit the United States to nuclear war—a major drawback with the long-distance nuclear-armed ABM systems of the early 1970s.

Furthermore, since the long-distance ABM layer would consist of

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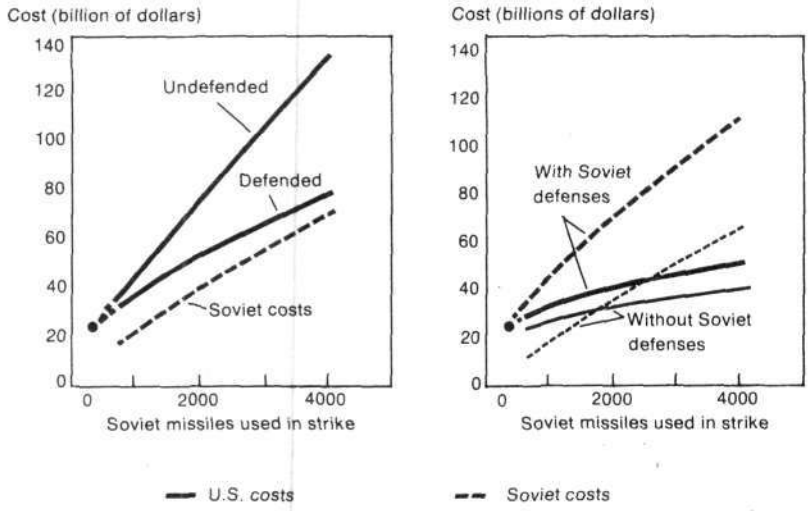


U.S. VERSUS SOVIET COSTS FOR MAINTAINING ENSURED DETERRENCE

The two graphs were prepared in the Los Alamos National Scientific Laboratory study of advanced ABM systems (LA-8632) to give some indication of the cost-effectiveness of advanced ABM defense technology. The projected costs to the United States for maintaining an ensured, survivable deterrence (1,000 delivered warheads) are shown for (a) the MX-MPS system and (b) the layered defense with MX silos. The x-axis gives the number of Soviet missiles used to attack U.S. missiles, while the y-axis gives the cost of ensuring deterrence in billions of dollars. With a layered ABM defense, U.S. costs would be less and would tend to flatten out, even with greatly enlarged Soviet expenditures. This is the case even if the Soviets implement their own advanced ABM defense system.

'FUSION IS NEXT' SAYS POLL

"Fission is here. Fusion is next. At least that's the consensus of 2,300 scientists and engineers polled by the staff of *Industrial Research & Development* magazine," as reported in a recent press release on the results of the magazine's Nov. 1980 poll on "How Big Is the Fusion Opportunity?"

The magazine's editorial in November had announced the passing of the McCormack fusion bill with enthusiasm: "For the first time since Americans began to acknowledge the shortage of available energy, we now have a commitment for all-out pursuit of a specific energy source. . . . It costs an immense amount these days ($20 billion or more) to answer the door when Opportunity knocks, but that by itself is not sufficient reason to let the knock go unanswered. We have ignored this knock unconscionably long. . . . Let it not be said that the scientific community failed to respond when finally given the chance to put an end to the energy crisis."

Readers were then asked to respond to a poll on the fusion opportunity, answering such questions as "Had you been in the shoes of Mike McCormack and others who planned and sponsored this energy bill, would you have put the emphasis on (a) fusion, (b) solar (direct), (c) wind, (d) geothermal, (e) biomass, (f) OTEC, (g) conservation, (h) other?" The scientists and engineers, all involved in research, development, and quality assurance, selected fusion by an overwhelming majority.

The press release reports, somewhat naively, that "suprisingly . . . only 21 percent of those polled felt that solar energy could solve the nation's energy problems." According to the survey, only 4 percent believe that the technology necessary to prove commercial fusion feasible is readily available, but 70 percent believe that the prospects are good for the future.

* * *

SOVIET PNE EFFORT EXPANDS

In the November issue of the Soviet geological journal *Geologiy Nefti i Gaza*, Dr. O. L. Kedrovskii et al. report on several successful experiments in the Zabalansovaya gas field, where peaceful nuclear explosives (PNEs) were used to stimulate enhanced recovery of gas. Increases in the rates of gas production of fivefold to sixfold were reported by the Soviet scientists.

Over the past decade, the Soviet Union has continued to expand its program to develop peaceful applications of nuclear explosives, both qualitatively and quantitatively. A similar effort, called the Plowshare Progam, had been initiated in the United States by Dr. Edward Teller in the 1950s. But during the Carter administration, the U.S. PNE program was completely abandoned. Now, more and more evidence is mounting that the Soviet program may be approaching the point where full-scale industrial use of this immediately available form of energy will be realized.

This is the first time in 20 years that the Soviets have publicly reported on this application of PNEs. Could this recent development have affected the new CIA analysis that the Soviet Union will be able to meet its oil and gas needs for the 1980s, contrary to their earlier warnings that the Soviets would be forced to invade Persian Gulf oil fields by the mid-1980s?

AAES CALLS FOR EXPANDED FUSION EFFORT

The American Association of Engineering Societies (AAES) published a timely pamphlet in March on the need to pursue research and development in controlled thermonuclear fusion. Although conservative in its timetable, compared with the accelerated schedule of the Magnetic Fusion Energy Engineering Act of 1980, the pamphlet is welcome in helping to overcome the budget cuts now threatening the fusion program.

The association's Coordinating Committee on Energy has been issuing such policy statements since March 1980 "because its members recognized that the government has failed to establish an energy policy capable of providing a comprehensive energy source mix which can meet our requirements for the last portion of this century and the greater portion of the next."

The pamphlet notes as an introduction that, to the end of furthering such a policy, "the energy content of the fuel resources for fusion on the more advanced deuterium-deuterium cycle is virtually unlimited." Pointing out that research into magnetically confined fusion reactors has shown significant promise in recent years, the committee makes a number of recommendations: (1) "The tokamak research program should be intensified to provide the basis for building a fusion engineering test device and to investigate improvements of the concept." (2) "The magnetic-confinement technology program should be intensified to provide the technological basis for building a fusion engineering test device."

The committee also recommends that a tokamak engineering test reactor should be scheduled for the early 1990s and that a national goal should be established to demonstrate reactor reliability and economic feasibility early in the next century, with research on other magnetic-confinement and on inertial-confinement concepts intensified so that their potential can be evaluated.

FEF Conf. Hits Science Cuts As Threat to U.S. Security

"Significant strategic decisions do not always, or perhaps do not even generally, come with a sign around their neck, saying 'I am a significant long-term strategic decision,' " FEF research director Uwe Parpart told a conference on the strategic significance of the U.S. fusion program in Washington, D.C. May 13.

Parpart was joined by former Democratic congressman Mike McCormack in outlining the threat to U.S. national security posed by the budget cuts planned for vital areas of scientific research, particularly the fusion energy program.

The 100 registrants at the FEF conference, titled "Fusion Energy: The National Security Implications," came from U.S. government departments, congressional staffs, and foreign embassies of Western and East bloc nations.

Haggling Over $150 Million

"Fundamental shifts in military technologies are now taking shape around high energy physics research," Parpart told the group, "which within a few years can shift the balance of power to the defensive in warfare for the first time in the history of nuclear weapons." To elaborate the point, he cited new studies of antimissile beam weapon potentials by Los Alamos Scientific Laboratory director Dr. John Kerr and by Dr. Edward Teller.

Outlining cuts in the proposed fiscal 1982 magnetic fusion and laser fusion programs, Parpart charged that "in our long-term strategic capabilities, we're now haggling over only $150 million—the difference between being on line on time or not. As a nation we have never sacrificed long-term national security this way, and those who say that we can get by funding only short-term hardware programs are proposing disaster."

Mike McCormack, now a member of the DOE Energy Advisory Task Force, followed by calling for a "national public outcry" against the folly of abandoning the near-unanimous congressional mandate fusion received in 1980. The Magnetic Fusion Energy Engineering Act of 1980, known as the McCormack bill, calls for the development of a demonstration commercial reactor by the 1990s.

"In Jimmy Carter we have had a president who was schizophrenic on energy policy," McCormack told a receptive audience, which swelled to 120 at the luncheon keynote at the L'Enfant Plaza Hotel. "The Department of Energy for four years has refused, as policy, to make a long-term projection of national energy production or demand."

Characterizing the DOE as a problematic agency even in a more pro-nuclear, profusion climate, McCormack called for concentration on elected institutions, Congress, and the presidency by a "constituency for fusion," which must grow rapidly in numbers and level of activity.

McCormack named the Fusion Energy Foundation, Atomic Industrial Forum, and Fusion Power Associates as the primary groups working to form this constituency. "Everything we do must be for the nation itself," he stressed, "for development and peace and security for our citizens."

Parpart's morning presentation (see excerpts, page 54) generated 40 minutes of debate and questions about the comparative nuclear programs and fusion capabilities of various U.S. allies and Warsaw Pact nations. In the back of many minds was the recent shock to international stability and the French nuclear program from the election of Socialist Party leader Fran-

Carlos de Hoyos

Former congressman Mike McCormack, the chief sponsor of the Magnetic Fusion Energy Engineering Act of 1980, called for a "national public outcry" against the folly of abandoning the mandate Congress gave the fusion program in 1980.

çois Mitterrand in France. The U.S. economic austerity policy and credit squeeze contributed to the defeat of President Giscard d'Estaing, and Parpart warned that the Reagan administration could be the next victim of its own economic policy, dropping the United States to a second-class world power despite the President's best intentions.

Threat to Security

"The primary threat to our security is the State Department's 'strategic resources and population policy,'" said Parpart, "defining resources as finite and fixed, and defining our military policy in terms of securing scarce resources and reducing competing populations. This leads to the Rapid Deployment Force misadventures, but, worse, it demands shaping our military preparedness around a buildup of fixed weapons technologies," he said.

"Advances in military technology are suppressed under the rubric of 'disarmament' by people who in other connections oppose the use of new civilian nuclear technologies as well. These are precisely the advances in technology that produce new resources to replace apparently finite supplies," Parpart said.

Asked by a U.S. Army representative about the "tradeoff" between investments in new technology research versus purchases of "necessary military hardware," Parpart replied that "anyone who proposes a military buildup of fixed weapons technologies is proposing strategic idiocy and disaster. Investment in expanding the scientific and industrial base makes each military budget dollar buy more in terms of real preparedness."

Dr. Steven Bardwell, editor-in-chief of *Fusion* magazine, led off the afternoon session with a discussion of the economics of fusion. Joining him on the panel were Dr. George A. Hazelrigg from ECON, Inc., speaking on the economics of long-range R&D programs, and Jon Gilbertson, FEF director of nuclear engineering, speaking on the fusion-fission hybrid.

Transcripts of the conference proceedings are available at $50 per copy.

Fusion and the Creation Of Strategic Resources

Excerpted here is a section of Uwe Parpart's presentation at the May 13 conference.

In discussing the broader question of the military and global strategic implications of fusion and space research, I want to divide this topic into two sections: First, the question of strategic raw materials and resources, and how this question—which has become a question of principal significance in our foreign policy planning—is affected by research in fusion and space; and second, the question of the more immediate military implications of research in these two areas.

When you read many of the recent pronouncements of the State Department and associated agencies, it is quite clear, I think, that the question of strategic resources . . . appears to be conducted from the standpoint of saying these resources are finite; they exist in certain parts of the world, . . . and somehow we must find ways and means of protecting our interests in those areas. The basic premise is that these resources are finite, they are in relatively short supply, and as we are moving ahead through the 1980s and toward the end of this century, this situation will become worse rather than better. Therefore, we have to conduct our foreign policy from this standpoint, making the assumption that our national security is based on somehow protecting these resources, and that indeed our entire military apparatus and capability must be shaped to accomplish this goal.

So this assessment of the finitude of resources has implications not only for the kind of broader foreign policy planning that says, all right, let's not mess up our relations with South Africa or with the southern African

Carlos de Hoyos

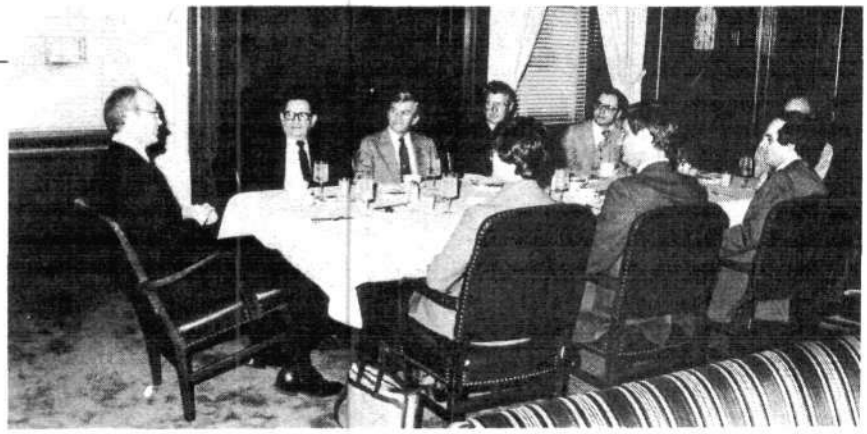
FEF research director Uwe Parpart attacked the cuts in the proposed fiscal 1982 magnetic fusion and laser budgets as a threat to national security. "We're now haggling over only $150 million—the difference between being on line on time or not. As a nation we have never sacrificed long-term national security this way."

countries . . . but it also has the implication of specifically shaping the military capabilities of the nation. It has implications all the way down to the point of making specific acquisitions of weapons programs. . . . Our entire way of looking at the world and of equipping ourselves to deal with the problems of the 1980s and the 1990s is somehow shaped by this outlook. . . .

The Strategic Role of Fusion

To the extent that we adopt an aggressive fusion energy development program as part of a broader nuclear energy development program for the United States, we will by the beginning of the next century be in a position of not depending on anybody either for our energy or for our strategic resources. Whether or not . . . we still choose to import certain raw materials at that point in time, that's quite a different question. What I'm saying is that we can easily maneuver ourselves into a position where we will have the option at that point to do what we want to do, rather than being forced into circumstances that diminish the national security and simultaneously undermine the overall standard of living of our population.

How is this to be accomplished? Fusion energy is not simply another, perhaps slightly more complicated, way of making electricity. In fact, I'm quite convinced that in the longer run, fusion reactors will principally be used for purposes other than electricity production. The most important thing about the fusion reaction, from the standpoint of the problem that I have defined, is that it produces very high temperatures very cheaply. And when you are in a position of producing temperatures of tens, in fact hundreds, of millions of degrees cheaply, you are in a position of profoundly and qualitatively transforming your industrial base. You will be able to set in motion a process in which resources that right now are economically inaccessible will become accessible and relatively cheaply so. . . . You will be able to avail yourself of a radiation spectrum for industrial processing that is not limited to that very small and, in fact, very uninteresting part of the spectrum called heat radiation. You will be able to avail yourself of the entire spectrum of the radiative output of a high temperature source and base new processes of industrial development upon that. And this is the principal advantage of fusion research.



U.S. Department of the Interior

The debate over strategic minerals was a top agenda item when Dr. Steven Bardwell and Uwe Parpart of the FEF attended a breakfast meeting with Interior Secretary Watt (head of table) in April, along with others who testified at his confirmation hearings.

In working on an economic development program for India, my colleagues and I came up against some seemingly insoluble problems. It appeared that for India to develop into a modern industrial nation, say, over the period of the next 30 to 40 years, India would alone have to consume most of the resources of the world. We had to think through this question of strategic resources, not only of the kind that I mentioned before—cobalt, titanium, and so forth—but actually of the much more basic kind—iron ore, aluminum, bauxite, copper, zinc, lead, and so forth. We had to see what was actually available on Earth and what could we do about that.

Let me just give you a very brief sense of what is possible with a high temperature source of the sort that fusion will make available to us. If you simply walked outside of this hotel and measured a square 1 mile long and 1 mile down into the earth, you would bring to the surface a cubic mile of earth. What would be the yield of what is contained in that? I'm not talking about "contained in it" from the standpoint of the economically possible, immediate exploitation of these resources, but how much does this contain by way of minerals? Our calculation, which anyone can make by simply getting out a handbook of chemistry, shows the following: A cubic mile of rock—of ordinary rock that lies anywhere in the world—contains about 10 times the total annual consumption of aluminum of the world today. It contains the total annual consumption of iron ore, twice the total annual consumption of copper, about one half of the total annual consumption of zinc, and about one half of the total annual consumption of lead. It contains enormous amounts of almost anything else you want—of uranium and of trace elements of all kinds. The only question when you look at that kind of situation is under what circumstances would it be economical to exploit such resources? That's the hitch.

The idea that these resources . . . are relatively finite on the Earth is in itself a false and deceiving statement. The correct statement is that relative to an existing technology base, the economics of exploiting these resources at any given point is limited. And that definition of the problem immediately suggests its principal solution—namely, to bust through the limits of economic exploitation by putting into motion the research and technological innovation programs that are capable of economically exploiting resources that cannot be so exploited at this point in time.

The Yost-Parpart Debate: Taking Apart

One of the principal architects of the Carter administration's *Global 2000 Report* was challenged to a full-dress public debate in Washington, D.C. May 20. Nicholas Yost, former chief counsel for the White House Council on Environmental Quality, heard his opponent, FEF director of research Uwe Parpart, indict the *Global 2000 Report* and its follow-up report, *Global Future: Time to Act*, before an audience of more than 100 diplomats, U.S. government officials, and university professors at the Washington Hilton.

The two debated "Global 2000: Premises and Implications" as part of a day-long conference on "The United States, the Third World, and the *Global 2000 Report*," sponsored by the news weekly *Executive Intelligence Review*. The conference organizers made no secret of their belief that the event would have an important impact on the political climate surrounding the Reagan administration, which has so far failed to break with its predecessor on the question of international economic development.

Yost, who is the son of *Christian Science Monitor* columnist and former State Department official Charles Yost, opened the debate with a quote from Woody Allen: "The human race is at a crossroads," he said. "We have to choose between despair, hopelessness, and total extinction. I hope we have the wisdom to make the right choice."

Yost proceeded to describe the *Global 2000 Report's* dire predictions of deforestation, energy shortages, overproduction of carbon monoxide, and overpopulation. "We need development," he said, "but we have to define the delicate balance between sustainable development and environmental concern."

One of the chief themes of Yost's presentation, as of *Global 2000* itself, was what he termed the "disproportionate" consumption by the advanced sector countries. "We in the richest corner of th world use resources on a per capita basis strikingly disproportionate to that of most of the world," Yost said. "As others escape from poverty, they too will use more. All of us will have to learn to use what we have as responsibly as possible.

Stuart Lewis

"The human race is at a crossroads," said Nicholas Yost, former chief counsel for the CEQ. "We have to choose between despair, hopelessness, and total extinction."

"First, we must make sure that there's enough to go around. Second, we Americans, who consume so much, are poorly placed to advise others to consume less."

Malthusian Politics

Parpart delivered his reply: "These reports are not simply an academic exercise undertaken by government professionals for the purpose of somehow understanding how the world works. *Global 2000* is a report that serves a political purpose and was issued under very definite political conditions and circumstances."

"The real premise of the *Global 2000 Report* is on page 526 [of the second volume], where the report notes that its projections assume that 'the existing economic system and associated financial institutions are fundamentally sound' and that 'these assumptions may seem to imply that recents demands by the LDCs [less developed countries] for a New Economic Order will not be met.' "

Parpart then described how in 1798 Parson Thomas Malthus, a director of the British East India Company, issued a similar report predicting a Global 2000-type population crisis for Britain by the year 1845.

"As a result of this, Malthus recommended, for example, that it would be necessary to abolish the poor houses and various social security systems of that time, and that people should live in smaller houses because fertility rates in smaller houses are lower than in bigger houses."

As it turned out, Parpart continued, the population in England more than doubled by 1845, while the standard of living also went up—about four times.

"However, Malthus was absolutely right, and with a vengeance, concerning India, precisely because the British had adopted a *policy* vis-à-vis India of not making any changes in investment flows. On the contrary, because they made the explicit decision to exacerbate the already existing *disinvestment* policy of that time, in the 19th century, by our best estimates, India experienced 31 periods of severe starvation and depopulation, in which at least 32 million people died. In that period, 32 million people amounted to close to one third of the Indian population."

Parpart then zeroed in on the basic, unstated assumption of the *Global 2000 Report*: "If present polices continue . . ."

"But who says those assumptions have to be made," Parpart asked.

"In an environment in which population is looked upon as an asset, rather than as a problem, what we can and must do is quite obvious. We educate our population; we make every effort to create circumstances

the Global 2000 Doctrine

in which these populations can develop their creative potential. If we make every effort to develop new technologies and diffuse them or allow them to be diffused . . . then under those circumstances, a newborn child is the principal asset of the human race, not a threat to the existence of the living.

"It is a very odd world indeed in which every time a cow is born, we feel that we are richer, and every time a child is born, we feel that we are poorer. That is the world and that is the assumption, the policy framework and environment, of these two reports, *Global 2000* and *Global Future*. And that is the policy environment and philosophy that have to be changed," Parpart concluded.

Global Disclaimers

In the exchange that followed, Yost was forced to issue a string of disclaimers: "Our report is a projection, not a prediction. We haven't recommended anything," he said.

Parpart continued to pound away on the theme of development: "The policy of the United States should be the industrialization of the entire Third World. Nothing less is in our interests."

At this point people in the audience started asking questions and making statements.

An official from the U.S. Agency for International Development (AID) said: "I've been with AID since 1957, and I agree with Parpart that it's been a failure. Mr. Parpart, I wonder if you could explain how development occurred where it has been successful—that is, the successful industrialization of Japan and South Korea?"

A businessman stated: "I think it is a mistake to limit the growth rate here, because in this country we are all producers."

An African diplomat: "I think we have to agree that human beings are the engines of technological advance."

The high point of the debate took place when Parpart was asked: "Why do you attack the World Bank? Its goal is industrialization."

Parpart replied: "If that is its goal, it has failed. But I can't believe that is its goal. Its real goal has been to keep the genie in the bottle. Wherever industrialization has taken place, it has occurred in spite of the World Bank."

After describing the policies of the World Bank in detail, Parpart went in for the kill on *Global 2000*: "*Global 2000*," he said, "is a coverup for this continuation of underdevelopment. It's a way of telling the Third World that there can be no rapid industrialization. It is a coverup for World Bank policies, just as Malthus was a coverup for the policies of the East India Company."

"That's not true," cried Yost. "That is not the purpose of the *Global 2000 Report*. And I must say that Mr. Parpart's views on the World Bank are not widely held by those familiar with the bank and its policies."

Parpart concluded the debate with a denunciation of the Carter-Haig foreign policy of "turning back the clock" through support of such primitivists as Khomeini in Iran and the Pol Pot regime in Cambodia.

"We had a clear choice in 1945," he said. "We could have gone with what Gen. McArthur was doing in Japan, or we could have gone with the policy of President Truman and Secretary of State Acheson. And unfortunately, we chose the latter. It is the Malthusian ideology exemplified by *Global 2000* that has allowed the State Department to maintain its policy of 'benign neglect' toward starving countries of the Third World."

After the debate, conference participants were invited to an afternoon of panel discussions by FEF representatives and other development specialists on the concrete steps the United States can take to ensure that global industrialization, not holocaust, takes place over the next two decades.

Stuart Lewis

Yost listens uncomfortably while his debate opponent, FEF research director Uwe Parpart, exposes the unstated assumptions of the Global 2000 Report: *"The real premise of the* Global 2000 Report *is on page 526, where the report notes that 'the existing economic system and associated financial institutions are fundamentally sound.'"*

Carol White Takes Fight for Science to Mexican Campuses

Carol White, editor of *The Young Scientist* magazine, toured Mexico this spring, addressing some 2,000 students and faculty members at Mexico's leading universities and technical schools.

In presentations in Mexico City, Puebla, Guadalajara, Monterrey, and Sonora, White used the examples of NASA's Saturn mission and the recent flight of the Space Shuttle to squash the Global 2000 doctrines of finite resources and overpopulation and to generate discussion about the scientific challenges ahead for man. White reported that she was warmly received everywhere she spoke—with the exception of a stronghold of the Rockefeller Foundation-funded "Green Revolution"—and that no one questioned her identification of morality and scientific progress, the central theme of her talks.

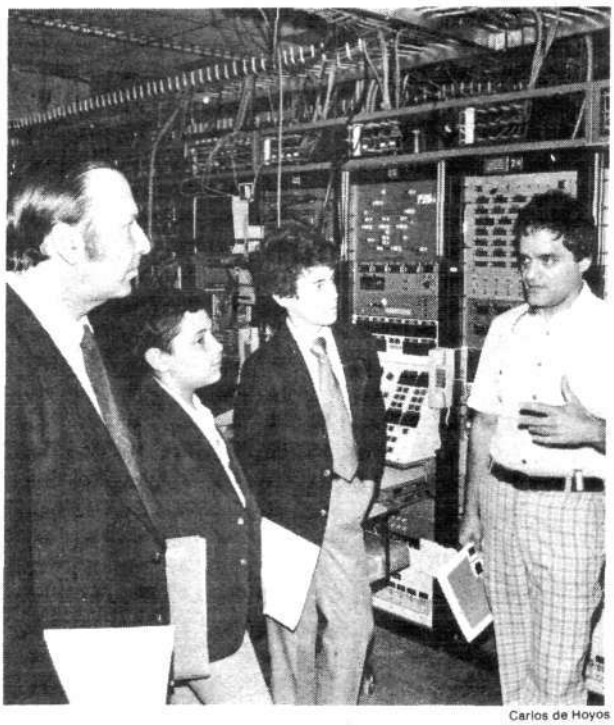
White's audiences were most excited by the fundamental issues she raised about scientific method. For example, in a lecture before a standing-room-only audience at the University of Puebla, sponsored by the engineering faculty, White went from a slide presentation on the Voyager fly-by of Saturn to a stinging attack on the Newtonian world view. White contrasted the Newtonian view of an entropic universe of increasing disorganization with Kepler's hypothesis of the generation of the universe through a progression regular Platonic solids.

In her talk before the physics and biology faculties of the Monterrey Technological Institute, White focused on the population issue, drawing on material from her 1980 book, *The New Dark Ages Conspiracy*. As in each of her presentations, she explored the connection between British empiricism and Malthusianism—the unscientific belief that presumed resource scarcity imposes limits on human population growth.

After the university presentations, White held informal talks with students and faculty members in which she urged that Mexico develop advanced research capabilities on par with the major U.S. fusion laboratories. Such discussion was especially timely in view of the Mexican government's recent announcement of its intention to double by 1986 the number of students enrolled in higher education, particularly in the sciences.

Philip Ulanowsky

Carol White, editor of The Young Scientist *magazine, after her recent tour of Mexican universities.*



Carlos de Hoyos

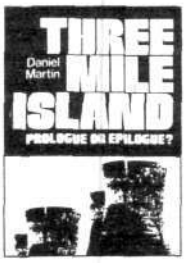
Tokamak Wins Nat'l Award

Two seventh-graders at New York City Intermediate School 187 who built a simulated tokamak power plant won first prize in the National Energy Foundation's SEER (Student Exposition on Energy Resources) competition June 3. Michael Masterov and Yaroslav Shoikhet, both 13, developed the tokamak project after their science teacher, Mr. Herb Friedman, taught a class on fusion in December 1980 based on the cover story of the premier issue of the FEF's children's magazine, *The Young Scientist*. The next issue of *The Young Scientist* describes in detail how Michael and Yaroslav conceived of, built, and modified their simulated tokamak with its steam-producing boiler and generator.

The FEF arranged a special tour for the two winners of the Princeton Plasma Physics Laboratory to give them a first-hand look at tokamaks. Shown here is a photograph from PPPL's "red carpet" tour for the boys. From left to right are Herb Friedman, their teacher; Michael; Yaroslav; and Anthony De Meo, PPPL Information Office director.

A Liberal's Account of Nuclear Power:

More Accidents 'Waiting to Happen'



Three Mile Island, Prologue or Epilogue?
Daniel Martin
Cambridge, Mass.: Ballinger/ Harper & Row, 1980

Now, two years after the incident at Three Mile Island and after tens of thousands of pages have been written about it in newspapers and commission reports, the books are beginning to come out. Unfortunately, the books perpetuate the media myths and seem aimed at preventing nuclear power plants from getting on with the job of supplying the world with energy.

Three Mile Island, Prologue or Epilogue? by Daniel Martin, a professor of political science at the University of Baltimore, is one of several TMI analyses that are getting a lot of publicity. It purports to be an unbiased review of the findings of the various state and federal commissions that were formed to investigate the incident. The author has added some novelistic drama to the account, but most of the book simply reports the findings as they were originally presented.

Although Martin goes through the motions of presenting the facts of what happened at TMI in an objective manner, the undertone that runs through his account is that there are many troubling unknowns to nuclear technology. This bias will of course feed directly into the fear of nuclear energy that the media have already created in many U.S. citizens, thus pushing them toward an antinuclear outlook.

The author gives himself away in the concluding chapter, "Prologue or Epilogue?" in which he takes the liberty of drawing his own conclusions. Dropping the pretense of objectivity, Martin states: "High technology is a risk. In return for the creature comforts it offers us, it requires too much information in advance about what possible accidents can occur. It requires too delicate an interface between breakable machines and fallible people. It requires an accounting system on quality control and operational status that overloads us with information. . . . There are other accidents at reactors still waiting to happen, and there is no guarantee that we will learn the lessons of Three Mile Island the first time we see them."

Making such claims without even asking what the risks will be of not developing nuclear energy is simply not telling the truth. Already, as Martin well knows, the U.S. economy has been plunged into severe and prolonged recession largely because of the high cost of energy, especially oil; the development and construction of the only economical alternative—nuclear power—has been intentionally stalled and delayed by its political opponents, with plenty of support from the liberal, antinuclear media.

For the developing nations, this situation means not only economic depression but eventual starvation for millions of people—a process that is already well underway in parts of Africa.

By ignoring such facts and instead posing the helpless, "technology is dangerous" line of the zero-growthers, Professor Martin is acting in an irresponsible and immoral manner. No one was hurt as a result of the TMI incident, but the consequences of not implementing nuclear power are very grave. —*Jon Gilbertson*

Club of Rome Aims To Capture Youth

Cent Pages pour L'avenir
(One Hundred Pages for the Future)
Aurelio Peccei
Paris: Economica Publishers, 1981

Aurelio Peccei, founder and director of the Club of Rome, published a new book in France this past spring, titled *Cent Pages pour L'avenir—One Hundred Pages for the Future*, that presents the Club of Rome's well-known litany on the population explosion, the destruction of nature, and the rapid exhaustion of natural resources. The importance of the book, however, is that it reveals the latest strategy of the zero-growth group: orienting toward the young. *One Hundred Pages for the Future* is dedicated by Peccei to "those young in spirit or age, the sole hope for humanity's future," whom the Club of Rome seeks to mold into a "people's army" to fight for a Malthusian cultural revolution.

Man must abandon his blind, vain, and even criminal trust in his own almightiness, Peccei writes. Christianity created a false image of man as standing in the center of the universe when man is but an accident of creation. Peccei also attacks the idea of the nation state, that "remnant of tribalism of old," which, he says, must be superseded by supranational modes of government.

In the course of the book, Peccei reports briefly on two other ongoing projects of the Club of Rome. First, in honor of the 10th anniversary of the Club of Rome's *Limits to Growth* re-

port in 1982, the International Institute for Applied Systems Analysis in Vienna will convene a major symposium to review the state of the art of systems analysis. For the occasion, the Club of Rome is preparing "a critical review of relations between microelectronics and society." "Major battles are already underway in the biological and genetics technologies," Peccei reports.

A second Club of Rome study titled *Dialogue sur la Richesse et le Bienetre (Dialogue on Wealth and Welfare)*, to be issued shortly by Economica, will formulate a new theory of wealth: "The economy and the ecology are inextricably united," Peccei writes. "A strategy of generating wealth and safeguarding this patrimony are opposed. . . . Activities that generate wealth but are destroying the natural patrimony even more are creating a negative or 'subtractive' value."

This will be an important document to examine in its entirety, for it sounds like the most radical statement to date of the Club of Rome's view that man does not create new wealth through scientific and technological achievements, but that humankind is an intrinsic drain on preexisting resources.

Peccei's preoccupation in *One Hundred Pages for the Future*, however, is with effecting the cultural transformation—by changing "man's very image of himself"—that will soften up the world's population for its bleak future under zero economic growth. This is where Peccei's people's army of the young comes in.

Peccei writes that "spontaneous grouplets" are arising everywhere "to meet new demands or change what has gone wrong in their societies.

"These are the peace movement, women's liberation, supporters of minorities and birth control, national liberation movements, defenders of civil liberties and human rights, the apostles of a technology with a human face, . . . friends of nature and animals, defenders of the consumer, conscientious objectors, etc.

"This is a kind of people's army, active or potential, which exerts a function similar to that of the antibodies that are created to reestablish normal conditions in a diseased biological body. . . ."

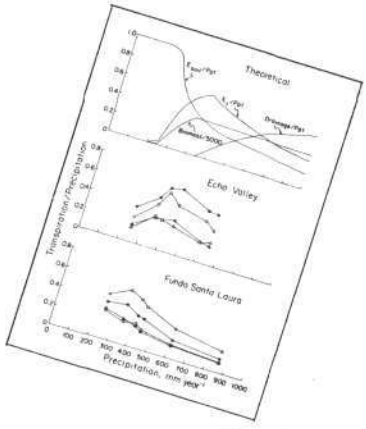
Peccei concludes that it is time for the diverse, disjointed strands of the counterculture movement to be consolidated and redirected toward "strategic aims."

One Hundred Pages for the Future may explain a great deal about the youth riots that swept Zurich and other European capitals in summer 1980 and the antinuclear, "peace" movement now aimed at bringing down the progrowth government of West German Chancellor Helmut Schmidt.

—Joelle Leconte

Restoring the Science of Ecology

Resource Use by Chaparral and Matorral: A Comparison of Vegetation Function in Two Mediterranean Type Ecosystems
edited by Philip C. Miller
New York: Springer-Verlag, 1981



Courtesy Springer-Verlag

Ecologists test theory aided by the computer analysis of data from diverse geographical regions.

Among the many crimes committed by the so-called environmentalists, one small evil is their attempt to destroy the science of ecology through guilt by association. Unfortunately, however, in recent times the science has not been served much better by its professional practitioners, who have retreated from investigating the self-ordering of the biosphere into a metaphysical preoccupation with niches, webs, and loops.

Although *Resource Use by Chaparral and Matorral*, edited by Philip C. Miller, does not fully avoid these problems, it does manage to reach some interesting conclusions and present the data necessary for others to go beyond its limitations.

The book is a study of convergent evolution, the existence of two or more separate ecosystems—in California and Chile, in this case—that are genetically distinct and yet appear extremely similar. Such convergent pairs or groups of systems have occupied the attention of biologists since at least the early 1800s work of Alexander von Humboldt and, in fact, provide one of the best refutations of the "Creationist" dogma, on the one hand, and the "every species for itself" anarchy of the Darwinians, on the other. It is clearly blasphemous to imagine the Creator maliciously forming pairs of shrub species, Chaparral and Matorral, that look almost identical and yet are totally unrelated genetically, just as it is statistical blasphemy to assume that the random operation of survival of the fittest could have created the same series of pairs, in totally distinct systems.

The questions asked by Miller, therefore, and in general by other students of convergent evolution, have naturally concerned the functioning of the ecosystem as a whole. In this case, the hypothesis is posed that the use of resources (light, water, and nitrogen) is more similar between two sites at the same elevation and latitude in Chile and in California than between the California site and two others less than 50 miles away that differ in elevation and rainfall.

In investigating this hypothesis, a large amount of data is gathered to allow real examination of the functioning of the systems. The method by which the data are assembled and

combined is itself interesting, since Miller argues for including the results of agricultural research in ecology, which has been generally avoided in the attempt to create a "pure science." From this he draws the use of nonlinear although rather simple simulation models, which allow the combination of detailed knowledge into an accessible form and the running of otherwise impractical "experiments." Although these techniques are used to the point of excess in the science of physics, they are generally ignored in ecology, where they can make significant contributions.

The major conclusion drawn in the book is that the way in which the ecosystems function is more similar between the shrub sites in California and in Chile than between neighboring sites in California. In fact, the Pole-facing slopes in the two countries are more similar than the Pole-facing and the Equator-facing slopes in California. This is demonstrated both for resource use (the amount of water transpired, the amount of nitrogen absorbed, and the amount of sunlight absorbed) and for resource-use efficiency (the ratio of use to availability). This convergence has occurred, it is noted, between systems that are startlingly new, having existed for less than 10,000 years.

Although the book is quite technical for the lay reader, it is worth the attention of anyone who wants to understand the actual functioning of ecological systems. The authors cover topics such as leaf angle and the accumulation of resistant organic matter, but all from the point of view of the effects of these processes on the ability of the system as a whole to capture and use radiant energy from the sun, transforming it into the ordered form of biological tissues.

In short, they provide a detailed, if sometimes inchoate look at the development by the biological sphere of technologies to master the world of inorganic nature, which is the fundamental characteristic of actual evolution—just as man's increasing mastery of inorganic and organic nature defines human progress.

—Sylvia Barkley

AIF Conference

Continued from page 22

even deeper budget cuts in fusion. We need a public protest. Most people in this country have not been informed of the damaging possibility of these budget cuts. . . . We've been conditioned not to stand up and fight. Fusion is real. We know it will succeed."

An Ongoing Battle

According to Dr. Allan Mense, the battle over the fusion budget is not finished. Mense is the fusion staff member of the House Subcommittee on Energy Research and Production, formerly chaired by McCormack and now headed by Rep. Marilyn Bouquard of Tennessee. Mense stated, "The fiscal year 1982 budget in no way reflects Congress's view of fusion." He stressed that "the Japanese are planning for future generations. We have to look 100 years ahead like the Japanese."

Dr. Kenzo Yamamoto, a member of the Nuclear Fusion Council of the Japan Atomic Energy Commission and an adviser to the Japan Atomic Energy Research Institute, which conducts Japan's tokamak research, confirmed that Japan is considering having its Fusion Experimental Reactor on line by the early 1990s. "We would begin construction in about 1988, and plan to burn deuterium-tritium fusion fuel by 1994-1995," he said. In addition, he reported, five major Japanese nuclear reactor suppliers will be involved in the new machine.

—Marsha Freeman

Fusion Budget Vote

Continued from page 23

1982, the committee's report says a decision should be made on an interim location of the center for Fusion Engineering (CFE) and then the information gathered to put together a data base for FED design work. The DOE is directed to provide funding for site evaluation studies for the FED within the fusion budget next year. By Sept. 1, 1982, the report directs, the DOE must submit to Congress the criteria for FED site selection and a list of five possible sites.

The $5 million added by the House committee goes specifically to the Reagan figure of $9.15 million for the CFE in order to carry out this accelerated timetable for beginning engineering work on the FED. The FED itself will not have a specific budget line until site preparation and construction are close.

The McCormack Fusion Materials Irradiation Test facility, which was threatened with elimination in the Reagan budget, received $6 million in the House authorization. The committee stated in its report that it will not terminate this important facility to test the materials that will be needed in an actual fusion reactor plant. The House committee also added $3.5 million for the ISX-C impurities experiment to be built at Oak Ridge National Laboratory.

The Senate Energy committee did not do a program-by-program markup of the DOE budget in their mid-May session but indicated that they would be adding about $60 million to nuclear and fusion programs. During June and July the Senate and House appropriations committees will be marking up the DOE budget. It is expected that the general outlines and figures submitted by the authorizing committees will be accepted.

Congress to Evaluate Fast Breeder

Congress is reviewing a Conceptual Design Study (CDS) for a 1,000-megawatt liquid-metal fast breeder reactor that was submitted by the Department of Energy. The study, part of a hard-won compromise with the Carter administration by probreeder Senator James McClure (R-Id.), was begun in 1978 as an industry-wide effort. Westinghouse, General Electric, Combustion Engineering, Babcock & Wilcox, Bechtel, Burns & Roe, Stone & Webster, and Atomics International all participated, with Boeing in the role of technical integrator.

A debate is now expected on the question of replacing the years of effort that have gone into the Clinch

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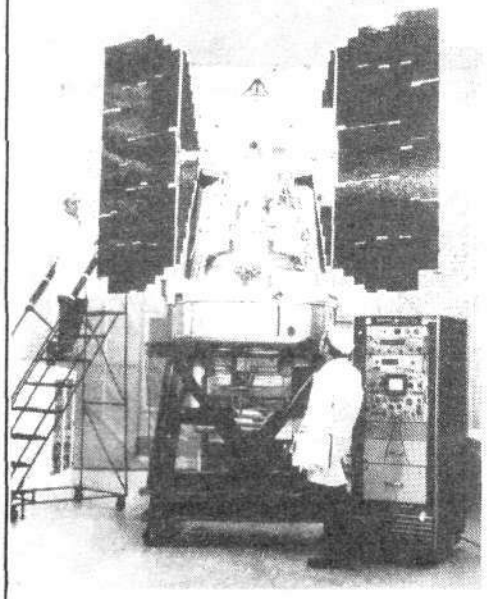

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Letters

Continued from page 12

Support Center, losing 6 positions in Water Management Information, and 10 other positions in small projects. Headquarters and regional staffs will lose 21 positions, and several programs will be completely eliminated, including the air pollution program, the fruit frost program, and the aviation area forecast program.

Forty offices will have reduced functions, and 38 Weather Service Offices will be forced to close throughout the nation, from Bakersfield, Calif., to Trenton, N.J. The reduction and closures of the NWS Offices will be harmful to operational meteorology throughout the United States through lack of observations, and decreasing forecast accuracy and discernment of severe weather events. Weather information and warnings will be degraded, not only in the vicinity of the closed offices, but also in adjacent areas because of the increased workload thus placed on those offices, with decreased manpower.

On June 30, 1967, the National Weather Service had 5,022 full-time employees. On Sept. 30, 1977, after 11 years of new, congressionally mandated programs had been added to our workload, the service had 5,015 full-time employees.

The National Oceanic & Atmospheric Adminstration's (NOAA) Natural Disaster Survey Report 78-1, "Northeast Blizzard of '78, February 5-7, 1978," discovered that "The offices visited were marginally staffed even for 'fair weather' situations. . . . Overtime and the time of unpaid volunteers are used routinely to compensate for the lack of staff. . . . Staff shortages have reached a critical point. Only the dedication, personal sacrifice, and the outstanding professionalism of the field personnel involved made the warning system work in this disaster."

There have been many other weather disasters that have taken hundreds of lives in the past few years. Thirty-five percent of the aircraft accidents that take 1,200 lives per year in the country are weather related. According to National Transportaton Safety Board figures, total aircraft accidents are steadily decreasing, but weather-related accidents continue at the same rate. At present, the total outstanding claims filed against NOAA for weather-related accidents amount to $111 million, with losses of $7 billion claimed. It does not cost the taxpayer to have a good weather service. It pays!

The increased profits for farmers and other commercial users in reduced casualty losses achieved through advance warning represent a sound investment in the NWS. It is not possible to place a dollar value on the lives saved. And the cost to each taxpayer is merely that of a large hamburger, french fries, and a soft drink. For this he gets surface weather forecasts, severe weather and hurricane warnings, and so on.

Although some see the dangers of slashing specific parts of the NWS—for example, the Department of Energy has requested that the Nuclear Support Office in Las Vegas, Nev. be kept open—it must be realized that by providing the necessary personnel and keeping all the offices open, the trend of gradual deterioration of the weather services provided to the public during the past few years would be reversed and would allow *service* to be put back in "National Weather Service."

Stanley W. Marczewski
National Vice President
National Weather Service
Employees Organization
Washington, D.C.

Breeder Review

Continued from page 61

River Breeder Reactor with a new breeder project based on the CDS. Clinch River is currently the strongest U.S. effort in breeder technology, and government sources contend that it could create a workable demonstration of a smaller 350-MW breeder much more quickly than could the CDS. One Nuclear Regulatory Commission spokesman familiar with both designs, however, noted that the Clinch River design features are not as advanced as the liquid-metal CDS.

The issue is not settled, by any means. A new industry report released in May by Edison Electric Institute, Westinghouse, and the Atomic Industrial Forum calls Clinch River "the most advanced demonstration breeder reactor design in the world." Answering criticism that the Clinch River breeder design, which was first authorized by Congress in 1972, lags behind French and Soviet breeder programs, the report outlines technical changes and design innovations not incorporated into the foreign breeder designs.

Commercial breeders would "extend existing uranium resources indefinitely," the report states, and the alternative to development of Clinch River as a demonstration is purchasing *foreign technology, with possibly* permanent dependence on foreign technology resulting.

—William Engdahl

Advanced ABMs

Continued from page 51

totally independent satellites with stand-alone computers and target access sensors, there would be no vulnerable ground-based radars or control centers whose destruction would cause the system to fail.

Will the MX-MPS Be Dumped?

It is far more economical and stabilizing to invest in advanced technology than to simply spend more money on existing defense systems. For example, if the administration takes the $20 billion now slated to set up the concrete MX-MPS and spends it on ABMs instead (that is, on science and advanced technology rather than concrete monoliths in Utah), the nation will have a more economical and effective defense, as the figure illustrates.

But more important, history has conclusively demonstrated that Maginot line types of passive defense always fail, while costing much more than active defense based on advanced technology.

—Charles B. Stevens

Note

1. The Kupperman-Kerr proposal was made in an op ed in the *Washington Star* Feb. 22 and at a defense seminar at the Georgetown University Center for Strategic and International Studies.

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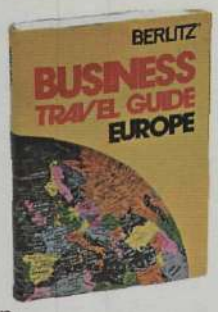

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Another Dividend from Air and Space

Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

Programmable Pacemaker

NASA technology used to send coded information to unmanned satellites or to receive data from satellites has been employed by Pacesetter Systems, Inc., Sylmar Calif., in the manufacture of two-way communication pacemakers which allow a physician to reprogram a patient's implanted heart device without surgery. Introduced in 1979, Pacesetter's Programalith* system consists of the implantable pacemaker together with a physician's console containing the programmer and a data printer. The physician communicates with the patient's heart device via wireless telemetry signals transmitted through a communicating head held over the patient's chest (see photo below).

Earlier design pacemakers only deliver a fixed type of stimulus once implanted. The Programalith system enables surgery-free "fine tuning" of the device to best suit the patient's needs which may change over time with changes in physical condition. The system permits a physician to reset as many as six different heart stimulating functions of the pacemaker. Once a physician programs an instruction for change

in a pacemaker's stimulus parameters, a return signal confirms that the change has been made as instructed. When reprogramming is complete, the system prints out a copy of the new settings for the patient's record.

The two-way communications capability also enables a physician to interrogate the device on the status of its interaction with the heart.

Another space technology application, known as pulse code modulation, has provided a "stimulus dependability" safeguard for programmable pacemakers; it ensures that the pacemaker will accept only properly coded instructions and will not respond to false signals generated by electrical noise or other interference.

* Programalith is a registered trademark of Pacesetter Systems, Inc. NASA does not endorse commercial products developed as a result of its Technology Utilization or Patent Licensing Programs, but does encourage the widest possible use of such technology.

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