FUSION

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The NASA Story

The Fight for America's Future

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FUSION

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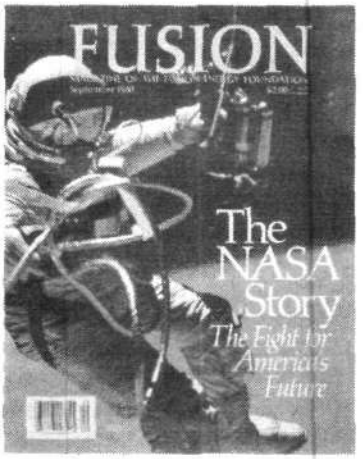

The cover: Astronaut Edward White taking the first U.S. walk in space, March 1965, outside Gemini IV. Cover design by Christopher Sloan; photograph courtesy of NASA.

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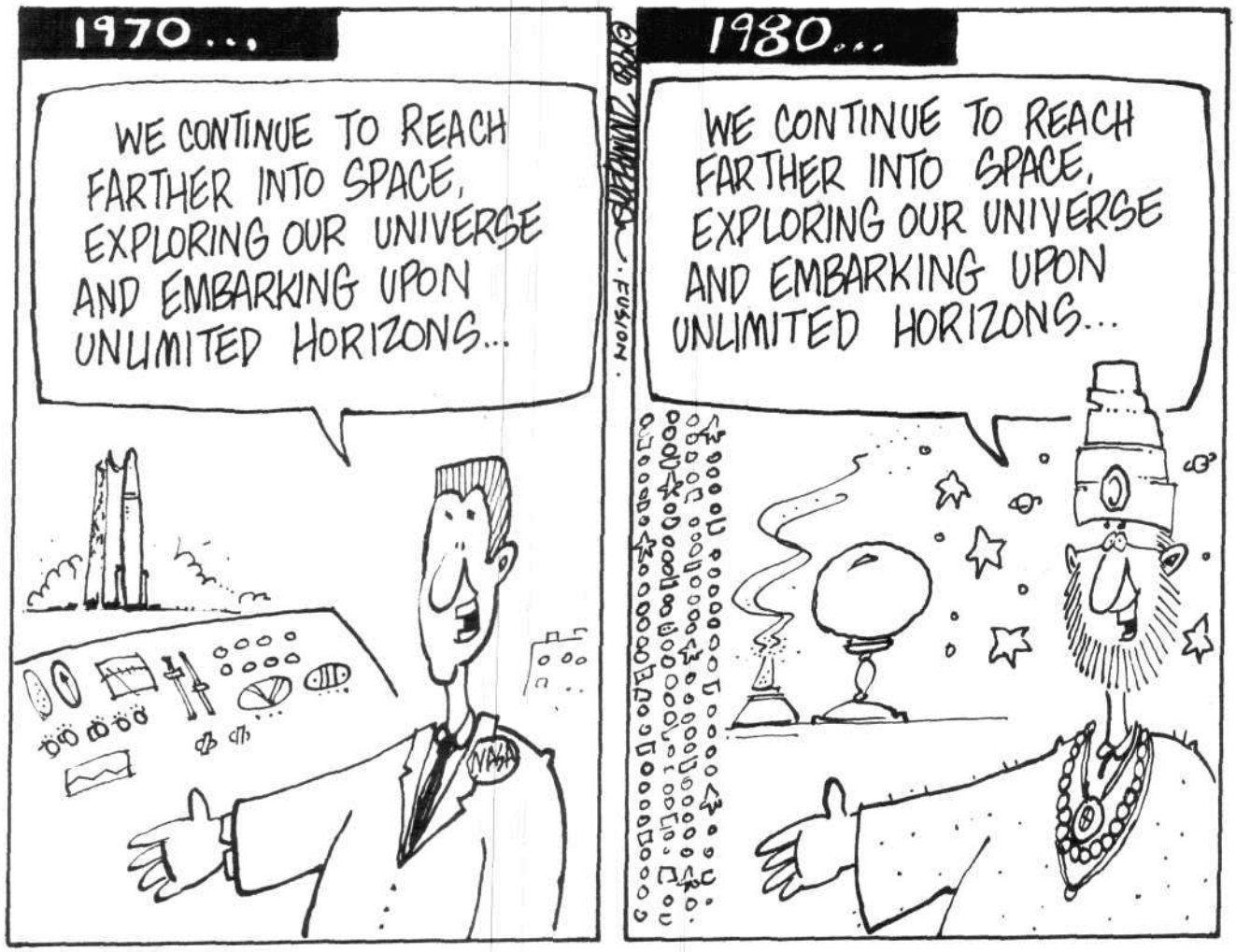
Editorial



The Great Debate Of 1980

Back in the middle-to-late 1960s all sorts of social commentators and philosophical pundits intoned that spending on the space program was diverting resources from needed programs "here on earth," such as education, health care, and jobs. Now the nation's media are filled with an unprecedented flurry of cover stories on the calamitous situations in the economy, the military, and the schools. Less highlighted is the fact that this has occurred despite continued growth in military spending and a huge Health, Education, and Welfare budget at the same time that the space program and U.S. science have been reduced to a hollowed-out shell.

Now, after 15 years of tolerating the destruction of the nation's science and industry at the hands of the Malthusian idiot-savants and the environmentalists, the nation is finally going to undergo a great debate on how to undo the wreckage. The available evidence indicates that there will be two most prominent features of the debate.

The first is that the heyday of the radical environmentalist, antinuclear faction—the Aquarians—is ending, and none too soon. Merely symptomatic is the recent statement by National Academy of Sciences president Philip Handler that the political influence of the environmentalists far exceeds the scope of their scientific competence. His remark occurred in the context of recent Naderite attacks on the NAS for allegedly representing "special interests" because a special NAS committee reaffirmed the necessity for meat and dairy products in the American diet! Several months ago another committee

of the Academy drew an editorial blast from the *New York Times* when it pointed out the dubious economics of large-scale solar energy at the same time that it promoted breeder reactor development.

The main factor that has stiffened the positions of the more traditional leaders of the nation's scientific institutions is easy to identify. The Soviet Union's bold program in scientific education and research—launched at the same time that the U.S. space effort was scuttled—has provided the Soviets with a marginal strategic advantage that threatens to turn into qualitative superiority. This fact alone has made it clear that the zero growthers and their policies must go.

What Kind of Reindustrialization?

This sets the stage for the great debate that will be at the center of the 1980 presidential campaign. It is now generally agreed that the United States must rebuild its science and industry. Thus, the renewed interest by the Pentagon and defense-related think tanks in increasing machine tool production and the use of robotics in military-related production. This has been accompanied by calls for a buildup of U.S. scientific and engineering capabilities and even a renewed emphasis on nuclear power production. This is a potentially positive development.

The burning issue remains, however: *What will be the guiding philosophy and method—the epistemology—of reindustrialization?*

Even at this early stage of the debate two basic positions are shaping up. Their historical dimensions are partially reflected in this issue's feature on the origins and decline of the U.S. space program. One tendency is represented by a systems-optimization approach to building up U.S. industrial and military force levels and capabilities so that military action can be carried through in any distant foreign theater. This form of recommended reindustrialization has as its primary objective the preservation of the very systems and institutions—such as the International Monetary Fund—that have brought us to the brink of economic collapse and war. Thus, it follows that the policies of these institutions, documented in this issue, include the continuation of "postindustrial" economics (small pockets of manufacturing and technology that ignore overall requirements for economic reproduction and growth in advanced-sector nations like the United States), opposition to global economic development and the sovereignty of republics, credit and monetary control by the most backward Anglo-American and supranational banking and economic institutions, and *opposition to generalized scientific progress*, aside from what's required for short-term military purposes.

Even though war and economic decline may be postponed temporarily by this package, its prescription for the continuation of basic North-South and East-West antagonisms (that is, the continuation of Malthusian scarcity economics for the Third World and "geopolitical" power politics among the advanced nations) will lead only to an even more dangerous showdown between the two superpowers by the end of the decade.

The Alternative: A Three-Phase Program

In forthcoming seminars and articles the Fusion Energy Foundation and collaborators will demonstrate in detail why these policies are not viable—strategically, politically, or economically. We shall do so from the standpoint of the policy objectives dictated by the nation's republican-scientific heritage and the needs of present and projected future human populations.

This requires a three-phase program for the 1980s: First, it requires the collaboration of the advanced Western nations and Japan with the OPEC sector to launch the massive nuclear-centered economic development of the Third World. This will be paced by leading developing sector nations such as India and Mexico under the aegis of a new gold-backed monetary and investment system to replace the IMF and United Nations institutions. Second, it requires bringing the Soviet bloc into collaboration with such arrangements to increase the momentum of developmental and war-avoidance activities. Third, we must secure peace through international cooperation among the

Continued on page 5

The Lightning Rod

My dear friends,

While thumbing through my favorite newspaper the other day, I chanced upon an item so extraordinary that, though I read it twice, I could hardly believe what my eyes insisted to be fact; in truth, I became convinced that my spectacles had betrayed me again, and got up to change them for another pair. Whereupon I examined the newsprint for a third time, and was compelled to admit that, indeed, it appeared that the ancient practice of Volcano Worship had been taken up again in our presumably civilized nation.

The item recorded a proposal by the Sierra Club, one of the oldest and most fervent apostles of the peculiar ethic known as "conservation," concerning the results of the recent fiery eruption of the Mount St. Helens volcano in the state of Washington. The Sierra Club, it seems, has urged the state government to designate an area of 10 square miles subjected to the volcano's fury as a National Park—"to commemorate the devastation of Nature," as the Club's spokesman put it.

Consoling myself with the thought that at least the Sierra bunch had not demanded the sacrifice of a dozen or so innocent virgins to the volcano's wrath, I reflected upon where our species might be today if the environmentalists' passion to "commemorate the destruction of Nature" had heretofore been given full sway. It is obvious that mankind would have experienced great difficulty getting past the Flood.

Imagine Noah, hard at work on the Ark, spurring on his sons with the certain foreknowledge of catastro-

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Editorial

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participating sovereign nations in a vastly expanded space and fusion research program aimed at basic scientific breakthroughs and solutions to resource limitations. Within this context, the United States can develop the depth of quality forces and new defense systems (such as particle-beam ABM weapons) required for national security.

Ultimately, a 50-year development perspective flowing from these policies requires a carefully analyzed mix of different development strategies for the various global sectors, the rapid expansion of existing basic industries at the same time that we "leap-frog" to new, more efficient and automated technologies, and the greatest research and education program in history, centered on commercialization of fusion power. All these areas—energy, industry, technology, education, and science policy—will be extensively discussed with the American citizenry in the coming months using the analytical tool uniquely suited to these problems: the LaRouche-Riemann economic model.

This nation produced so mightily to win World War II in the 1940s, marshaled its technological forces to develop commercial nuclear power and to put a man on the moon in the 1950s and 1960s, and achieved the scientific breakthroughs in the 1970s that have brought us to the brink of the fusion era. Now we have the unique opportunity to win permanent security and peace in the 1980s, finally realizing the centuries-old Grand Design of our republican forefathers—if we guide American reindustrialization by the same principles of political economy and morality that built the nation.

Lightning Rod

Continued from page 3

phe, suddenly interrupted by an environmentalist. Naturally the environmentalist would carry a court order in his back pocket, as they are practically never seen without one.

"You must quit this task immediately," our Mr. Green informs Noah officiously. And when the venerable gentleman protests, as he must, "You're crazy, there's a Deluge coming," the environmentalist whips out his legal document in reply.

"Exactly my point," says Mr. Green. "Your ark constitutes an unacceptable interference with the natural progress of the waters, and besides, it is not equipped with an airbag and may be unsafe. It's all here—in triplicate."

Noah's appeals to a higher law are, of course, misconstrued by the environmentalist. "Yes, yes," he exclaims, "you mean the Permanent Wilderness Act, which specifies that alterations in Nature are permissible for the commemoration of some Unspeakable Catastrophe. You want to build a monument to the Flood, that's okay, I can't stop you. But it's still gotta have an airbag."

It would probably take some assistance from Ham and Shem, together with a few pointed gestures with Noah's hammer, to dispatch Mr. Green from the premises and allow the building of the Ark to proceed. (And you can be sure the moment Noah was finished and had begun loading up the animals "two by two," Mr. Green would reappear at the head of a Gay Rights group demanding that the Noah family cease and desist from its discriminatory practices against the third sex.)

Taking a more contemporary instance, suppose the Sierra Club had been an influential force in midwestern American political life at the time of the Great Chicago Fire. Would the citizens of Illinois today, instead of enjoying the benefits of the vast commercial and industrial metropolis on Lake Michigan, be better off with a giant bronze statue of Mrs. O'Leary's cow?

Let us commemorate the power of Nature by improving her works.

Yr. obt. svt.,

Letters

Riemann Vs. Darwin: Evolution Not Random

Carol Cleary's article "Evolution: A Riemannian Approach to Biology" in the March 1980 issue of Fusion *has drawn blood from James Bonner, one of the nation's leading researchers in molecular genetics and a staunch Darwinian.* Fusion *is pleased to print Dr. Bonner's letter and the author's reply and plans future articles on the subject of evolution.*

To the Editor:

I bought an issue of your magazine at the Los Angeles Airport the other day and I read it with great enthusiasm, happy to find somebody who, like me, believes that the future of our civilization depends upon nuclear energy as the principal source for energy in the next, perhaps, one or two generations. I read with special interest "The Fight for Nuclear Energy: Showdown in Sweden" [March 1980], which has now come out very well indeed, and the varied suggestions about how to promote fusion research which I admit is underfunded and should indeed be very much more intensively funded. . . . All in all I found *Fusion* to be an absolutely first-class magazine. . . .

And then I came to the article by Carol Cleary about "Evolution, A Riemannian Approach to Biology." The opening sentence of this article shows that the author is uninformed or otherwise incompetent: "The recent publication of chromosomal studies of the offspring of two different primate species threatens to trigger the final collapse of the shaky marriage between Darwinian theory and molecular biology."

The hybridization of species of different chromosome numbers or different chromosome structure has been known for years and years. It

started, perhaps most clearly, with the hybridization of two different subspecies of Drosophila pseudo-obscura by Theodosius Dobzhansky in the 1930s. Anyway, the fact that species with different chromosome numbers can cross is understandable; it's a well-known fact; it's been going on for thousands of years. It generally does not produce fertile offspring, of course, and that's what makes them be different species in the first place.

Now we go on to pages 48 and 49: "After the acceptance of Darwin's theory, the development of molecular biology and Mendelian genetics led to the viewpoint that inherited differences occur at the gene level, the level at which a nucleic acid molecule apparently 'codes' for one specific protein molecule. Thus, the marriage between molecular biology and Darwinian theory was consecrated on the basic tenet that changes on the gene level brought about by random-point mutations slowly create variations that, under the pressure of natural selection, cause evolution to occur."

No Use to Complain

This is a true, accurate, and accepted statement of the way things are in the state of knowledge today. It's no use to complain, as the author does on page 49, that prokaryotes are different from eukaryotes and don't have the "institutionalized internal differentiation of more evolved cells, the eukaryotes." Evolution in prokaryotes is exactly the same as it is in eukaryotes. It's selection of the fittest and the differences between individuals are brought about by random mutation as has been shown over and over again by mutagenizing populations and selecting for particular characteristics.

The author's complaint that attempts to extend comparative biochemistry beyond the case of bacterial cells to eukaryotes were largely unsuccessful is absolutely and totally untrue. The advances in our knowledge of eukaryote evolution and the nature of eukaryote selection are totally dependent upon the knowledge that we have gained from the study of prokaryotes, but most importantly, due to the knowledge that we have gained from the study of Drosophila,

This op-ed in the June 23 New York Times is an example of the fuzzy thinking of contemporary biologists. Author Harold J. Morowitz of Yale University decries the recent U.S. Supreme Court decision that allowed genetically engineered organisms to be patented (see News Briefs, page 11).

which is, of course, a highly differentiated eukaryote.

I totally disagree with the conclusion reached on page 50 that changes in chromosomal number and chromosomal arrangement, rather than point mutation, occur at a sufficiently rapid rate to account for speciation among vertebrates. This is not proven. It's not even a viable hypothesis. And it's particularly clearly not the case when we look at Drosophila where major changes in the chromosomal arrangements occur with minor changes in Drosophila speciation. Take, for example, the many, many collections of Drosophila pseudo obscura collected by Dobzhansky and his followers, which differ from one another by inversions, translocations, etc. and are, nonetheless, one and the same species.

I don't want to go on and on complaining. The whole article is not a professional one: The Hapsburg traits that occur only under static equilibrium conditions, the rapid evolution of the horse (God knows how many reasons there are for the rapid evolution of the horse, although obviously there were many), the case of wheat, but wheat has been played with by humans and that's why it's evolved so enormously fast during the last 10,000 years, as everyone knows.

The Ultimate Insult

And finally, on page 52, the ultimate insult which is stated, "Once it has been established that evolution occurs on the chromosomal and not on the gene level, one or another clever student will inevitably conclude that the epistemological features of this argument are just rhetoric." Well, they are. Evolution occurs on the level of mutation and I think every geneticist of any maturity and sense of proportion and sense of sense knows this.

Even Francis Crick knows it. When he says that in higher organisms the gene has, if anything, more nonsense than sense in it, he's referring to something on the molecular level which the author of the present article hasn't even thought about and probably doesn't even know about, namely the introns and the exons. And then the author goes on to ask, "If we smash the mysterious idol of natural selection, and throw away its dice, what kind of causality can we come up with?" This is just the kind of stupid argument that I can't see why anyone would ever bring up. Remind me to read your journal, if ever again, only to be annoyed.

Stick to stuff you know about, like fusion and fission, and don't quote John Sedat, my former advisee, and Laura Manuelidis (something about the structure of chromosomes). I am confident that John and Laura don't go for this sort of guff either. What the author is talking about is absolutely nonrelevant to the study of biology today. It makes your otherwise worthy journal suspect. If a person that knows something about a particular article in your journal finds that it's just a bunch of hogwash, then what is he to think about the rest of the journal? . . .

James F. Bonner
Professor of Biology
California Institute of Technology
Pasadena, Calif.

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Letters

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The Author Replies

In his haste to defend Sir Charles Darwin, Dr. Bonner has neglected the experimental evidence of Drs. Bush, Wilson, Levin et al. which was the main scientific substance of my article. This oversight conveniently allows Dr. Bonner to ignore the point of my article, "Evolution: A Riemannian Approach to Biology." However, I will not let him dodge the scientific evidence or its epistemological and moral implications.

In studies involving more than 10,000 species, Drs. Bush, Wilson, Levin et al. have demonstrated that random point mutations cannot account for the relatively rapid rate of evolution of placental mammals. Of all the inherited features studied, only chromosomal changes correlate with that evolution, and these changes are associated with changing *global* bioenergetic relationships.

The traditional tenets of Darwinian biology, fully elaborated by molecular genetics, are thereby disproven. The article's point is to explain why that should be so, and to propose an alternative.

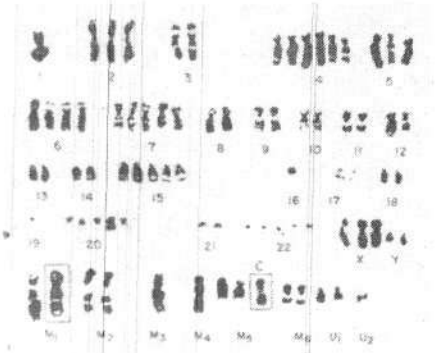
Dr. Bonner, you have prowled around the outside of this discussion, sniffing something that, perhaps, frightens you. Hurling epithets in its direction ("incompetent," "uninformed," "stupid argument"), you scamper off in the other discredited direction. Why not face the evidence, probe to the core of the argument, and rethink your area of expertise from the standpoint of a more advanced hypothesis?

The evidence establishes that changing chromosomal structures occurred at a rate that could uniquely account for the rate of evolution in the historic record of placental mammals. This, of course, is a matter of correlation. What remains open is the *causal* question. If chromosomal change accompanies speciation, under what circumstances, and how?

There is really no point in referring to T. Dobzhansky's experiments on pseudo-obscura fruit flies. Admittedly, he managed to produce all sorts of chromosomal changes that did not result in speciation. But then, evolution could not have occurred under the constrained conditions of Dobzhansky's laboratory.

A Riemannian Approach

I used the phrase Riemannian approach for this reason: Evolution is not "random point mutation" of a particular member of a species, but a nexus of the most rapidly evolving species currently transforming the biosphere. This internally differentiating nexus, or singularity, is socially organized such that general increases in biological energy throughput are nonlinearly amplified and channeled into the progeny of those species. Such progeny, born within this geometry of biological energy surplus, then generate still further advances in the biochemical and technological capacity of the singularity to transform the biosphere even more rapidly.



Chromosomes: The chromosomes from a human cancer victim, showing pronounced structural aberrations.

Thus, evolution is the path of the biosphere from lower to higher rates of overall energy throughput via speciation.

What evolves is the characteristic mode of capture of solar energy by life forms whose "living" nature is to employ inorganic "resources" to convert solar energy into biological material. The mammalian-angiosperm "warm blooded" complex, for example, constituted a new "technology" of the biosphere, altogether redefining inorganic "resources" for life on earth. Compared to reptilian forms, they had significantly greater population potentials, greater differentiation potentials, higher rates of solar energy conversion by biological processes, and a capacity for sustained increases in overall biological energy throughput by further development in this way. By the time of the Upper Oligocene, the mammalian-angiosperm forms were, quite literally, "making deserts bloom."

No theory of "natural selection" is required or possible. "Survival of the fittest" and "scarce resources" are the driving force of decay. Abundant and growing "free energy" is the driving force of evolution. By the Upper Oligocene, for instance, a certain array of angiosperms began to speciate into the forms called grass and spread with rapidly speciating ungulates into the deserts of continental interiors, transforming net "reflectors" of solar energy into concentrations of biomass 10 times the density of the deciduous forest. Evolving mammalian-angiosperm forms did not adapt to an environment, but evolved to create their own, ever more energy-dense biosphere.

Negentropy

Evolution is not random, but causally negentropic.

In light of the evidence presented in molecular biology by Bush et al., the substance of my article addressed the proposal that highly ordered chromosomal geometries mirror increased rates of biological energy throughput in a species positively interacting with an increasingly differentiated, energy-dense biosphere.

My hypothesis was that the most rapidly evolving species of placental mammals were socially organized, such that general increases in biological energy throughput were concentrated, amplified in a nonlinear fashion, and channeled via chromosomal reordering into the progeny of the species. In sum: speciation means relatively rapid increases in biological energy throughput, sustained and, as it were, "institutionalized" in chromosomal change.

The case of flax is one of inherited

change accompanied by an at least temporary increase of DNA per cell, implying a significant change in global chromosome geometry in flax nuclei—achieved by increased biological energy throughput under optimal growing conditions. This is contrasted with cancer—inherited genetic change by entropic changes in biological energy throughput—and with the necrotic cell, in which sudden collapse in energy throughput changes cell geometry dramatically toward quasi-crystalline structures like those found in inorganic chemistry.

Biological "space" is a geometry corresponding to a higher energy flow than that of the inorganic realm at comparable temperatures. The highly ordered, highly differentiated geometries of eukaryotic nuclei are susceptible to both entropic and negentropic change based on biological energy throughput. The flax case, in fact, corresponds to the "singularities" through which the biosphere evolved in the Cenozoic: chromosomal change under conditions of increasing biological energy throughput and higher states of organization resulting (uniquely) in speciation.

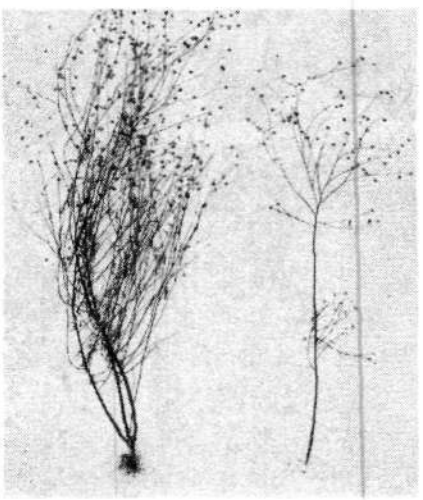
Dobzhansky Vs. Causality

It is most useful that Dr. Bonner raises the issue of Theodosius Dobzhansky, his mentor. Dobzhansky trained under circles at Kiev associated with the Societas Jesu; in 1969, he was president of the Teilhard de Chardin Association, of which he was a member of long standing; and he is the exemplar in molecular biology of that apparently contradictory combination of Jesuit empiricism and mysticism that logically ensues from the substitution of statistical correlation for causality in science.

In contrast, the Neoplatonic tradition locates the emergence of man in his unique powers of Reason. Conspiracies of Reason have generated the Renaissances that have repeatedly transformed the biosphere itself by qualitative leaps in the pace of human scientific and technological activity. These leaps lift the human species from the burden of beastlike pursuit of sustenance to its highest creative potential. This, in turn, becomes the primary force for continued evolution of the lower-order inorganic and organic domains.

This is certainly not the worldview of Malthus, nor the pseudoevolutionists Darwin and Dobzhansky. As one of this century's most respected experts on genetics and "evolution," as he terms it, Dobzhansky conducted experiments in an "equilibrium" fishbowl, effecting genetic mutations on totally inbred laboratory Drosophila, without a thought for the actual historic processes of evolution and their causes. With causality stripped out, the evolutionary process is rendered inexplicable and man is relegated to bestialism and the supernatural.

"To many, Darwin seemed to have delivered the heaviest blow, making the schism in man's soul irreparable:



Flax: Fourth-generation flax plants derived from a single set of parents, showing nonmutational heritable changes that refute current neo-Darwinian dogma.

far from the world having been made for man, man himself proved to be merely one of some two million biological species . . . and a relative of creatures as disreputable as monkeys and apes," wrote Dobzhansky in his oft-quoted *Mankind Evolving*.

There is, however, "a source of hope in the abyss of despair." Dobzhansky continued: "Teilhard de Chardin saw that evolution of matter, the evolution of life, and the evolution of man are integral parts of a single process of cosmic development. . . . He chose to designate the direction in which evolution is going as 'The Point Omega' . . . 'a harmonized collectivity of consciousness' . . . a kind of superconsciousness. . . . The plurality of individual thoughts combine and mutually reinforce each other in a single act of unanimous Thought. . . . In the dimension of thought, as in that of Time and Space, can the Universe reach consummation in anything but the Measureless? . . . This is nothing less than a fundamental vision. And I shall leave it at that."

But Dobzhansky did not leave it quite at that—an "equilibrium" world where all evolution ends and man just meditates with Teilhard and the rest of the Aquarians. For example, he wrote:

"Despite having been temporarily perverted by racists, *the eugenical idea has a sound core*: human welfare, both with individuals and with societies, is predicated upon the health of the genetic endowment of human populations," Dobzhansky wrote in the same source. "Osborn (1951) has rightly said that 'eugenics is not in opposition to efforts to improve the environment, but in many cases a necessary supplement to their success.' "

Quite predictably, the outcome of Dobzhansky's Darwinian method is eugenics, dividing the world into the "fit" and the "unfit." Do not mistake my meaning. We must pursue all promising avenues of genetic and recombinant DNA research to achieve all the obvious benefits in medical and agricultural practice. But we must also have the larger theoretical basis for making the *fundamental* research breakthroughs we need to cure cancer, to develop more productive agriculture—in short, to make possible new leaps forward for future generations. Dobzhansky's Darwinian genetics lead only to the depopulation schemes of the Malthusians.

Is this really what you want, Dr. Bonner?

Carol Cleary

News Briefs

Carlos de Hoyos

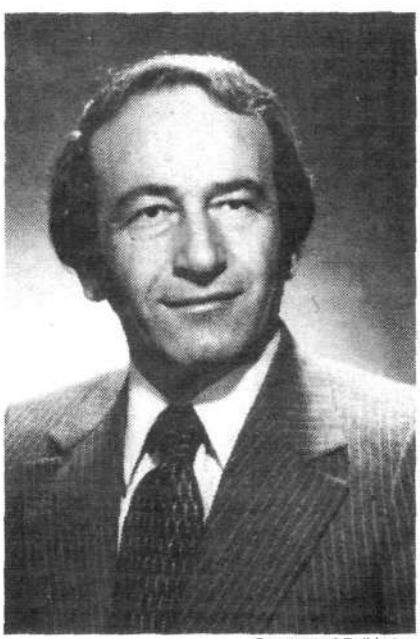
Uwe Parpart

FEF RESEARCH DIRECTOR PARPART TOURS INDIA

Addresses in New Delhi to the Indian National Science Academy and the Nehru Memorial Museum and Library concluded a three-week lecture tour of India by Dr. Uwe Parpart, director of research for the Fusion Energy Foundation. The tour, which Parpart described as one of his most refreshing in recent years, included speeches before hundreds of scientists, planners, industrialists, and technicians in Hyderabad, Bombay, and Bangalore on India's exceptional potential for economic "takeoff" and on recent progress in thermonuclear fusion energy development.

"Fusion is not only an energy source," Parpart told an audience of 45 scientists and policymakers at the National Science Academy June 6, "it is a revolution in technology, in disposal of nuclear waste, in chemical recycling and reprocessing, and reducing materials to plasmas at the high temperatures in a fusion reactor," as well as cracking water to develop hydrogen as a portable fuel. Challenging all "limits to growth" perspectives, Parpart concluded, "Science is not for the colonies or the colonizers nor for the rich or the poor. Science is universal. Only if we view it from that standpoint does mankind have hope for the future." At the Nehru Memorial Museum and Library June 7, Parpart's warning that without industrialization India faces uncontrollable chaos was followed by lengthy discussion with the 70-member audience. The chairman of the lecture, Dr. Raga Ramanna, a leading scientist with the Indian Defense Ministry and national nuclear program, commented on his pleasure at "somebody coming from abroad who makes the case for nuclear energy."

Parpart's tour received wide coverage in such major Indian daily newspapers as the *Times of India*, the *Statesman*, the *National Herald*, and the *Patriot*. The next issue of *Fusion* will feature a full report on Parpart's tour.



Courtesy of Bell Labs

Dr. Solomon Buchsbaum

DOE PANEL URGES UPGRADING OF FUSION

The fusion review panel of the Department of Energy's Energy Research Advisory Board released its preliminary report June 23, urging a vast upgrading of the U.S. fusion program. The panel, led by Bell Lab vice president Dr. Solomon Buchsbaum, has recommended a timetable for fusion development similar to that proposed by Congressman Mike McCormack (D-Wash.) and supported by the Fusion Energy Foundation. The Buchsbaum committee recommends that in the next decade the department's magnetic fusion program build a $1 billion facility to demonstrate the engineering feasibility of fusion power. Before the end of the century, it states, the United States should demonstrate commercial feasibility under the guidance of a Fusion Engineering Center, which would supervise the construction of a demonstration power plant. At the same time, the panel concludes, the annual magnetic fusion budget should be increased to $1 billion per year within five years to prepare the program for the next-step large fusion devices.

The October *Fusion* will publish the full Buchsbaum report.

MEXICO FEARS MISUSE OF U.S. WEATHER MODIFICATION

The Mexican Federal Electricity Commission June 20 ordered electric power cutbacks of up to one-third for industrial users in many parts of the nation because of hydroelectric power shortfalls caused by the worst drought in two decades. Oil pipe output, aluminum smelting, and automotive engine block production are among the industries affected. On June 15, the federal government had asked the Carter administration to halt its meteorological reconaissance flights over Mexico, which divert the path of hurricanes. The chief of the Mexican Agriculture and Water Resources Minister's meterological department has stated that the experiments produce "nonbeneficial effects," citing last year's inundation of Cuba by hurricanes while storms never turned inland to bring rain to Mexican farmlands. Four and a half million head of cattle are in danger of starvation because of the drought, millions of dollars'

worth of crops are in jeopardy, and peasant unrest could intensify. The agricultural devastation may increase pressures by the Carter administration to force diversion of Mexican oil revenues from industrialization programs into food imports from the United States, which observers have noted means surrender of Mexican sovereignty over export and pricing policy.

WESTERN SUMMIT PROMOTES 'COAL AND NUCLEAR' POWER

The June 22-23 economic summit meeting of Western leaders in Venice resolved to decrease oil consumption from 53 percent of total energy resources to 40 percent over the next decade in the leading noncommunist industrialized nations. Pledging to "conserve energy but also develop alternative alternate sources," the heads of government proposed to double coal production and increase nuclear power output. The 1979 summit in Tokyo had mandated an expansion of each country's nuclear energy program, a mandate ignored over the past 12 months by the Carter administration. At Venice, the final communiqué regrettably affirmed a polcy of "delinking" energy, in particular oil, consumption from economic growth.

COAL STRATEGISTS PUSH FOR CARTEL

The U.S. Interagency Coal Export Task Force established this spring by the White House issued recommendations in June for an expansion of U.S. coal exports from the present 66 million tons to 266 million tons by the year 2000. The recommendations are based on this year's *World Coal Study*, produced by the Massachusetts Institute of Technology under the direction of Prof. Carroll Wilson, a member of the Trilateral Commission and the Club of Rome. It proposes that one-half of the increments in world energy use over the coming decades should derive from coal rather than oil, natural gas, or nuclear power, supplied by a de facto "coal OPEC" consisting of major exporters Australia, Canada, the United States, and South Africa.

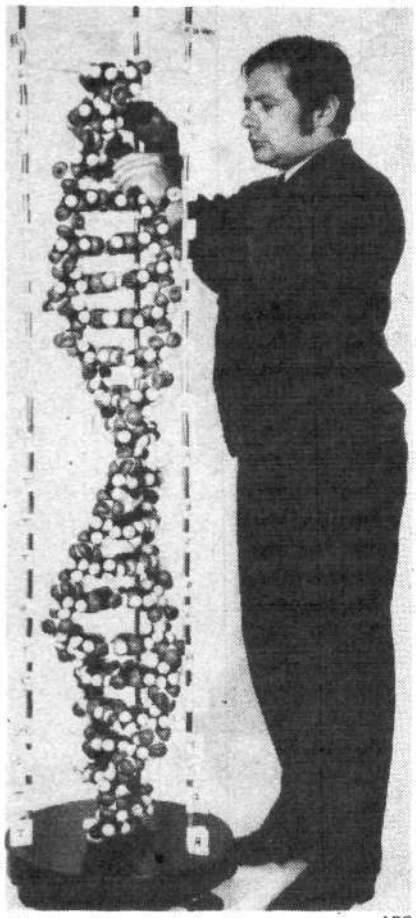
COURT UPHOLDS GENETIC ENGINEERING PATENTS

The Supreme Court ruled 5 to 4 June 16 that the products of genetic engineering techniques are covered by U.S. patent laws. The divided vote reflected concern over whether Congress intended the patent laws to include new life forms, and not over the so-called ethical questions that have become associated with the recombinant-DNA issue. Current patent laws basically cover manufactured or synthesized products, but also include unique seed stocks, reflecting governmental encouragement of agricultural innovations.

The ruling should provide a strong impetus to commercial engineering of bacteria to produce such biomedical products as insulin, interferon, growth hormones and other hormones, and products for the chemical, oil, and farming industries. The People's Business Commission, which supported the losing government position as a friend of the court, called the ruling a mandate for a "Brave New World." The PBC was formerly the proterrorist People's Bicentennial Commission.

COLONIES IN SPACE: SOVIETS TO LAUNCH 12-MAN SPACE LAB

In a major step toward initiating colonies in space, the Soviet Union plans to launch a 220,000-lb., 12-man permanent space station in earth orbit as early as 1983, according to the June 16 issue of *Aviation Week & Space Technology*. Awaiting completion of the 14-million-lb. thrust booster and a winged, reusable shuttle for supplies and men, the space lab will facilitate in-orbit assembly of vehicles for the Soviets' planned exploration of Mars and the Moon. Lt. General Vladimir Shatalov, leader of the cosmonaut training program, commented June 5 that the space lab will allow expansion of ongoing scientific and industrial research, since a large number of the crew no longer need be flight specialists. The Soviet space program employs 100,000 scientists and engineers and has kept up a 3 to 5 percent real rise in annual funding.



Molecular model of DNA AEC

News Briefs

U.S. BUDGET CUTS TARGET NATIONAL LABORATORIES

The House Appropriations Committee's Water Resources and Energy Subcommittee approved in mid-June a Department of Energy budget that would cut $28 million from high-energy scientific research funding. Researchers meeting June 18 at Fermi National Accelerator Laboratory in Batavia, Illinois said that more than 600 highly skilled basic-science researchers might have to be dismissed, and might be very difficult to rehire. According to Fermilab director Dr. Leon Lederman, the cuts would also mean mammoth waste of capital investment and manpower. The physicists said that the cuts will necessitate closing major particle accelerators for several months a year for lack of operating funds. "We are equally concerned about all the other areas of basic science that will be affected by these cuts," Lederman added.

ANTINUCLEAR CONGRESSMEN MOBILIZE AGAINST URANIUM EXPORTS

After President Carter reaffirmed his decision June 19 to license the shipment of 38 tons of enriched uranium for India's Tarapur nuclear power facility, members of the U.S. Congress sought to block the export by securing a two-thirds vote against the authorization within 60 days. Led by Rep. Ed Markey (D-Mass.), 35 congressmen have filed a resolution opposing the fuel shipment, and a joint resolution of the Senate Foreign Relations and Government Affairs Committees strongly condemned the White House move as jeopardizing the administration's nonproliferation program. The president's decision was shaped by State Department insistence that breaching the fuel shipment accord would damage relations with India, to whom, as Undersecretary of State Warren Christopher recently told Congress, the Soviet Union would be "delighted" to make up the enriched uranium deficit.

WESTERN WATER SUPPLY STILL JEOPARDIZED

The U.S. Supreme Court voted June 16 to exempt California's Imperial Valley from the 1902 Reclamation Act, which denies federally funded water supplies to irrigate farms over 160 acres. Unanimously overturning an appellate court decision, the justices ruled that the valley's farms are entitled to draw Colorado River water through the canal financed by the Boulder Canyon Project Act of 1980, which specifically exempted large farms from the 160-acre limit.

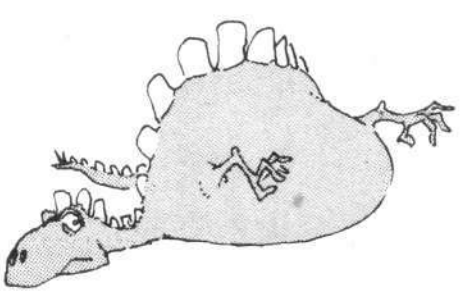
Less noticed, however, was the Arizona state legislature's passage a week earlier of strict conservation mandates on groundwater use by all major agricultural, industrial, and municipal consumers. The law was drafted by private and public users under a threat by the Department of the Interior to delay the Central Arizona water project. One effect of the state law will be to restrict owner-operated farms' use of natural reservoirs.

LOUSEWORT LAURELS TO AIF'S CARL GOLDSTEIN

Unhappily, this month's award is the first to a member of the nuclear industry. The Lousewort Laurels for September go to Carl Goldstein, public relations officer of the Atomic Industrial Forum, for his views on high technology. Our thanks to a visiting West German industrial representative who submitted the item to us, quite outraged at the outlook of the ostensibly pronuclear Mr. Goldstein.

As relayed to us, Mr. Goldstein commented on the "attractive views" of the Fusion Energy Foundation and then offered the following remarks about the alleged effect of a full nuclear gearup: "Nuclear energy, any high technology, and intensive energy development will bring this country to a state of prosperity and complacency, which only a lot of energy and high technology can bring you to. And then, once this country is so prosperous, and so complacent, and so fat, then it can be subverted; the government can be toppled because it will be half asleep."

Does this mean that if the United States is poor, unhappy, and austere, then it will have true national security?



Viewpoint

The Logic of Nuclear Waste Disposal

by Joseph R. Dietrich

The so-called problem of nuclear waste disposal is a favorite theme of members of the antiprogress cult that seeks to deprive the world of the blessing of peaceful nuclear energy. Their arguments defy logical reason:

- They consider the design of a permanently safe means of waste disposal beyond the power of human ingenuity; yet, they consider the far more difficult problem of generating economical solar electricity to be readily solvable.
- They stress the immorality of leaving to future generations a store of radioactivity that they perceive might enter the biosphere millennia from now; yet, they think nothing of burning up our coal, oil, and natural gas in a few centuries—resources that in the long term are far more important as raw materials than as fuels.
- They stress the dangers of nuclear waste disposal and nuclear power plants; yet, they discount the dangers of a world energy shortage that could lead to nuclear war as nations seek to gain the energy they need to survive—a war that could depopulate the earth.

This environmentalist cult has misled the public to the point that politicians are afraid to allow disposal sites within their respective states. What an absurd situation! Deep geologic burial, which is only one of the barriers to be engineered into the waste disposal facility, in itself can isolate the waste from the biosphere for thousands of years.

When such a delayed risk of a low-level addition to the natural radiation background is compared to the far greater risks that the human race faces over the next few thousand years—from hunger, depletion of natural resources, and the wars that these problems can engender—it hardly seems a subject for political controversy at this time.

Overriding the Uncertainties

Thus the disposal of nuclear waste has become a political problem rather than a technical one. The government has taken responsibility for disposal, and it postpones action because there are "uncertainties."

Engineers know that there are uncertainties in many engineering projects that can affect human health and safety. The way to make such a project safe is to employ design conservatisms that override the uncertainties. This can be done in the case of nuclear waste disposal and at a cost that will add little to the consumer's bill for nuclear electricity.

Design engineers are problem solvers. Those who agonize over nuclear waste disposal are problem seekers rather than problem solvers. Design engineers *can* provide safe, permanent, nuclear waste disposal through the applications of conservative design methods. That is not to say that research and development on nuclear waste disposal should be stopped; continuing R&D will reduce the needs for conservatisms and thus reduce costs.

Since the beginning of the nuclear era, research on high-level waste disposal has been concentrated on the disposal of wastes separated from spent nuclear reactor fuel. The current government ban on reprocessing of commercial nuclear fuel, if permanent, would require further development and further delay (because there would be no separation of high-level waste from reprocessable spent fuel). Meanwhile, there is much high-level separated waste awaiting permanent disposal—waste from the military programs. We should proceed rapidly with permanent disposal of that waste, and by the time the task is completed we will probably have more perceptive government policies.

It is essential that we move quickly, for the perceived "problem" of disposal turns more and more people, and local and state governments, away from nuclear energy—an energy source that can supply our electrical needs for tens of thousands of years and that has the potential for supplying energy needs other than electrical.

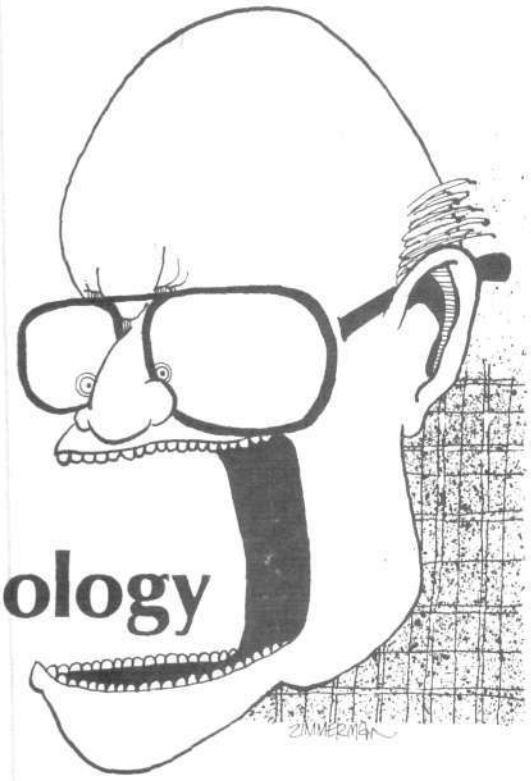
An Act of Compassion

Nuclear power is supported by knowledgeable leaders of disadvantaged minorities in the United States and by many developing countries. Their experience with poverty has convinced them that abundant energy is necessary for them to achieve a comfortable position in the world. They have learned, through bitter experience, the lesson of history: that energy generation by mechanical means is the alternative to slavery.

For these reasons I believe that anyone who has compassion for the poor and for the disadvantaged, if logical, will support nuclear power. Anything that will remove the misconceptions that nuclear power is a dangerous, immoral route to follow is an act of compassion. Therefore, *Fusion* magazine is to be congratulated for providing an article on nuclear waste disposal [August 1980] that should remove some of those misconceptions.

Joseph Dietrich, who recently retired as chief scientist of the nuclear division of Combustion Engineering, is one of the founders of the U.S. nuclear industry.

Special Report



Why Monetarism Destroys High Technology

by David Goldman

One suspects that American conservatives who try to portray the monetarism of Milton Friedman and others as a route to high-technology economic growth either have not done their homework or are less than ingenuous on the subject. It is not merely that the application of Milton Friedman's methods to the American economy—such as Paul Volcker's announcement Oct. 7, 1979 that the Federal Reserve would pursue strict monetary targets no matter what—have thrown us into the most rapid industrial collapse in American history. Friedman's views, like those of his counterparts in the Vienna monetarist school, are zero-growth in content and origin.

Monetarism Is Not Economics

Monetarism is not really economics at all because, as Milton Friedman put it, "real income is determined outside the system." Factors that even in the short run make behavior of the money stock irrelevant as a yardstick of economic performance are excluded from Friedman's consideration; for example, the rate of introduction of technology, the rate of growth of labor productivity, the rate of capital formation, the distribution of investment between goods-producing and service sectors.

It is obvious that net credit creation is noninflationary, or even counterinflationary, if that credit puts on line new technologies that significantly increase labor productivity. Was it inflationary to increase credit availability to the computer industry, which has reduced data processing costs by *50 percent* per year over the past 10 years? If similar technologies are available in other sectors, will credit extension to these sectors increase or decrease inflation?

Friedman's widely circulated proposal to limit the growth of money supply to 3 to 5 percent per year assumes that this band represents the long-term growth potential of the United States, a wholly arbitrary and indefensible presumption. The long-term growth rate is an industrial engineering consideration that Friedman intentionally ignores. During World War II America achieved 20 percent annual growth rates. The LaRouche-Riemann computer econometric model, developed jointly by the *Executive Intelligence Review* and the publishers of *Fusion* magazine, has also demonstrated that under the right investment mix, the American economy could achieve a potential growth rate of close to 9 percent by the end of the 1990s.

Technologies Stifled

The effect of Friedman's policies is to stifle investment in productivity-generating, counterinflationary technologies. In fact, monetarist policies are likely to be inflationary rather than deflationary, particularly when applied to an already weak economy. Milton Friedman and the monetarists should have been laughed out of the profession on the basis of the past year's events in Britain alone. At the time the Conservative Party government of Margaret Thatcher took office in April 1979, British inflation was 6 percent annually, measured by the Consumer Price Index. Thatcher applied Friedman's monetary doctrine rigorously and cut money supply growth by half, to about 7 percent per year. During the same period, the British inflation rate *quadrupled* to 22 percent per year, while industrial output fell by 8 percent!

No Keynesian free-spender has ever managed to produce such stunning results in any industrial country and Friedman deserves a certain type

of congratulations. In fact, something similar happened in the United States, after Paul Volcker announced last October that the Federal Reserve would restrict money supply growth by a Friedmanite formula. When Volcker introduced his program the inflation rate was 13 percent; within five months it had risen to 20 percent.

The reason that Friedman's recommendations have produced the 180-degree reverse of the expected is not really obscure. Weakened by 15 years of obsolescence and underinvestment, American industry must react to increased interest costs by raising prices. There is no give left in its financial structure. Britain's industry is currently running a financial deficit about equal to the government's, at 7 billion pounds a year, and the impact of higher interest rates is purely inflationary.

Deliberate Zero-Growthers

There is nothing accidental about Friedman's antiindustrial bent. His predecessors among the "quantity of money theorists" were explicit zero-growthers. David Ricardo, the formulator of the "quantity theory," believed—along with his close friend Parson Malthus—that the exhaustion of arable land would lead to higher grain prices, hence higher wages and lower profits, until industrial growth stopped. The Vienna monetarists—Menger, Mises, Hayek, and others—not only insisted that production was doomed to the Ricardian "falling rate of profit," but argued that industrial production was "nothing more than changing the position in space" of objects given by nature. The *feudal* notion that wealth is bounded by nature goes back to Aristotle's *Politics*, culminates in the Club of Rome's *Limits to Growth* nonsense, and includes the entire monetarist school along the way.

No one should be surprised that the "classical school" of Smith, Ricardo, Malthus, Bentham, and Mill was antigrowth in basic outlook. Every one of them worked for the East India Company, which plugged the hole in Britain's foreign payments account with revenues from the opium trade. Ricardo was a member of the East India board of directors, Malthus the chief economist of its training school, James Mill its chief of intelligence, and Adam Smith, in an earlier period, the author of a report projecting the expansion of the opium trade to China—a theme he also takes up in the *Wealth of Nations*.

The Chicago Tradition and 'Felicific Calculus'

Milton Friedman's own version of the Quantity Theory comes not directly from Ricardo, but from Oxford University's attempts to revive the Jeremy Bentham "felicific calculus." Bentham argued that "nature has placed man under two sovereign masters, pleasure and pain," and he tried to work out index-numbers to explain human action. After two generations of Oxford and Cambridge "marginal utility" theorists had failed to come up with a quantification of the felicific calculus, Alfred Marshall proposed to use money—the *means* of making pleasure effective—as a simplified universal equivalent.

That is the so-called subjective, or marginal utility, theory of value. It not only assumes that man is a pleasure machine without a mind, but throws out any objective consideration of the real, physical economy. In England, this was the work of raving medievalists like John Ruskin, the Oxford political economy and fine arts professor who demanded that society return to *status quo ante* the industrial revolution and the Golden Renaissance.

The researcher is appalled by the fact that Friedman's (and Keynes's) antecedents were a bunch of raving lunatics. Bentham went mad trying to work out the felicific calculus and died a virtual hermit, unable to speak his own queer sort of Newspeak to anyone but James Mill. Ruskin, who gave both Alfred Marshall and W.S. Jevons their first important jobs at the Royal Colonial Institute, was a Theosophist, mystic, celibate (after a terrifying wedding night), and extreme racialist. Jevons died believing that sunspots cause trade cycles.

What Friedman calls the "Chicago tradition" was the American colony of Oxford and the University of Vienna, as Friedman's sponsor and teacher, Wesley Clair Mitchell, admitted freely in his own writings. And,

according to Mitchell, the seminal influence in Chicago economics was the ferociously anticapitalist Thorstein Veblen.

Emotion and Lies

All of this is evident from a glance through the writings of the monetarists, from Ricardo through Friedman. Friedman sells the sizzle but not the steak; he makes his pitch on emotional appeal to Americans who are fed up with bungling and malign government interference in production, without ever talking about the real economy.

He also lies outrageously about some crucial issues; such as his suggestion in the new book *Free to Choose* that the island of Hong Kong is the "exemplar" of free enterprise. Possibly so, but the freest thing about Hong Kong's enterprise is the narcotics traffic, which has made its capital in that island since 1837 to the present. Hong Kong's $10 billion annual flow of drug money is double the island banking system's money supply; and $1 billion of that, according to estimates published by the Hong Kong government, flows into bribery of police!

Or, to take another egregious example: Friedman is the man who traveled to Chile in 1975 to inform the fascist Pinochet junta that it was not cutting spending fast enough—when average caloric consumption in the Chilean population had already fallen to 1,200 calories a day and the infant mortality rate had begun to rise.

William F. Buckley, Friedman's friend and publisher, was right when he wrote on Aug. 16, 1971: "Friedman's theories suffer from the inherent disqualification that they cannot get sufficient exercise in democratic situations, because the population is not willing to wait long enough for them to work." Chile best represents the quality of Friedman's touted free enterprise libertarianism, and that's a long way from the American system of Alexander Hamilton, Abraham Lincoln, and the others who built this nation as an industrial power.

David Goldman is the economics editor of the weekly Executive Intelligence Review.

Wide World

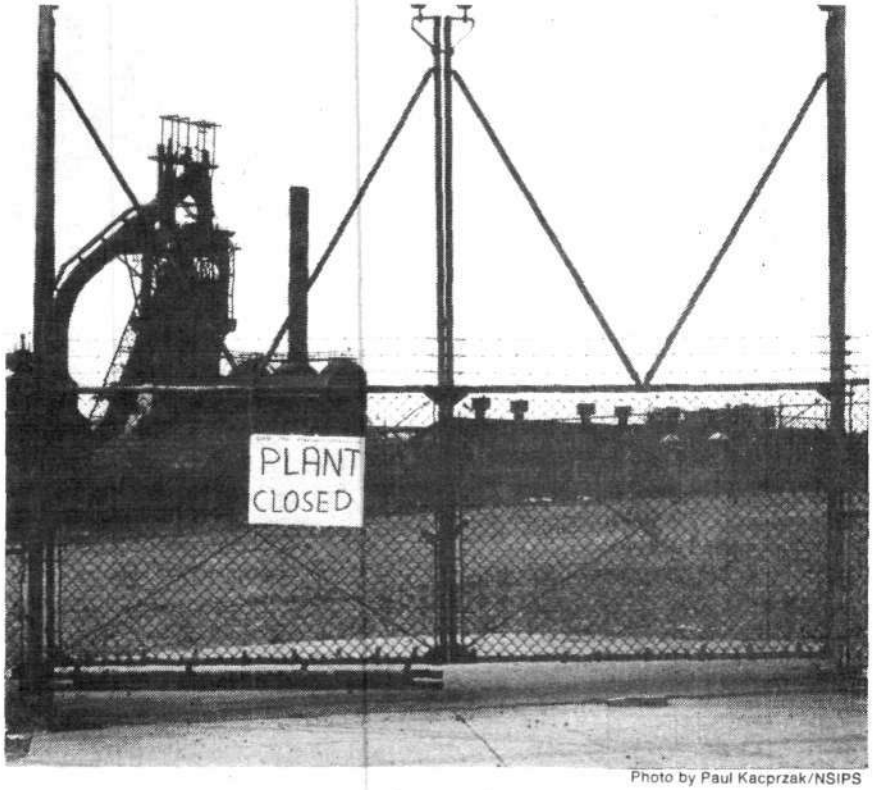
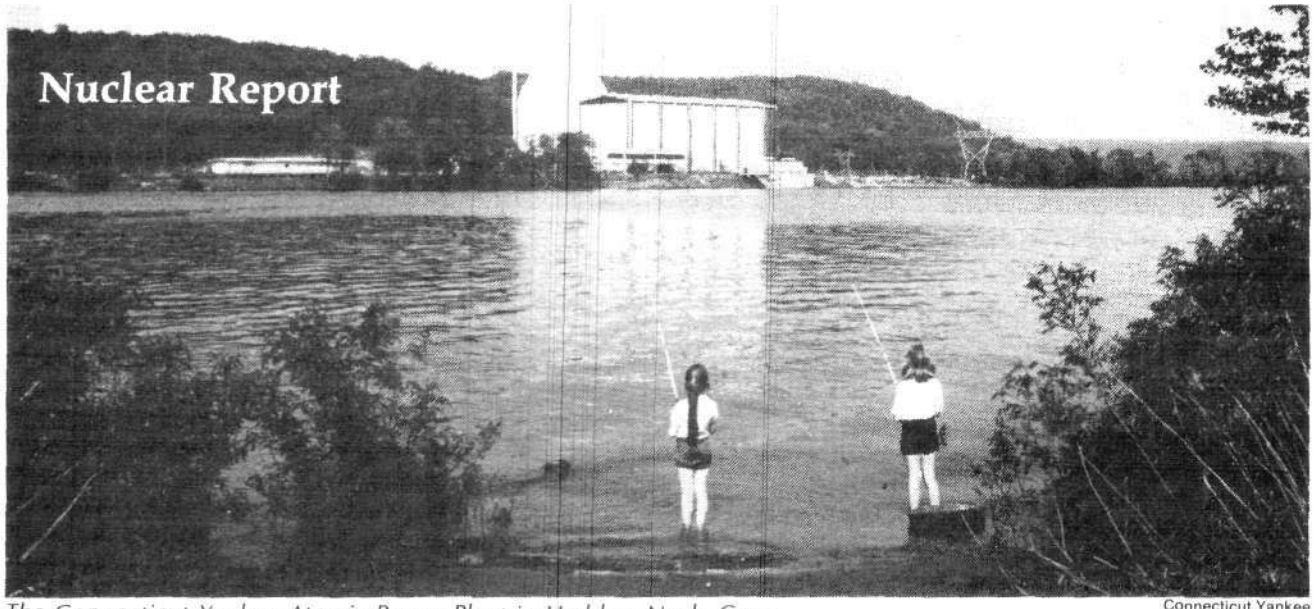


Photo by Paul Kacprzak/NSIPS

Stunning results: After applying the Friedman monetary method, Britain's inflation tripled while industrial output dropped 8 percent; the United States is not far behind. Above, Friedman is shown receiving the 1976 Nobel Prize in Economics from Sweden's King Carl Gustaf; below: the closed Republic Steel Plant in Cleveland, Ohio.



The Connecticut Yankee Atomic Power Plant in Haddam Neck, Conn. Connecticut Yankee

After Three Mile Island:

Nuclear: The Safest Energy Around

by Jon Gilbertson

This is the first in a two-part series on nuclear safety. Part Two will analyze the Three Mile Island incident.

Although critics have tried to claim that Three Mile Island was a "near disaster," the evidence proves just the opposite. In fact, the Fusion Energy Foundation and many other knowledgeable organizations have concluded as a result of post-TMI studies that nuclear power is even safer than had previously been thought.

In the words of Edwin Zebroski, head of the Nuclear Safety Analysis Center in Palo Alto, California: "Assertions of a narrowly averted catastrophe at TMI have no foundation. Even if the operators at TMI had continued to misread the condition of the core for several more hours and melting had begun, the addition of water at any subsequent point would have stopped the accident."

The utility-sponsored safety center is part of the Electric Power Research Institute and has done the most comprehensive technical investigation of the TMI incident to date. Zebroski based his statement on the results of EPRI's newly released study demonstrating that when a plant operator adds water to the reactor core, any melting stops or is prevented, as happened at TMI.

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

Although this conclusion has long been accepted as fact, it is only through an actual incident such as TMI that reactor safety analysts have the opportunity to prove it to be true by comparing their smaller-scale experiments and calculations to full-scale operating results. This, in fact, is what the group at EPRI has done in its analysis of the TMI incident. The actual event and EPRI's analysis simulating it have proved that in the "real world" of reactors, the result of an accident is actually much less severe than had been predicted from various postulated abnormal operating conditions. The actual design and construction of reactors, which are all quite rightly based on very conservative assumptions and calculations about such hypothetical, abnormal operating conditions, therefore, mean that nuclear plants are even safer than engineers had previously presumed.

Why is this true, and why can we confidently state that nuclear power is the safest energy around?

To answer these questions it is necessary to review the concepts and criteria behind the design safety of nuclear reactors and how the application of these safety design criteria completely protected the public in the TMI case and will continue to protect the public in the future, in case of any other abnormal reactor experience.

All U.S. reactors and those in the rest of the world are designed around a concept called the "defense in depth" philosophy. Simply put, this means that the design engineers take

the worst accident that could possibly occur in the plant, design the plant so it cannot happen, assume that it does happen, and then design the reactor safety systems to withstand the effects of the worst-case accident while completely protecting the public from any danger. The reactor design provides many levels of protection in case of the "worst event" (or design basis accident, to use safety terminology) using back-up systems, back-ups to back-ups, and so forth; hence the term defense in depth.

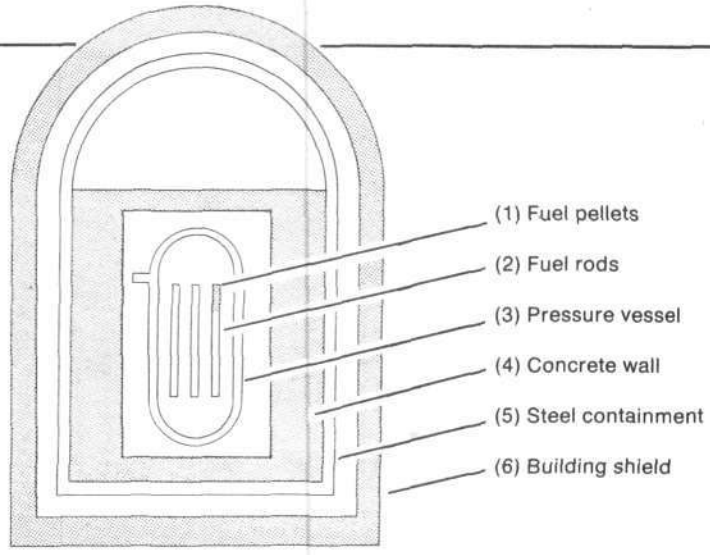
Specifically, the lines of defense include: (1) the *best quality assurance* to guarantee that all components and equipment in the plant have been manufactured and assembled to required design specifications; (2) highly redundant and diverse *protective systems* designed to protect against the occurrence of abnormal operating conditions; and (3) *engineered safety systems* designed to protect against the consequences of highly unlikely but potentially dangerous accidents, such as loss of coolant, equipment failure, human error, sabotage, and severe natural disasters such as earthquakes, tornadoes, and floods.

This means that nuclear engineers must do everything possible to prevent accidents from happening by conservative design and protective systems. In addition, to cover the possibility that some systems will not work as intended, engineers must add on so-called engineered safety systems to minimize the consequences of any accident that might occur.

What Dangers Are Involved?

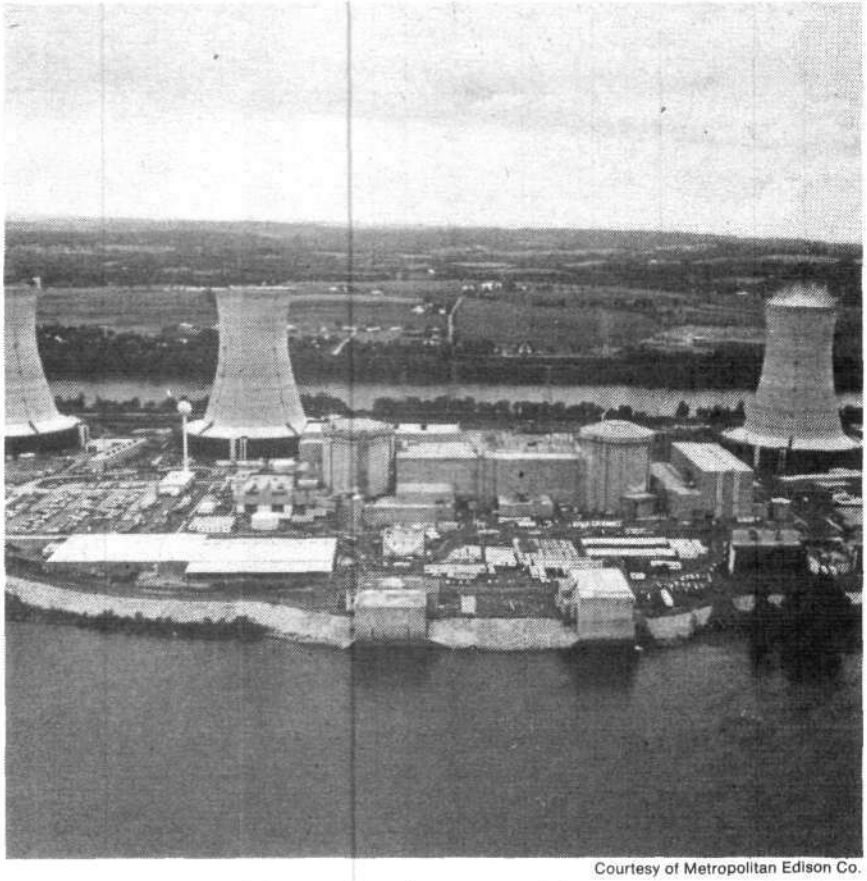
Contrary to the false claims of many antinuclear groups, reactors are not atomic bombs; they cannot explode under any conditions. The fuel in a reactor is different in a very important way from the material in an atomic bomb. Its enrichment (that is, the amount of fissionable material available) is far lower than in bombs, and therefore, the mix cannot produce a nuclear explosion.

Other explosions, such as hydrogen gas or other chemical reactions, are also not possible within the reactor vessel. This fact was known before and during the TMI incident, yet the fraudulent story of an impending hy-



MULTILEVEL PHYSICAL BARRIERS TO CONTAIN RADIOACTIVITY

This schematic of a nuclear reactor containment building shows the six levels of containment barriers to prevent any fission products from escaping: (1) the fuel pellet; (2) the fuel rods or tubes; (3) the pressure vessel with 10-inch thick walls; (4) 7-foot to 10-foot concrete shielding; (5) 4-inch thick steel shell; (6) 3-foot concrete shielding.



Courtesy of Metropolitan Edison Co.

Two containment buildings are in the center of this aerial view of the Three Mile Island units 1 and 2.

drogen explosion in the TMI reactor vessel was scare headlines for days in early April 1979. As the Nuclear Regulatory Commission later admitted, it was known at the time of the TMI incident that no free oxygen was present and, indeed, that no free oxygen could be present; thus a hydrogen explosion was impossible.

The main concern in reactor safety, in fact, is the large inventory of radioactive material (mostly fission products) that builds up in the reactor's fuel pins during operation. The goal of the reactor safety engineer is to make sure that this radioactive material is contained in a controlled manner under all conceivable operating conditions, normal or accidental, and that only very small quantities are ever released to the outside environment at any given time.

This is a straightforward procedure, except that the radioactive material releases heat along with the radiation; therefore it must be cooled at the same time that it is contained. Under normal conditions, the radioactive fission products remain contained within the fuel material itself and are part of every fuel pellet. Over the three-year lifetime of the fuel, the fission products build up to a little over 3 percent by weight of the pellets. While the reactor is operating, most of the heat in the fuel is produced from the fissioning of the fuel that results from the neutron reactions (chain reaction). However, after it is shut down (that is, after the neutron reactions have stopped), heat is still produced from the decay of the radioactive fission products. To remove this heat, the fuel must continue to be cooled while the reactor is in a shutdown condition. The job of the nuclear safety engineer is to contain and cool the fission product under all conceivable conditions.

Prevention of Accidents

Quality assurance and protective systems, the first two items mentioned in the defense-in-depth philosophy, are combined in the design of a nuclear reactor to do one thing—to make sure the reactor operates correctly and safely at all times. This, of course, ensures an extremely high probability that nothing happens in the reactor that will threaten the safe containment of all radioactive material.

To achieve this goal, everything in the plant is carefully manufactured, constructed, tested, and inspected to provide maximum assurance that it operates exactly as designed. In addition, a very elaborate protective system is installed in the plant that is designed to detect any equipment failures or abnormal plant operating conditions. If certain preset operating conditions are detected, the protective system will automatically shut down the plant. The focus of these two design principles, quality assurance and protective systems, therefore, is to prevent accidents from occurring.

The protective system is a specialized electronic/mechanical system that monitors every important operating parameter in the reactor—temperature, flow, pressure, reactivity, and so forth—and is prepared to take control of the plant in a preprogrammed manner if the system detects an abnormality. Most modern manufacturing processes, transportation systems (such as airplanes and

subways), fossil-fueled power plants, and so on, have protective systems; however, a nuclear plant probably has the most complete and dependable system existing today.

For example, actions taken by the protective system in a reactor are automatic and cannot be overridden manually by the operator. Thus, once an abnormality is sensed by the protective system and a preprogrammed protective action is initiated, the action will go on through completion. Once the protective system makes a decision to shut the plant down or to reduce the power output, for example, it will carry out the decision no matter what the plant operators might think.

The protective system consists of a large system of sensing equipment that feeds signals into logical decision-making units—computers. Both analogue and digital computers are used, depending on the application, and are preprogrammed with various actions that respond to the type and value of the incoming signal. The computer carries out the desired action, sending an outgoing signal to the appropriate reactor equipment. Most often, signals will be sent to the control rod drives above the reactor vessel, which will automatically drop the control rods, shutting down the reactor (called a reactor scram) or begin driving them in at slower rates, which gradually reduces the power. Simultaneously, other signals would go out to the steam turbine, pumps, and so on, to begin shutting down other parts of the plant.

An extremely important item to note here is the inherent safety mechanisms in the reactor that result from the nuclear physics that take place in the core. Anything that might go wrong in the reactor that causes the fuel and the coolant to heat up changes the internal nuclear physics of the reactor to cause the reactor to shut down. In a water-cooled reactor, such as pressurized water reactors and boiling water reactors, this is called the *negative temperature coefficient of reactivity*, while in a fast breeder reactor it is referred to as the negative Doppler reactivity effect. Although the actual physics involved in the two

Continued on page 74

Washington

Fusion Budget Stalled In Congressional Fight

Funding for the magnetic fusion program in fiscal year 1981 is still unsettled because the entire federal budget has been held up by President Carter's attempts to "balance" the budget. Carter's budget changes have forced Congress to revise its overall fiscal year 1981 budget projections more than once, with fusion in limbo.

At this point the House has authorized approximately $433 million for magnetic fusion for fiscal year 1981, but the Appropriations Subcommittee on Energy and Water has recommended only $373 million. The original DOE request for $403 million was cut to $396 million under the budget revisions. The full Appropriations Committee will consider its subcommittee's mark-up of the bill as soon as the House passes the House Budget Committee's budget resolution.

According to the office of Congressman Mike McCormack (D-Wash.), the president's science advisor Dr. Frank Press has written a letter to Appropriations subcommittee chairman Tom Bevill (D-Al.) asking that the committee restore funding for the fusion program to the administration's $396 million level. Washington sources have noted that pressure from the scientific community, the 160 cosponsors of Congressman McCormack's Apollo-style fusion bill (HR 6308), and the readership of *Fusion* have convinced the administration that the fusion program should not suffer a setback under the "antiinflation" gun of Congress or the president.

The limits on the entire federal spending package are set by the House and Senate Budget Committees. When the president resubmitted his revised budget request in the spring, the Budget Committees went back to their drawing boards to redraft their budget resolutions. House and Senate versions differed considerably, and the House refused to accept the Senate's lower overall budget figures.

The House Budget Committee has now done a second complete draft of spending limits for the entire federal budget, to be voted on by the full House in mid-June. The Senate and House committees have now reached an agreement in conference, and House Budget Committee spokesmen are optimistic that both Houses will pass the resolution.

At that point, upper spending limits for the Department of Energy will be set so that the Senate and House Appropriations Committees can finish marking up the budgets for specific budget-line items and programs. Capitol Hill sources indicate that the congressional budget ceilings will be lower for the total DOE budget than the president requested.

The Senate Appropriations Committee has not yet acted on the fiscal year 1981 DOE budget, and is reportedly waiting for the House Appropriations Committee to finish its business first. The veto-override on the president's proposed oil import fee and the speed with which the Oct. 1 deadline for the beginning of fiscal year 1981 is approaching with no legislation on the books indicate the chaotic nature of this year's congressional budget process.

Levitt Testifies Before Buchsbaum Fusion Cttee.

Dr. Morris Levitt

In testimony before the DOE fusion review committee May 23, Fusion Energy Foundation executive director Dr. Morris Levitt focused attention on "what policy will best achieve the goal of the most rapid possible development of economical fusion power."

Levitt, editor-in-chief of *Fusion*, stressed that although fusion will "extend our nuclear electrical capacities by a combination of pure fusion reactors and the fusion-fission hybrid breeders," the "ultimate payoff will come from the fusion-based production of new resources of all kinds."

The committee, headed by Dr. Sol Buchsbaum of Bell Laboratories, was commissioned by the Department of Energy Research Advisory Board (ERAB) last fall to review the status of the nation's magnetic fusion program and recommend possible changes in the DOE's present timetable and goals. The last review of the fusion program was headed by Dr. John Foster of TRW in 1978.

A draft report is scheduled to be ready for ERAB in June, and a full report should be released to the public in August.

The fusion community and the fusion advisory panel for the House Committee on Science and Technology's Subcommittee on Energy Research and Production have both made it clear that fusion experimental results since the Foster Committee review have been so impressive that a reexamination of the DOE's "go-slow" timetable is in order.

'Yes' to the ETF

One major question that the committee is considering is the timetable for the next-step Engineering Test Facility (ETF). The Fusion Energy Foundation gives an uncategorical "Yes" to the question of whether the ETF

should be started now, Levitt stated: "It should be stressed that there is no known scientific barrier to preclude a successful tokamak ETF. . . . The alternative approach of adding more small, intermediate steps is inferior methodologically as well as economically."

"The final argument for the ETF is more general, but also more fundamental," Levitt continued. "This nation will never solve any of its basic problems without a renewed commitment to scientific and technological progress in research and education. . . . Fusion is not simply the key to a sound energy policy; as a national priority it can become the focal point for a renewed commitment to progress and a sense of moral purpose in the nation. This is an even more precious gift to our posterity than the boundless energy of fusion power."

In response to his statement, committee chairman Buchsbaum asked Levitt to expand on the FEF's conception of the process necessary to formulate a new policy for the fusion program, specifically on the policy decision to go full-steam-ahead on an ETF. Levitt replied that this committee had a vital role to play in this decision-making process and that President Carter had indicated in a letter to Congressman Mike McCormack that the Buchsbaum committee's findings and recommendations would weigh heavily in his administration's decision to alter the current fusion timetable. (McCormack chairs the House Subcommittee on Energy Research and Production.)

The only negative comments came from ERAB member Thomas Cochran, attorney for the Natural Resources Defense Fund, who questioned Levitt on the "military implications" of fusion research. Levitt responded that without a national effort to rebuild the scientific and educational capability of this nation there was no possibility of formulating a national military policy. Fusion scientists in the audience during the day of public testimony indicated their agreement with the FEF statement.

Congressional Line-up

Tell Your Congressman About Fusion

As we go to press, the Buchsbaum Committee has issued its report to ERAB calling for the DOE to increase the magnetic fusion budget to $1 billion a year. "Recent progress is impressive" and "the panel is pleased to record its view that the taxpayers are receiving their monies' worth," the panel wrote.

Your letters to President Carter, your congressman, and senators supporting an increased fusion budget can help ensure that the fusion program continues to make progress, putting a fusion plant on line by the year 2000.

Here are some specific congressional targets. All addresses are Washington, D.C. 20515, unless otherwise noted:

Rep. Jamie Whitten (D-Miss.), chairman, House Appropriations Committee, 2314 Rayburn.
Rep. Tom Bevill (D-Ala.), chairman, Subcommittee on Energy and Water, House Appropriations Committee, 2305 Rayburn.
Sen. Henry Jackson (D-Wash.), chairman, Senate Energy Committee, 137 Russell, Senate Office Building, Washington, D.C. 20510.

Support the Nuclear Waste Legislation

We recommend support for the nuclear waste legislation proposed by *Rep. Barry Goldwater, Jr.* (R-Calif.). Write him at 2240 Rayburn.

Inside DOE

DOE Proudly Unfurls Solar Banner

The Department of Energy proudly unfurled an orange and white banner over its Forrestal headquarters on Independence Avenue in June to celebrate the first of 843 federal buildings across the country that are switching to solar-powered energy units under a $31 million pilot program. DOE's expensive solar showpiece will provide "some" of the hot water and process heat for the building's cafeteria, a DOE spokesman said.

The spokesman announced, "What we're trying to do is to stimulate the solar industry across America."

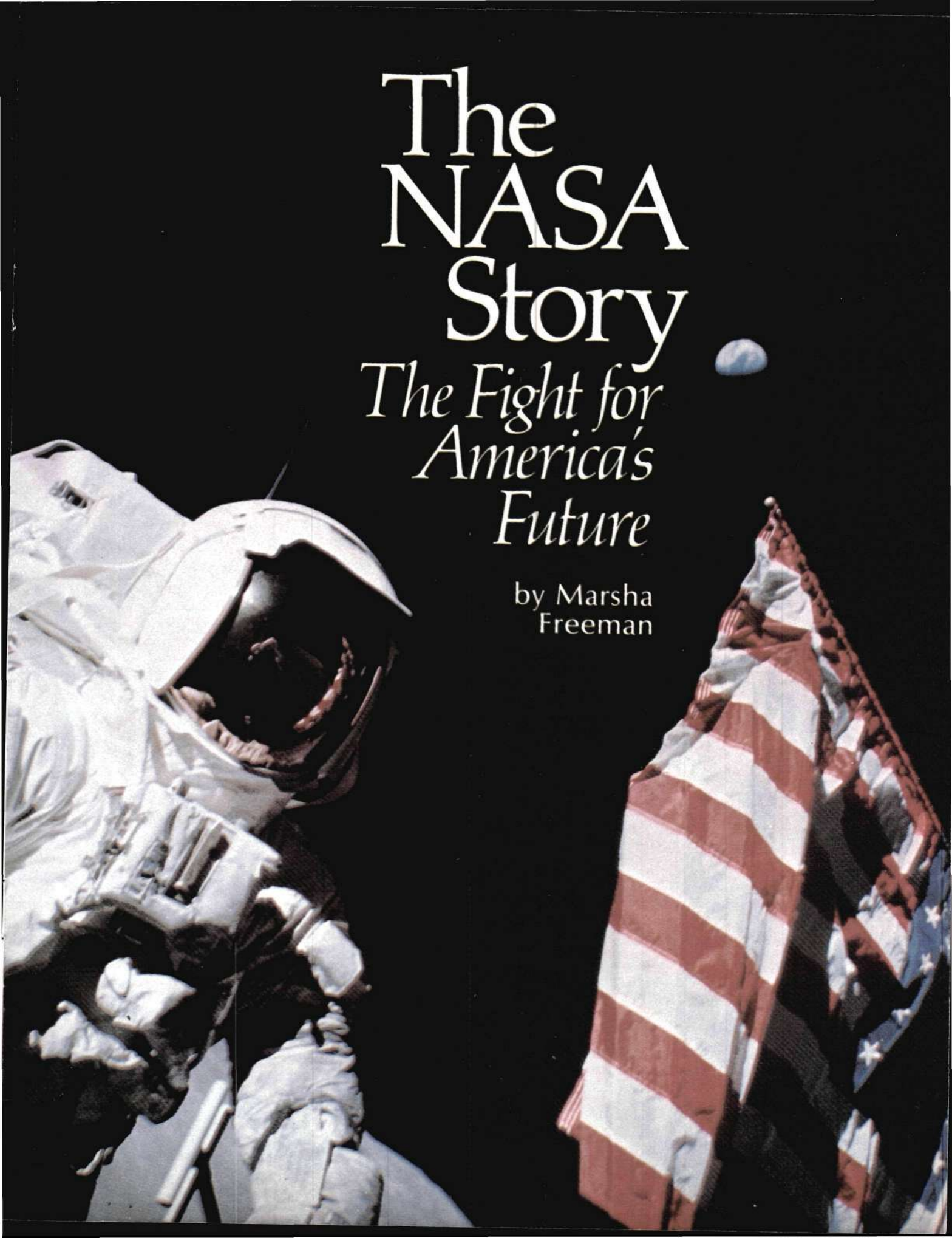
Under current DOE tax credits and grants, a consumer can already have about 40 percent of the cost of his solar unit paid for by tax dollars, a subsidy necessary for an industry that cannot compete economically on the open market with existing, more productive technology. The question is just how far the DOE will go to "stimulate" an industry that consumes more energy than it produces.

It is not surprising that the Forrestal building has been selected for this demonstration of solar collection techniques. Visitors to the DOE headquarters will undoubtedly notice when they enter the lobby that they cannot see anything. The reception area of this "energy-saving" building is so dark that the title outside, "United States Department of Energy," seems to be a contradiction in terms.

The NASA Story

The Fight for America's Future

by Marsha Freeman



The advances during the space age have rivaled the accomplishments of science and technology in all previous human history. In fact, the space effort for a time supplanted the threat of war as the ultimate stimulus in the development and exploitation of new technology.

Many are suggesting that science and technology be fixed in place—so that the behavior of human beings can catch up. Yet science and technology will continue to be advanced, if not by the United States, then by other nations. Indeed, such advancement and its sensible utilization offer the less developed nations their only hope for improving the quality of life for their people.

—NASA, "A Forecast of Space Technology 1980-2000," Jan. 1976

THE FIGHT OVER THE U.S. SPACE PROGRAM during the past 25 years was never a fight over whether to go to the moon, how much money should be spent on space, or whether one project was more important than another. From the very beginning, the fight was defined by three distinct policy perspectives: the first advocated the use of space and space technology strictly for purposes of military and psychological warfare; the second advocated the position that the quality of personal life, "inner space," was more important than any societal use of outer space; and the third believed that a scientifically vectored program such as space exploration was the only driving force capable of maintaining U.S. preeminence in science and industry and of developing the rest of the world.

One or another of these policy perspectives has been dominant during this long struggle for a U.S. science and economic policy. At no time, however, did the American public have the slightest idea of what the real issues were or what was ultimately at stake. Today, an understanding of the political history of the space program is of urgent necessity, for the same forces, and in many cases the exact same people who have been the major proponents of the first two policies, could finish off the space program, U.S. science, and the nation's military security as well.

To the overwhelming majority of the American people—most scientists and engineers, industry, and the nation's youth—the NASA effort presented the greatest challenges and opportunities for scientific understanding and technological revolutions that the United States has ever had. NASA represented the gateway to the future.

Frontispiece: Scientist-Astronaut Harrison Schmitt of Apollo 17 is photographed next to the U.S. flag during the 1972 lunar landing of the lunar module "Challenger." At left: The 363-foot Apollo Saturn V space vehicle rushes skyward from the Kennedy Space Center launch complex March 3, 1969.

NASA

To one leading military faction at the Rand Corporation and in the Army Air Force, however, the space effort presented a challenge to their monopoly on science and advanced technology as well as an opportunity to advance their confrontation policy toward the Soviet Union.

And to the economic and social planners intent on reducing the industrial United States to the "postindustrial society," NASA was the ultimate threat. As long as NASA advanced, the Brookings Institution, the Institute for Social Research, the Tavistock Institute, and later the Club of Rome and its spinoffs could not succeed in forcing the American public to believe that the "age of progress" was over.

Despite the successes of these organizations via their control over the U.S. administration, NASA is still the nation's greatest resource in manpower for basic science, engineering, and the development of new technology. Its national laboratories, now being turned into soft technology centers by subcontracts from the Department of Energy, remain the legacy of a nation once committed to science and development. The United States is at a crossroads: Either the manpower, experimental facilities, knowledge, management skills, and experience of NASA will be destroyed, or the nation will develop NASA's resources to meet the challenges of the next century—the exploration and study of the solar system and the universe and the commercial development of fusion energy, bringing the energy of the stars down to earth.

As NASA goes, so goes the nation.

The Thrust into Space

> Escape into space—the exploration of the heavenly bodies around us—is a deep-seated aspiration of all mankind. . . . At every intellectual level man longs to know the nature of other bodies around him, so astronomy was among his earliest sciences. Man prizes this idea of escape from the earth to the universe as the highest symbol of progress. . . .
>
> Our scientific preparation for space must always be far ahead of the availability of vehicles. . . . Here lies the greatest challenge of our space program. Underlying the planning for each flight must be a strong, continuing, and very basic scientific program. . . .
>
> —Lloyd Berkner, *Peacetime Uses of Outer Space*, 1961

At the end of World War II, it became clear to the military that the next generation of weapons systems would be airborne; rocket-propelled intercontinental ballistic missiles guided by the most sophisticated electronic systems would end the predominance of ground-based warfighting. To the confrontation-oriented planners in the Army Air Force this new horizon also represented the possibility to use the earth-orbiting satellites, which they assumed the United States would develop before the Soviets, for maximum psychological warfare impact. The "aura of power" became an obsessive concern of the Army Air Force and its think tank, the Rand Corporation:

> The psychological effect of a satellite will in less dramatic fashion parallel that of the atomic bomb. Combined with our present monopoly of the A-bomb such a threat in being will give pause to any nation which contemplates aggressive war against the U.S. . . . As an aid to maintaining the present prestige and diplomatic bargaining power of the U.S., it would be well to give the world the impression of an ever-widening gap between our technology and any other possible rivals since other nations are obviously hoping . . . to overcome the existing lead of this country. . . . It is therefore recommended that the satellite be considered not as an academic study but as a project which merits planning and establishing of a priority in the research program of the Army Air Forces.
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> —Rand Corporation, "Time Factor in the Satellite Program," Oct. 1946

At the same time, the nation's foremost scientific thinkers looked toward the heavens and saw the possibility, for the first time, to gain an observation and measuring capability to study the earth and the nearby bodies without the interference of the earth's atmosphere. Their concern was to begin to answer the most far-reaching questions about the origin of the universe, as well as phenomena such as weather, the aurora borealis, the magnetic fields of the earth, and changes in the sun's behavior.

From 1946 until the successful launching of man's first artificial moon, Sputnik, the issue of which path for satellite and space exploration would be followed was not an overtly political one in the eyes of the nation or leadership in Washington. But the battle lines were being clearly drawn.

Polar Years

The first attempts by scientists to study the earth on a large-scale basis were through international programs called Polar Years. The first such undertaking took place from August 1, 1882 through August 31, 1883 and included the participation of 11 nations. The focus of this First Polar Year was the exploration of the virgin territory of both the Arctic and Antarctic, to study the earth's magnetism, meteorology, auroras, and geology.

During the evaluation of the massive data accumulated during the First Polar Year the scientists agreed that another international cooperative project should be undertaken in 50 years. In the middle of the 1930s, when the 50 years had elapsed, studies of the ionosphere and cosmic rays were comparatively new and had captured increasing attention of geophysicists in the United States and Europe.

Like the first polar year, the second, which took place in 1932-1933, concentrated its efforts on the Arctic. Scientists from 44 countries participated in the Second Polar Year; 22 countries sent out field expeditions. One of the most important discoveries of this effort was the verifica-

tion that magnetic storms had seriously disturbing effects on the reflection of radio waves by the ionosphere.

Twenty-five years after the Second Polar Year, in April 1950, a group of distinguished scientists met at the home of Dr. James Van Allen to discuss the state of science and some of the important problems requiring investigation. Dr. Lloyd Berkner made the suggestion that since science had made such progress during and immediately after World War II another international scientific year was in order, without waiting for the 50-year interval to elapse.

He suggested that the year 1957 to 1958 would be the best time since, according to astronomers, sunspot activity would be at its peak. By 1952, Berkner's suggestion was being studied by the International Council of Scientific Unions, and the world scientific community broadened the purview of the project to include the new, exciting fields of rockets and satellites.

A series of World Data Centers was established, with complete data collection in the United States and the Soviet Union and subcenters in eight other nations. When finally functioning, the International Geophysical Year included 66 nations, 20,000 to 40,000 scientists, and an almost equal number of volunteer observers. When the committee for the International Geophysical Year met in Moscow in July 1958, it decided to extend the highly successful international cooperation program past the 18-month planned deadline of December 1958. Numerous research projects continued after the year ended, and the scientists stated openly that continued international cooperation was the key to continued breakthroughs in science.

Berkner drew up the proposal for U.S. participation in the International Geophysical Year in 1954, and through Alan Waterman, the director of the National Science Foundation, presented it to President Eisenhower. Ike gave his full support to the effort, and in March 1955, he gave the go-ahead for the civilian development of a satellite for the U.S. contribution to the International Geophysical Year.

At that time, the U.S. Army was already doing developmental work on the Jupiter C (Redstone) Rocket under General John Bruce Medaris and Werner von Braun. But Eisenhower wanted the IGY scientific program kept separate and nonmilitary. The Vanguard Project was given to the U.S. Navy with executive support but not the top priority that the military program already had. The National Security Council went along with the program as long as it did not interfere with the military missile program.

The Role of Lloyd Berkner

Lloyd Berkner was the least public but the most important mind behind the U.S. effort in space in these early years. From 1928 to 1930 he had accompanied Admiral Byrd on his exploration of the Antarctic and become an expert on the ionosphere and plasma activity in the sun. His insistence that scientific inquiry and not publicity stunts be the driving force of man's exploration of space came from a deep-seated appreciation of the role of science historically. In the tradition of the humanist thinkers from Plato through Leibniz and the Göttingen Association of the preceding century, Berkner understood science as the fundamental creative activity of humanity:

National Academy of Sciences

Dr. Lloyd Berkner: The least public but most important mind behind the early U.S. space effort.

> Science is creative beauty in the highest sense. It provides a systematic and reliable criterion of universal applicability in Plato's search for "the harmonious, the beautiful, and the desirable." . . . The search by the modern composer for the ultimate harmony of dissonant chords reflects the excitement of the scientist in his association and reassociation of ideas during the intuitive hunt for the coherent generality that represents a higher order of human thought and comprehension. . . . Truly, the characteristic of civilized man that distinguishes him from all other creatures is his learning, his ability to utilize knowledge to free himself from the vicissitudes of his environment. . . .

To Berkner, science was not an academic exercise for the personal pleasure of the scientist:

> Those countries that have encouraged the development of abundant energy and the application of advanced technology to its control have now abolished the traditional economy of scarcity. . . . We *have*

Astronaut Ed White taking the first U.S. spacewalk June 3, 1965 from Gemini 4.
NASA

created since the midcentury, in at least one nation, an economy that comes close to the elimination of poverty. . . . Each new technology derived from science has a permanence that continues to benefit society indefinitely in the future. Thus capital represented by discovery outlives all other forms. Consequently, the investment in basic research should be written off over an indefinitely long time against the permanent gains acquired by society.

In addition to serving as a scientific advisor to various government agencies, Berkner was the chairman of the Space Science Board of the National Academy of Sciences, which had important input into the formulation of a U.S. space program. From 1951 to 1960 Berkner was the president of Associated Universities, a grouping of scientific facilities including Argonne, Oak Ridge, and Brookhaven National Laboratories.

The purpose of Associated Universities was to make training and on-site educational facilities from the national labs available to institutions that did not have such a capability in order to produce the nation's current generation of nuclear engineers. In addition to being the guiding force and scientific conscience of the space program, Berkner was one of the staunchest supporters of Eisenhower's Atoms for Peace program.

The Military Psywarriors

While the scientists working with Berkner and Van Allen were planning the experiments that would open the "space age," the "aura of power" military planners, best represented by the Rand Corporation, were devising ways to substitute psychological warfare for a real strategic war-winning science and technology program. While the nation's top physicists worked through scientific advisory boards to develop the most advanced weapons systems, the Rand Corporation was assessing the best ways to "scare" the enemy.

The Rand Corporation, which operated as a division of Douglas Aircraft from April 1946 to November 1948, was given the mandate by the Army Air Force to "perform a program of study and research on the broad subject of intercontinental warfare, other than surface, with the object of recommending to the Army Air Force preferred

Milestones in the NASA Program

Feb. 17, 1959: **Vanguard 2,** NASA's first Earth satellite, launched to demonstrate feasibility of global weather data acquisition.

Aug. 7, 1959: **Explorer 6,** placed in an elliptical Earth orbit, returned first crude TV photo of the Earth.

May 5, 1961: **Freedom 7,** manned Mercury spacecraft, launched carrying first U.S. astronaut Alan Shepard into space.

Feb. 20, 1962: **Friendship 7** launched with John Glenn in first U.S. manned orbital space flight.

Oct. 25, 1962: **Telstar** conducted first two-way live radio broadcast.

July 14, 1964: **Mariner 4** launched on flight to Mars, sending back first close photos of the planet.

June 3, 1965: **Gemini 4** spacecraft launched to make 62 revolutions around the Earth, during which Edward White became the first American to walk in space.

Dec. 4, 1965: **Gemini 7** launched, achieving the first rendezvous in space in orbit with **Gemini 6.**

May 30, 1966: **Surveyor 1** launched to become the first U.S. spacecraft to softland on the Moon, where it touched down on the Ocean of Storms.

Dec. 21, 1968: **Apollo 8** launched, the first manned mission to orbit the Moon; first manned photos taken of Earth and Moon.

July 16, 1969: **Apollo 11** launched on first lunar landing mission; four days later Neil Armstrong and Edwin Aldren landed in the Sea of Tranquility.

Nov. 13, 1971: **Mariner 9** launched into Mars orbit, the first to circle another planet.

March 2, 1972: **Pioneer 10** Jupiter probe launched to become first man-made object to escape the solar system; also first NASA spacecraft powered entirely by nuclear energy.

May 14, 1973: **Skylab 1** launched, the nation's first orbiting laboratory.

Nov. 3, 1973: **Mariner 10** launched to conduct exploratory investigations of Mercury and later fly by Venus.

Dec. 2, 1974: **Pioneer 11,** launched in April 1973, sends back first pictures from Jupiter; NASA announces it will fly by Saturn, sending back pictures in 1979.

June 15, 1975: **Apollo-Soyuz** mission begun, to dock with the Soviet spacecraft.

Aug. 12, 1977: **Space Shuttle** undergoes its first approach and landing test in free flight.

Aug. 20, 1977: **HEAO** (High Energy Astronomy Observatory) launched to study and map X-rays and gamma rays.

Aug. 20, 1977: **Voyager 2** launched to study Jupiter and Saturn, including their satellites and Saturn's rings.

Oct. 22, 1977: **ISEE 1** and **2** launched (International Sun-Earth Explorer) with the European Space Agency to study the Earth's interaction with its interplanetary medium.

June 26, 1978: **SEASAT** launched, the first ocean-monitoring satellite.

techniques and instrumentalities for this purpose." Rand was never a competent scientifically oriented organization, but a psychological warfare think tank.

In 1946, in its paper "Time Factor in the Satellite Program," Rand stated, "no promising avenues of progress in rockets can be neglected by the U.S. without great danger of falling behind in the world race for armaments." Though Rand concluded at that time that rockets carrying explosives or atomic bombs were unfeasible, it postulated that rockets could guide missiles.

In January 1949, Rand held a conference on "Methods for Studying the Psychological Effects of Unconventional Weapons." One of the major topics of discussion and debate was the physical appearance of the first U.S. satellite. Some conference attendees, including Dr. J.E. Lipp, were in favor of painting the artificial moon black, so it could not be seen. Others argued that it should be painted fluorescent or have surface mirrors to make it visible to the naked eye. "Would it be possible to contrive a message that would make them think they [the Russians] are listening to Saturn?" one participant asked.

The question of national sovereignty arose in the discussions. The answer of consensus was that if pictures are being taken of another country from our satellite: "There is no legal responsibility. All we do is send it up at one point—the earth does the rest by revolving [sic] under the satellite."

For those who could not grasp the potential of this arsenal of weapons, the attendees gave the example: Think of the impression from our broadcasts in "God bless you" compared to the effect of "This is God blessing you."

Another key question was the timing and manner in which the United States would announce the existence of its satellite. Lipp suggested that the United States could announce the satellite had been created for purely scientific purposes and then let the Soviets speculate on what other purposes it might have. Others suggested that it could be launched at a time when the United States would want to create a diversion from a political crisis.

The conference closed with this consensus:

> We may make a truthful announcement and add that the satellite is being used in retaliation for Soviet noncooperation in connection with atomic energy control. [The Baruch Plan for U.S. control of civilian nuclear power worldwide—rejected by the Soviets.]
>
> The potentialities are so great that we must not squander them by making disclosures without fitting them into a psychological warfare program.

While the Air Force and Rand were planning the best way to "scare" the Soviets, scientists in the United States and Soviet Union were trying to launch an earth-orbiting satellite during the International Geophysical Year to demonstrate man's mastery over an expanding part of the universe. All of the best laid plans of the military utopians went down the drain October 4, 1957 when Sputnik, the "traveling companion," began circling the earth.

Sputnik and the U.S. Space Effort

> . . . No conventional organization would be adequate for so exotic an undertaking as a space program. The organization would have to construct and manage the greatest technological project of our time. It would have to design and master some of the most exquisitely refined electronic and computer technology ever devised. . . . It must be prepared for political pressure and for ambitious personalities who saw an opportunity to ride rockets to a new realm of glory and power. It must serve the sometimes competitive requirements of the military and the scientists. . . . This is the organization President Eisenhower asked his science advisors to design and recommend.
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> —James R. Killian, Jr., *Sputnik, Scientists, and Eisenhower,* 1977

The single event that dramatically propelled mankind into the space age was the Soviet announcement October 4, 1957 that earth now had a "second moon" orbiting it. The reaction to this event, an event that the scientific community, the military, and President Eisenhower knew was likely to happen as part of the International Geophysical Year, was an indication of the fight that would take place over upgrading the space program in response to the Soviet accomplishment.

Sputnik was actually *no surprise.* From the beginning of 1953, Soviet scientists had kept the world scientific community apprised of their progress in rockets and satellite development. In November 1953, Academician A.N. Nesmoyanov, the president of the Soviet Academy of Sciences, remarked that satellite launchings and moon shots were feasible.

In March 1954, Moscow Radio exhorted Soviet youth to prepare for space exploration, and the next month the Moscow Air Club announced that it was undertaking studies in interplanetary flight. That summer the Soviets committed themselves to participate in the International Geophysical Year satellite program. By January 1955, Radio Moscow announced that a satellite launching might be expected in the "not distant future." In April the announcement was made that a permanent high-level interdepartmental commission for interplanetary communications had been created in the Astronomics Council of the Soviet Union.

At that point, the U.S. President's Science Advisory Committee estimated that Russia's top scientists were working on the satellite program. On August 2, 1955, the *New York Herald Tribune* reported that at a meeting of the International Astronautics Federation in Copenhagen, a distinguished Soviet physicist declared that the Soviet satellite would be launched in 1957 and would be much larger than any the United States would attempt. The June 21, 1957 issue of *Science* magazine reported a statement made by Nesmoyanov in *Pravda* saying "scientists have

created the rockets and all the instruments and equipment necessary to solve the problems of the artificial earth satellite." At the same time, the *New York Times* reported another Nesmoyanov statement that, "soon, literally, within months, our planet Earth will acquire another satellite."

Certainly to the scientists, therefore, Sputnik was no surprise. Four days before the Soviet launch scientists representing the United States, the Soviet Union, and five other nations assembled at the National Academy of Sciences in Washington for a six-day conference on the rocket and satellite activities of the International Geophysical Year.

On that Friday evening, while the delegates to the conference were at a reception at the Soviet embassy, Walter Sullivan of the *New York Times* received a call from his Washington editor and then informed the American delegation: "It's up." Dr. Berkner clapped his hands to get everyone's attention. "I wish to make an announcement," he began. "I've just been informed by the *New York Times* that a Russian satellite is in orbit at an elevation of 900 kilometers. I wish to congratulate our Soviet colleagues on their achievement."

Members of the U.S. delegation and of the President's Science Advisory Council, including the soon-to-be first administrator of NASA, Dr. Keith Glennan, recommended that the president send a telegram of congratulations to the Soviets.

But the thrill of a scientific accomplishment that dramatically indicated the future possibilities of space was to turn into a political watergating campaign against the president overnight.

The Military Makes Its Move

In December 1957, two months after Sputnik, then-senator Lyndon B. Johnson held hearings to evaluate the U.S. space effort, as chairman of the Senate Armed Services Committee. Major General John Bruce Medaris, the commanding officer of the Army Ballistic Missile Agency in Huntsville, Alabama, with German rocket scientist Werner von Braun under his wing, blasted President Eisenhower for the Sputnik "coup" and demanded that Congress give the army a free hand for military-controlled rocket development.

Since 1954, von Braun had been working on Project Orbiter, which produced the Jupiter C rocket. According to James Killian, "even after Vanguard had been selected [for development by the navy] and all the army's pleas to proceed with a satellite had been denied, Medaris and von Braun bootlegged the development of Jupiter C." To Medaris and the rest of the confrontationist military faction in the Air Force and Rand Corporation, a civilian space program was tolerable only as long as it did not interfere with military aims. Scientific endeavor and the technological advancement of the economy, the only basis for real military strength, were anathema to the "limited tactical warfare" this group in the military was proposing.

The clamor for military control of the International Geophysical Year satellite program as the foot-in-the-door for total takeover increased to a roar when the navy's Vanguard exploded on the launch pad December 6. The British press reveled in the U.S. embarrassment, calling Vanguard "Puffnik, Flopnik, Kaputnik, or Stayputnik." In view of the Vanguard failure, Eisenhower asked his science advisor, James Killian, to evaluate whether the Jupiter C should be given a chance.

On January 31, 1958, von Braun's Jupiter C rocket launched Explorer I into earth orbit, and Major General Medaris increased his loudmouth campaign for the Army Ballistic Missile Agency to run the U.S. space program. Medaris vehemently proclaimed that the military satellites should have greater priority over ballistic missiles, that the Department of Defense had rightful claim over the space program, and that giving the program to a civilian agency would be a terrible mistake. Aligning himself with the space fantasy proponents in the U.S. Air Force, who argued that the next war would be fought in space and that ICBM development should not be primary, Medaris enraged the White House, and much of the "regular" military.

But Medaris lost the fight. Eisenhower signed the Space Act in July 1958, and six months later NASA was established as an independent civilian agency. When the Huntsville facility and von Braun's team of more than 4,000 were transferred to NASA the next year, the curtain came down on Major General Medaris.

It may seem curious to most that Medaris went on to become the chairman of the Lionel Corporation. Although Lionel is best known for making toy trains, its more important political role was its involvement in the founding of Permindex. Permindex, incorporated in Canada in 1959, is a corporate front for the international political faction that has been intimately involved in the more than $200 billion per year international drug trade. Permindex has also been implicated in the murders of John Kennedy, Robert Kennedy, Martin Luther King, and in numerous attempts on the life of General de Gaulle. (For this last operation, Permindex was forced out of Europe and relocated in South Africa; its ties to the Kennedy assassination have come into the public eye through New Orleans District Attorney James Garrison.)

From his new post, Medaris aligned himself with the military-strategic view of limited tactical war associated with General Maxwell Taylor. In the Kennedy administration, under the guidance of Taylor and DOD Secretary Robert McNamara, this policy succeeded in propelling the United States into the Vietnam War, a war that nearly destroyed the U.S. military. Later, Medaris became an Episcopal priest, Father Bruce. In an interview with *People* magazine July 14, 1975, Father Bruce Medaris noted, "No human being without the guidance of the Lord could have been right as much as I was."

During the late 1950s, Eisenhower reorganized and centralized the increased authority of the secretary of defense to ameliorate the competition and inept advice he was getting from the military, but he came under increasing attack for neglecting the nation's defense. The familiar "missile gap" issue of the 1960 presidential campaign was manufactured by General Taylor and made a public issue

by the Gaither Report, issued November 7, 1957, one month after Sputnik.

The panel, headed by Rowan Gaither of the Ford Foundation, included people who later became key in the Kennedy administration, particularly those involved in the psychological warfare game of arms control and confrontation with the Soviet Union around predetermined "hot spots." These included William C. Foster, Paul Nitze, Spurgeon Keeny (Arms Control and Disarmament associate director), and MIT's Jerome Wiesner, as well as input from the Rand Corporation and the Brookings Institution.

The Gaither report portrayed the United States as being at the edge of annihilation by the Soviet Union. The Soviets had probably already surpassed the United States in ICBM development (the Soviets had tested the first ICBM six weeks before Sputnik), the report stated, and a nationwide fallout shelter program was needed. This effort should be tied to a broad program of "organizing for the emergency and its aftermath"—an early version of the current Federal Emergency Management Agency.

The specific findings of the report were later discredited, and after Kennedy won the presidency in 1960, he admitted that most of the "missile gap" had been sheer propaganda. Perhaps the most blatant example of the self-defeating military thinking involved is the fact that the report's recommendation that intelligence was needed "regardless of the consequences" laid the basis for the Dulles brothers' U-2 spy operation that destroyed the president's peace initiatives with the Soviet leadership.

The Aquarian Fight For 'Inner Space'

> It is especially desirable that the space effort be concerned with the consequences of its own activities, for it will probably be the most costly of the various exploitations of technology and science that present societies are currently prepared to undertake during peacetime. The exploration of space requires vast investments of money, men and materials and creative effort—investments which could be profitably applied also to other areas of human endeavor, and which may not be so applied if space activities overly attract the available resources. . . . Hence, there is a pressing need to examine carefully the claimed benefits and goals and the possible consequences and problems of space activities. . . .
>
> —Brookings Institution, "Proposed Studies of the Implications of Peaceful Space Activities for Human Affairs," March 1961

A view of the Soviet Soyuz spacecraft in Earth orbit, photographed from the U.S. Apollo spacecraft during the 1975 joint U.S.-Soviet Apollo-Soyuz Test Project docking-in-earth-orbit mission.
NASA

While the military and the president were in a tug of war over the future of the nation's space program, a grouping of social scientists and economists were becoming increasingly alarmed as the nation's youth set their sights on studying science and becoming astronauts. Led by the Tavistock Institute, the premier psychological profiling institution that directed Britain's psychological warfare operations in World War II and in the colonies, several U.S. institutes and university centers began to develop programs to divert the U.S. space effort from its scientific and technological goals.

Before the ink was dry on the July 1958 Space Act, which created NASA with the mandate for the peaceful exploration of space, the Institute for Social Research at the University of Michigan, the Brookings Institution, and Tavistock were presenting studies to Congress and NASA to try to convince them that the "social effect" of the space program was as important as the scientific and economic benefit.

These were not simply well-intentioned people concerned with the societal effects of such a large-scale program. The organizers of this effort to force NASA to evaluate the effects of science on the "inner space" (or mental health) of the population went on to become members of the Club of Rome, the New York Council on Foreign Relations, and various Malthusian operations of the United Nations Organization. In their own words, they are the "Aquarian Conspiracy."

The alarm was sounded in February 1959, when the Institute for Social Research released results of a study in which four out of five respondents said the world is better off because of science. Other surveys indicated that American businessmen had the sense after Sputnik and U.S. space successes that "nothing was impossible." Most disturbing to the Aquarians was the observation that "The long range possibilities of the space age apparently have much more meaning for those people who are most likely to live to see them" (that is, the youth).

In March 1961, the Brookings Institution completed a report on "Proposed Studies on the Implications of Peaceful Space Activities for Human Affairs." The principal author was Donald Michael, who a few years later became a member of the U.S. committee of the zero-growth Club of Rome.

The major proposal of the 1961 Brookings report was that NASA establish a "social sciences research capability" to be "concerned with the consequences of its own activities"—a miniature Brookings. This early report outlined every guise under which the U.S. space program would be attacked in the next five years.

The most deadly Brookings weapon against NASA was economic—limited resources are "economic reality" in an Aquarian worldview. "If and as horizons were broadened as a result of space activities, other aspirations would compete with them for attention and resources, and continuous study would be required to evaluate the appropriate position of space in this competition," Brookings wrote.

Another line of attack was the claim that there were differences in the scientific community as to the "appropriate role" of the space program. Although scientists did differ in judgment on the speed and choice of various space projects, few scientists ever proposed putting the brakes on the NASA effort. Nevertheless, Brookings proclaimed:

> Even among scientists in the space community . . . there is some concern as to whether an "all-out" space effort is in the best interests of science and the nation. While this concern is related in part to the anticipated costs of space activities, there is also a feeling that continued excessive attention to space may blind the policymakers to the compelling needs and opportunities in other physical and social sciences.

To ensure that any potential for disagreement would be promoted, Michael proposed as an area of "study" for NASA the "disillusionment and cynicism" among NASA scientists, who feel they are "being used by the politicians."

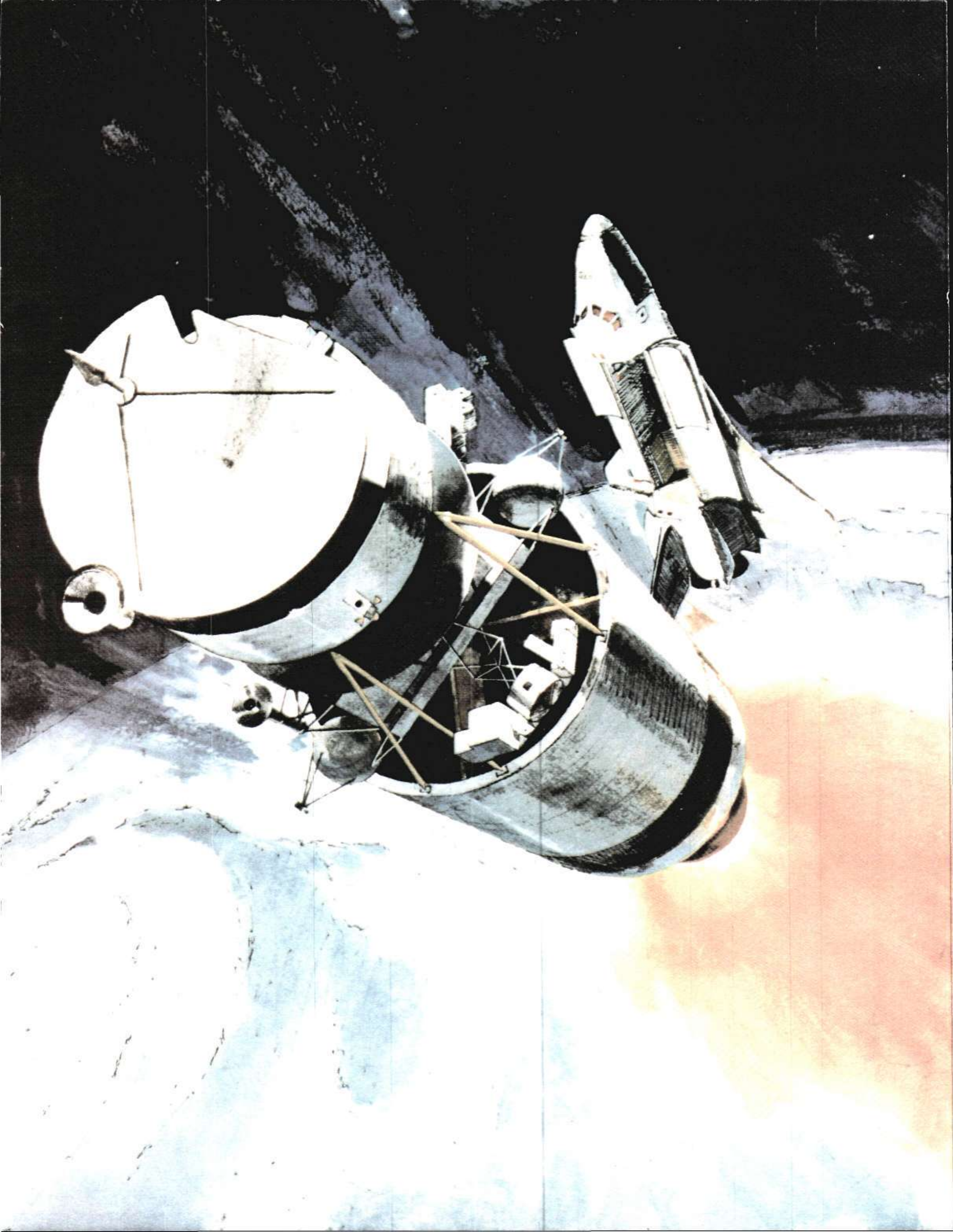
Finally, Brookings laid out the now well-established Malthusian prescriptions against the transfer of advanced technology:

> Acceptance or rejection of technological innovation by a society is seldom exclusively a matter of rational assessment. A melange of personal and culturally defined values, as concepts of what is worthwhile, desirable, good and ethically right, plays a large and often dominating role in generating the attitudes that in part determine an innovation's fate. . . .

The Brookings assessment was completely contrary to the real excitement of developing nations in sharing in the satellite communications and education potential of the space effort, but this was a situation the Aquarians intended to change. In this endeavor, Brookings author Donald Michael was joined by Margaret Mead, who devoted her life to "cultural relativism," promoting the idea that the primitive should be kept primitive. In 1958, Mead and Michael authored a study for the New York Academy of Sciences titled, "Man in Space: A Tool and Program for the Study of Social Change." The next year, Mead came out with a piece titled, "The Newest Battle of the Sexes," which asserted that women were against the space program because they were afraid of men going into space!

Despite these early attacks, Eisenhower, the scientists, and the leadership of the House and Senate committees with jurisdiction over the space program never waivered in their commitment to formulate a scientifically vectored civilian space program. The basis for NASA in these years was not Brookings but studies done by the Space Sciences

Artist's depiction of the Solar Polar Mission. Here the two spacecraft that will explore the Sun's poles begin their journey from the space shuttle's upper stage.
NASA



Board of the National Academy under the chairmanship of Lloyd Berkner, by the National Society of Professional Engineers, and by the scientists that the president and Congress brought into policymaking discussions and decisions.

Just as Eisenhower was the first president to bring scientists into the White House during peacetime, so the chairman of the newly formed House Committee on Science and Astronautics, Overton Brooks, a Louisiana Democrat, formed an extraordinary panel of scientists and engineers to advise Congress on space science and policy. On March 25, 1960, Brooks announced the formation of the Panel on Science and Technology:

> We shall provide for these men of science a forum in which they can speak out to the world on the problems that face it in basic and applied science, in space technology and space exploration. It is unfortunately true that too many times scientists with important ideas that would help advance the interests of the United States and mankind in general have been unable to find anyone to listen to them. Theirs have been, on too many occasions, voices in the wilderness. Now, through this panel, we shall make available to them a public forum in which they can be heard.

Dr. James Van Allen gathered together some of the most respected physicists, engineers, meteorologists, astronomers, and biological scientists to advise the committee, which was the predecessor of today's House Committee on Science and Technology.

The Great Society Vs. Science

> Because of NASA's involvement in all critical disciplines, the space program has become a central, organizing and advancing force in the maintenance of the technological health and overall stability and prosperity of this nation. . . . For the long run it is my hope that the space program will not need to be stimulated by the accomplishments of any one nation or nations. . . . I hope that we can be motivated in the future by the realization that space exploration increases our total scientific and technological capability and at the same time contributes to a more stable world order. . . . I can think of no better way for mankind to join hands than in facing together the challenge of the solar system and the universe.
>
> —James E. Webb, *Preliminary History of NASA*, Jan. 1969

The criterion for whether a large-scale scientific and technological endeavor is progressing or not is not how well it is performing at the present, but how it is planning for the future. With President Kennedy's highly publicized announcement May 25, 1961 that the United States would aim to "land a man on the moon and return him safely to earth before the end of the decade," the space program had an executively mandated goal, difficult to attack head-on.

Therefore, as early as 1961, the focus of public debate became how much money should be spent by NASA *beyond* what it would take to get to the moon, and where the space program fit in to the use of the "limited resources" defined by Brookings et al.

There is no question that President Kennedy viewed the Apollo Project as a politically wise initiative, following the political fiasco of the Bay of Pigs. There is also little question that he saw the U.S. program in space as an important part of America's world leadership role. In Sept. 1962, speaking at Rice University, Kennedy said:

> Those who came before us made certain that this country rode the first waves of the industrial revolution, the first waves of modern invention, and the first waves of nuclear power, and this generation does not intend to founder in the backwash of the coming age of space. We have vowed that we shall not see space filled with weapons of mass destruction, but with the instruments of knowledge and understanding.

Kennedy's single most important step in the acceleration of the lunar landing program and in the overall leap forward in NASA was the appointment of James E. Webb as the administrator of the space agency. A political administrator with no technical background, Webb was a personal friend of Lloyd Berkner and had been involved in federal government service for many years as well as in the development of commercial flight.

What kept NASA intact during the crucial period of 1961 through 1968 was the quality of NASA's leadership. Webb was committed to keep scientific discovery and the development of new technologies the focus of the space program, despite the escalating attacks from the antiscience faction that took hold of the country in the 1960s.

The Postindustrial Society

The single area of debate that defined the pro and anti positions in terms of the space program is the same area that today defines the fight over energy policy, fiscal policy, and science policy in general—economics. In the early 1960s, the Aquarians barraged scientists, congressmen, aerospace executives, and, of course, the American public with a "new economics," the economics of a postindustrial society.

Most readers will be familiar with the litany: Too many Americans have too much, two cars in the garage, at least two televisions, and so on. Therefore, the real question for the future is not more economic growth but the quality of life, which the antiscience faction was careful to define as nontangible factors such as individual happiness and sensual gratification. America, the Aquarians stated, no longer had a moral purpose except to cut back its embarrassingly high standard of living. At home, this became the "War on Poverty." But here and abroad the policy was the same: There is no way to solve the problem of limited resources except by cutting back on use and more equally distributing what is left.

NASA

James E. Webb (right), the NASA administrator who expedited the successful lunar landing program, is shown here March 13, 1961 testifying before Overton Brooks (D-La.) of the House Committee on Science and Astronautics.

The psychological warfare tools developed primarily by the London-based Tavistock Institute, the Stanford Research Institute in California, and other offshoot institutes in American universities and think tanks are familiar to Americans who lived through the past two decades: the proliferation of drugs, the student revolution, the fragmentation of society into narrow and competing special interest groups.

Scientists like Berkner and administrators like Webb, however, were unable to counter this flood of propaganda with the reality that economic progress and the standard of living Americans require is based on the investment that society makes in science and new technology. By 1965, NASA was losing ground.

In 1966, a book called *Social Indicators* was published that stated most precisely how the space program was being destroyed. The idea of the study, part of a series NASA had contracted on "Technology, Space, and Society," came from Bertram Gross, an economist and social scientist who had been in a position to implement the Aquarian policy as a member of the President's Council of Economic Advisors and as the editor of Tavistock Institute's periodical *Human Relations*.

According to *Social Indicators:*

> . . . Measures of social performance are all the more important in a "postindustrial" society, one in which the satisfaction of human interests and values has at least as high a priority as the pursuit of economic goals. The development of social indicators and accounting is a subject of real interest to the Johnson administration. . . . The Great Society looks beyond the prospects of abundance to the problems of abundance. . . . The task of the Great Society is to ensure our people the environment, the capacities, and the social structures that will give them a meaningful chance to pursue their individual happiness. Thus the Great Society is concerned not with the how much, but the how good—not with the quantity of our goods but the quality of our lives. . . .

President Johnson was the most vociferous proponent of a strong space program, but by the time he made his "Great Society" State of the Union address in January 1965, Gross and others had convinced him of the thesis later laid out in *Social Indicators:* "In the conduct of human affairs, our actions inevitably have second-order consequences. These consequences are, in many instances, more important than our original action." Instead of standard measurements of economic performance, Gross and others persuaded Johnson that "social indicators" had to be used in order to account for "second-order consequences."

What are these second-order effects? Again, to quote *Social Indicators:* the fact that pesticides designed to kill insects were secondarily killing birds. Or the fact that new detergents used for better cleaning were also clogging people's plumbing. Or the secondary effect of workers being thrown out of work as a result of increasing automation.

As for NASA's secondary effects, *Social Indicators* identified "the lack of diffusion of technology into the civilian

economy, the effects on small communities of the location of new NASA installations, the allocation of government contracts and their effect on industry, the effects on the educational system." The solution the study promoted was for NASA to build a "feedback system into the environment" to get the input from the people affected by this massive government program.

The Gross book, meanwhile, had already a precise view of this "postindustrial society" and its characteristics: There will be a concern for the "large-scale conservation of natural resources"; "manufacturing will be below 10-15 percent of the labor force and services will be above 60 percent of the labor force"; "values" will change from nationalism to "transnationalism," and transnational planning systems will replace sovereign governments.

Johnson's State of the Union address January 4, 1965 was the first such speech since 1958 that did not mention the space program; paraphrasing the Aquarians, Johnson said: "The Great Society asks not only how much, but how good; not only how to create wealth but how to use it; not only how fast we are going but where we are headed. It proposes as the first test for a nation: the quality of its people."

It is not surprising, then, that 1965 was also the first year since Sputnik that the NASA budget declined in absolute dollars. With many of the procurement expenditures already made for the mandated Apollo lunar landing, the question on the agenda was the future of the exploration of space. While von Braun and some NASA people at headquarters pushed for the absolute supremacy of the manned space program, Webb and the scientists tried to keep the question of scientific discovery and excellence foremost.

The Aquarians fanned this debate with a high-level media campaign in the nation's press to push the idea of "limited resources" and thinking "small" for NASA. Here are some samples:

Rev. Dr. Theodore M. Hesburgh, member, Council on Foreign Relations, Trilateral Commission, Nov. 18, 1962, in the *New York Times:*

> . . . The preoccupation of scientists with space and military research is prostituting science to something far below its capacity for abolishing disease, hunger, and illiteracy on a worldwide basis. Should we pioneer in space and be timid on earth and leave man in bondage below?

Barry Commoner, leading environmentalist, Dec. 16, 1962, in *The Nation:*

> At this moment, in some other city, a group may be meeting to consider how to provide air for the first human inhabitants on the moon. Yet we are meeting here because we have not yet learned how to manage our lives without fouling the air man must continue to breathe on Mother Earth.

Dr. Philip Abelson, member, American Association of the Club of Rome, Council on Foreign Relations, and editor of *Science*, April 19, 1963:

> NASA has sought examples of technology fallout in its program. To date, those cited have not been impressive. The problems of space are different from the earthly tax-paying economy.

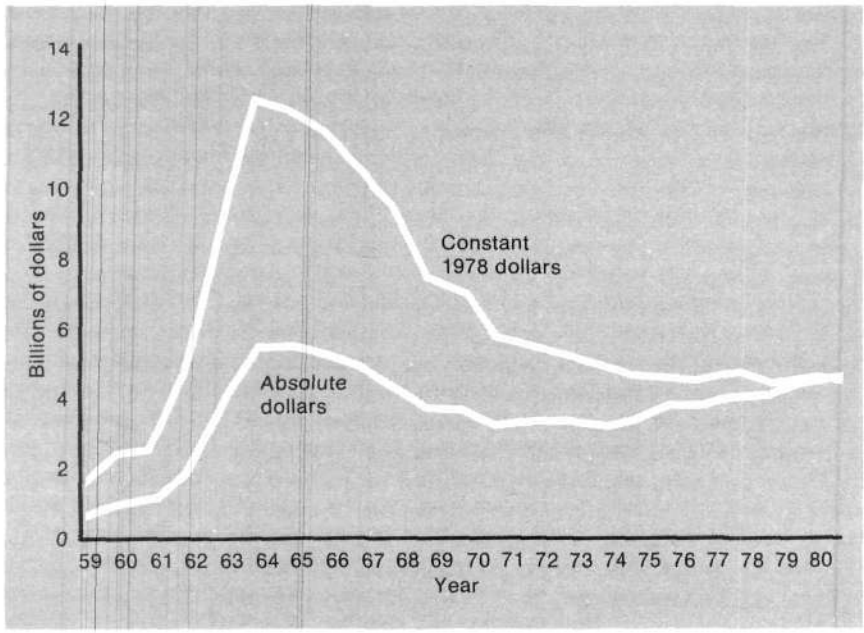


Figure 1
NASA BUDGET IN CONSTANT 1978 DOLLARS
Since 1965, the NASA budget has been declining in constant dollars, although not in absolute dollars. The budget fell off as the Apollo program reached completion and new project areas were not started. In absolute dollars, the Department of Health, Education, and Welfare now spends every nine days the total amount of the annual NASA budget.

NASA

Anatoly Dobrynin (foreground), Soviet Ambassador to the United States, watching the Apollo/Saturn 1B as it lifts away from the launch pad at Kennedy Space Center, July 1975. With Dobrynin are NASA administrator Dr. James Fletcher (right) and test conductor Richard Thornburg.

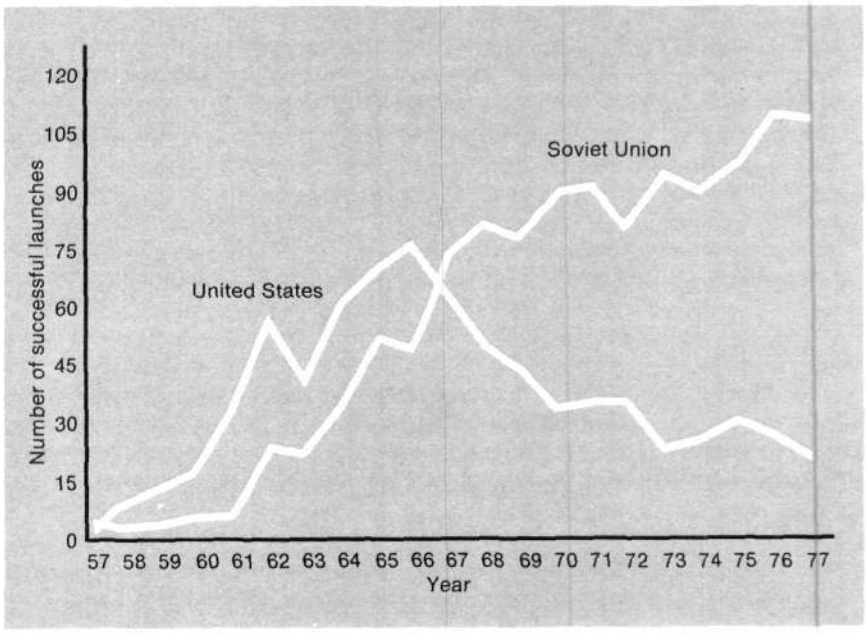


Figure 2
U.S. VS. SOVIET SUCCESSFUL SATELLITE LAUNCHES

As the NASA budget for future space exploration was reaching its all-time peak in 1966, the Soviet Union surpassed the United States in successful satellite launches for the first time since Sputnik. The Soviet space budget has continued to increase in real dollars, along with an overall science education effort—both of which are reflected in the steady climb of Soviet satellites launched.

Abelson, June 10, 1963, in the *Washington Star:*

> Columbus was seeking economic returns while we already know there will not be objects of economic value brought back from the moon or any of the planets. I believe the program may delay conquests of cancer and mental illness.

Senator William Proxmire, Aug. 20, 1962, in *U.S. News and World Report:*

> I think there is great waste in this program. This latest single increase [to $5.5 billion] in the space budget will result in a tax of $70 for every American family—for all of our 50 million American families—for the nondefense program. I wonder if most people approve of spending at that rate for this kind of program. . . .

By 1968, *Newsweek* magazine was able to crow in an editorial on the occasion of James Webb's resignation as NASA administrator:

> Now as NASA draws close to the time when it either fails or fulfills that commitment [to land on the moon], the U.S. space program is in decline. The Vietnam war and the desperate conditions of the nation's poor and its cities—which make spaceflight seem, in comparison, like an embarrassing national self-indulgence—have combined to drag down a program where the sky was no longer the limit.

The irony of this phony battle over limited resources was that NASA's technological advances had made possible vast improvements in man's living standards. Anti-science writers like Henry Hazlitt could write in *Newsweek* that more urgent or useful projects than the moon landing were "increased food production, new and cheaper sources of power, human disease elimination, prolonging human life, decontaminating the air, desalinating water, weather control." Yet, through technology developed from satellites, remote sensing, advanced energy system work with the Atomic Energy Commission, biotelemetry, and others, NASA was the prime contributor to solving these problems "on earth" throughout the 1960s—and today.

An Ineffective Defense

The defenders of a strong space effort, in Congress, NASA, and the scientific community understood the salient points and tried to counter the arguments as they emerged from the Aquarians and the "aura of power" military. For example, in hearings before the Committee on Aeronautical and Space Sciences of the U.S. Senate on June 10-11, 1963, Lloyd Berkner commented:

> In response to this assertion that the space budget could better be diverted to other ends, we should not forget that we live in a dynamic civilization in which some aspects of technology must always lead to others. Failure to press these technological differentials will bring technology to a halt, and our space program is the greatest spur to technology today. Beyond this, in satisfying man's primitive aspirations to conquer the unconquered, we spur him to greater effort. Only 1 percent added effort will pay for the whole space program, and there is no doubt that the program exercises a mighty influence in the advancement of both education and industry. The point is that poverty is far more likely to disappear when men work vigorously under strong motivation.

James Webb, who refused to succumb to the notion that NASA had been created simply to go to the moon, stated the case eloquently during hearings on the fiscal year 1965 request:

> The policy on which this budget is based is the mastery of space, and its utilization for the benefit of mankind. This mastery and the relation of our position to those of other nations, will not be determined by any single achievement. Superiority in the space environment will be won by that nation which first fashions into a usable system all of the scientific knowledge, all of the technology, all of the experience, all of the space launches and terminal facilities, and all of the aids to space navigation required for safe and regular operations. The NASA program is designed to expand both science and technology. . . . We have avoided a narrow program, one limited, for example, to developing only the technology needed to reach the moon with state-of-the-art hardware. To do so might well be to find, some years hence, that we had won the battle and lost the war as far as ultimate and enduring superiority in space is concerned.

But Webb, Berkner, and others were losing the battle and potentially the war. Perhaps the most crucial determining factor in the fight was that they stood virtually alone, without the muscle from industry and the scientific community to back them up.

At its height in the mid-1960s, NASA directly employed 37,000 scientists, engineers, and skilled technicians, while an additional 403,000 Americans worked directly on NASA contracts in the aerospace and related electronics industries to build the hardware for space exploration. Thousands of scientists and engineers were educated and trained under NASA's guidance and funding and went on to do excellent work in all areas of science and industry.

The United States is still living off the human and technological wealth created during the space efforts and breakthroughs in fundamental science that NASA made in the 1960s. Now we need a new burst in the space program to pace the scientific, industrial, and energy developments required by the end of the century. But we are running out of time.

Marsha Freeman is the director of industrial research for the Fusion Energy Foundation.

The NATO Plan to Kill U.S. Science

by Mark Burdman

Observers of U.S. scientific-military trends have been alarmed by the overall collapse of American capabilities in the wake of the space program's decline. It is an open secret that decisive contributions were made to this impasse by the NATO command itself. Here is the story of how NATO planners launched the 1960-1970s "Limits to Growth" campaign on the deluded strategic assumption that the West could deindustrialize and induce the Soviet bloc to contain its scientific development as well.

IN A 1977 SEMIAUTOBIOGRAPHICAL account, Aurelio Peccei, founder and chairman of the Club of Rome International, had the following to say about his sponsorship of the 1971-1972 *Limits to Growth* report:

> To have an impact, the Club of Rome's message . . . had to provide shock treatment. . . . Our purpose remained that of mounting a commando operation with a view to opening a breach in the citadel of self-complacency within which society had foolishly entrenched itself. . . . Partly as a result of the report's impact, the growth began to disinflate like a punctured balloon. . . .

It is no accident that Italian oligarch Peccei defined the Club of Rome's *Limits to Growth* project in such military and psychological-warfare terms. Peccei has been a top-level operative of the North Atlantic Treaty Organization command structure for the past 15 years. The Club of Rome is a NATO special intelligence branch.

This fact will only come as a surprise to those who still maintain the illusion that NATO was established to "defend the Western world against Soviet aggression." NATO headquarters, in the wake of Senator Robert Taft's unsuccessful late-1940s effort to avert tying the United States to an Anglo-American alliance, served as a control point for economic and psychological warfare against the populations of the United States and Europe. The British-dominated NATO command aimed at extending its social engineering and enforced scarcity of resources to the postcolonial world as well as the member nations of the Warsaw Pact itself.

It was NATO that secured overclassification of U.S. nuclear data—obstructing civilian applications—while Great Britain has enjoyed access to all U.S. atomic secrets. In Aurelio Peccei's conception, the "limited war," "flexible response" doctrines of NATO were chiefly a means to the end of stifling new technologies and advanced energy sources.

The consequences of the Club of Rome's "commando operation" are now apparent in the overall deterioration in American scientific, military, and economic capabilities. Ironically, NATO's success in constraining the National

Aeronautics and Space Administration has been the paramount single factor in ensuring the inability of the United States to mount even an "aura of power" on the frontiers of science and industry. The counterculture and pseudoscience promoted by the Club of Rome and its affiliates have neared their goal of deindustrializing the nation. The supranational planners have outfoxed themselves, at the nation's expense. While the hardcore futurologists plunge ahead with their New Dark Ages scenarios, the realists within NATO now acknowledge a strategic crisis.

The Club of Rome was launched when the British-centered NATO policymakers panicked at the imminence of new global scientific and technological breakthroughs led jointly by the two great world powers, the United States and the Soviet Union.

In November 1966, the Soviet scientific and industrial planning elites embarked that country on what official Communist Party of the Soviet Union documents referred to as a "scientific and technological revolution." To carry this out, the Soviet leadership committed itself to the in-depth scientific and mathematical education of the entire generation of students then entering Soviet educational institutions.

In the same year, the United States was in the midst of experiencing the scientific shock waves from the late-1950s initiation of the space program and the creation of the National Aeronautics and Space Administration (NASA). The space program had generated an avid interest in scientific exploration, and had attracted to it some of the best minds both from American scientific institutions and institutions throughout Europe.

H.G. Wells

Immediately after the Cuba Missile Crisis of October 1962, President John Kennedy took the important step of rejecting the counsel of the British think tank, the Tavistock Institute, its cousin the Rand Corporation, and others that were then prompting him to adopt a NATO defense strategy based on psychological "flexible response" gameplans and large-scale psychological manipulations of the domestic NATO populations by means of "civil defense" programs. The president, at that time, opted for cutting down the civil defense program and pressing forward with the massive expansion of NASA, the space program, and the general scientific-technological upgrading of American industry.

The leading circles of NATO were very alarmed by all this.

In 1963, the year of Kennedy's assassination, the British Royal Society began issuing distraught reports about a "brain drain" from the United Kingdom to the United States. Social scientists associated with Tavistock, the Brookings Institution, and the Rand Corporation had been combing through the raw data on Americans' response to the space program assembled through surveys by the Stanford Research Institute, the University of Michigan's Institute for Social Research, and others since the late 1950s.

By the mid-1960s, Tavistock's journal *Human Relations* reported that the space program was producing an extraordinary number of "redundant" and "supernumerary" scientists and engineers. "There would soon be two scientists for every man, woman, and dog in the society," one related report wrote. These new scientists and engineers had the nasty propensity of reproducing themselves at a rate much faster than any other segment of society, according to Tavistock. Their very presence and rate of expansion had a profound impact on the values of the entire American population from skilled workers and office clerks down to grammar school children eager to explain to anyone who would listen all the secrets of rocket propulsion from construction to fueling to liftoff, all the way to reentry and retrieval procedures.

Tavistock was shocked!

NATO's policymaking directorate began an alarmed mobilization to stop this, activating a twofold scheme: First, to redirect the U.S. thrust away from the NASA direction and into transforming the United States into a 1984-style "information society" premised on elaborate communications grids and sophisticated techniques of "mind control." Second, to establish new global institutions to stem and channel technology into only those directions that NATO saw fit to permit.

The decision was made to "decouple" the new technologies associated with the space program from the process of mass involvement with scientific outlook and activity. Space technologies would be coopted for military applications and global communications grids; but on earth a new ideology would supersede Americans' commitment to progress and individual responsibility. This incompetent approach was to spell disaster for U.S. in-depth capabilities.

Nominally a businessman—for 30 years he had served as a top-level executive and planner for the Fiat conglomerate owned by Italy's Agnelli interests—Aurelio Peccei was a specialist in the "information economy" and "world order." Peccei had been trained by the leading futurist of

Europe, Bertrand de Jouvenel, himself a student and disciple of H.G. Wells. Wells was a ferocious opponent of the American industrial republican form of government. He believed that science should be the preserve of a chosen elite, and not a subject of concern to the "sheeplike masses." His writings on "The Open Conspiracy" and "The World Brain" outline his belief that nations should be governed by a supranational dictatorship. Wells envisioned the era of mass communications as ushering in unparalleled potentialities for social control; the "War of the Worlds" radio experiment in 1938 was one public example. Wide-scale drug consumption (*The Island of Dr. Moreau*) and top-down manipulation of social planning ("futurism," as sketched in Wells's 1910 *The Discovery of the Future*) are the instrumentalities Wells identifies.

Wells's promulgation of an "open conspiracy" is cited by Marilyn Ferguson in her book *The Aquarian Conspiracy* (1980) as the earliest 20th-century statement of the aims of the hard-core counterculture.

Wells was no isolated futurist. His conceptions, devised in collaboration with the British Secret Intelligence Service, guided the psychological warfare conducted during World War II by the Office of Strategic Services' Strategic Bombing Survey and the Committee on National Morale.

The postwar period saw the emergence of a complex of institutions assigned to conduct mass psychological profiling and manipulation and confinement of the U.S. technological boom: these included the Rand Corporation, the Palo Alto Center for Advanced Behavioral Sciences, the University of Michigan's Institute for Social Research, the National Training Laboratories, and the National Institute of Mental Health.

Such think tanks served as a sort of priesthood for a corporate group that was already in a position to begin shaping the U.S. economy along Wellsian lines—pursuing neither industrial expansion nor financial profits, but acting as NATO's lever in the sphere of American business strategy. The directorates of Rank-Xerox, IBM, Standard Telephone and Cables, AT&T, Prudential Insurance, and ITT are among the most important executives accountable for the decoupling of high technology from mass-scale scientific capabilities in the population of the United States.

These were the NATO resources thrown against the space program's potential in the early 1960s.

The most public "information society" salvo of the 1960s came out of California at the same time the drug culture was created there by think tanks in Palo Alto, Menlo Park, and San Francisco-Berkeley. The Center for the Study of Democratic Institutions, drawing on Aspen Institute perspectives, initiated the 1962 Ad Hoc Committee on the Triple Revolution. The report from their Michigan meeting concluded that human labor was being replaced by "a combination of the computer and the automated self-regulating machine," heralding "the postscarcity era" of cybernation. Man must now find "a new purpose," the report asserted, since the "traditional link between jobs and income" is about to be broken.

The Santa Barbara sponsors of this initiative were former University of Chicago president Robert Maynard Hutchins, proponent of a supranational bucolic elite and one of the most vocal post-World War II opponents of the development of nuclear power as an energy resource, and his protégé W.H. Farey, vice president of the Fund for the Republic.

Aurelio Peccei United Nations

Objectively, the Triple Revolution outlook was preposterous: by any measure of the need to upgrade the world economy and world labor skills, exponential growth in U.S., European, and Japanese industrial capacity was urgently required.

Yet the myth of an overfed, supernumerary work force became a media formula and an academic truism, creating among other things the "New Left." Endorsers of the Triple Revolution perspective included Tom Hayden, a founder of the Students for a Democratic Society (SDS). SDS appealed to both jaded suburban youth and would-be intellectuals, with the pitch that a "postindustrial America" ought to find "new values."

The publicist of the cybernation concept, Donald Michael, had just completed one of the major profiling studies on the U.S. space program. Michael is currently in San Francisco collaborating with Stanford Research Institute's Willis Harman on an array of projects including the promulgation of a concept of "appropriate science," which, like its stepmother "appropriate technologies," puts limits on the realm of scientific investigation and the freedom allowed researchers.

How far these concepts had become hegemonic was evident in a series of three simultaneous "Year 2000" projects launched in 1966-1967: one by a group in France called the "Futuribles," a second by the Tavistock-linked Science Policy Research Unit in Sussex, England, titled "Mankind 2000," and the third by the U.S. Academy of Arts and Sciences, titled "The U.S. in the Year 2000."

The Paris "futuribles" group was run by Bertrand de Jouvenel, the hardcore Wells disciple who is the most revered figure among today's "futurist" operatives. During the 1930s and early 1940s, de Jouvenel was one of France's most ardent supporters of Hitler. Upon seeing Germany first-hand under the Nazis, he wrote: "How can one help but think of the Order of the Jesuits, of the admirable unity of its diverse activities? The German intellectual world constitutes in the same way an Order working for the greatest glory of the fatherland."

De Jouvenel offered advice on how to perfect the workings of the fascist state: "In our recent admiration for the totalitarian state, we have not yet understood that the absolutism of the State must be corrected by the constitution of small collectivities which solicit and satisfy the human instinct for loyalty, which make bloom those feelings which the State takes advantage of but which is itself incapable of arousing."

Centralized control and "small community groups": the essence of the Aquarian Conspiracy.

De Jouvenel's influence was pervasive throughout the Year 2000 work. One piece of evidence is a document published in 1967 by a participant in the U.S. Commission for the Year 2000 who came to the commission from the State Department Policy Planning Staff. The document was titled "America in the Technetronic Age." The author's name is Zbigniew Brzezinski.

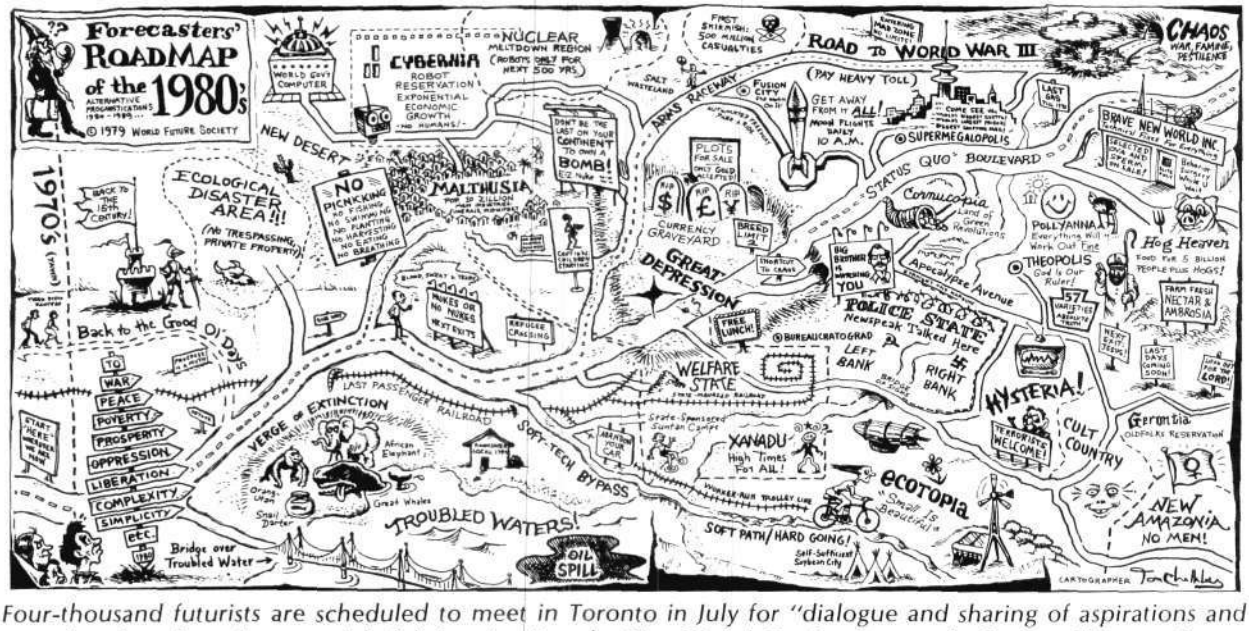
Brzezinski wrote that America was moving into a society "increasingly unlike its industrial predecessor," a "technetronic" society that could easily become a "technocratic dictatorship." The society would be characterized by an "information revolution," "cybernetics," and the replacement of "achievement-orientation" by "amusement-focus" based on "spectator spectacles [mass sports and TV] providing an opiate for increasingly purposeless masses."

"In the technetronic society," Brzezinski went on, "industrial employment yields to services, with automation and cybernetics replacing individual operation of machines." This will occur simultaneously with "the increasing availability of bio-chemical means of human control." Also, "new forms of social control may be needed to limit the indiscriminate exercise by individuals of their new powers. . . . The possibility of extensive chemical mind control . . . will call for a social definition of common criteria of restraint as well as of utilization."

This transformation, wrote Brzezinski, means that

> America, having left the industrial phase, is today entering a distinct historical era, a different one from that of Western Europe and Japan. Subtle and still indefinable changes in the American psyche provide the psychocultural underpinnings for the more evident political disagreements between the two sides of the Atlantic. . . . Europe and America are no longer in the same historical era. What makes America unique in our time is that it is the first society to experience the future . . . be it pop art or LSD. . . . Today, America is *the* creative society; the others, consciously and unconsciously, are emulative.

This fact, Brzezinski continued, will have enormous international repercussions. "The instantaneous electronic intermeshing of mankind will make for an intense confrontation, straining social and international peace." There



Four-thousand futurists are scheduled to meet in Toronto in July for "dialogue and sharing of aspirations and new directions for a 'born again' global society" at the First Global Conference on the Future. This map is part of the publicity kit of the World Future Society, conference sponsor.

could well be a "three-way split into rural-backward, urban-industrial and technetronic ways of life" that will "only further divide man."

The "implications of a truly new era" will require a "universal intellectual elite" and a "world superculture" produced "inevitably" by "the network of electronic communication." This will also entail "creative interpreters of the new age" who will develop a concept of "regionalism with due deference to the symbolic meaning of national sovereignty." This could all be best thrashed out at "a special world congress, devoted to the technetronic and philosophical problems of the coming age."

Brzezinski's "America in the Technetronic Age" laid the basis for the initiating document of the Club of Rome, Aurelio Peccei's 1969 book, *The Chasm Ahead*. In that book, Peccei lavishly praised the then relatively unknown Brzezinski.

In 1967, Peccei began his six-year term as head of the Economic Committee of the Atlantic International Institute in Paris. That institute is the sister-organization to the Atlantic Institute in Washington, which shares its offices with the Atlantic Council, the top NATO policymaking institution in the United States.

By 1967, Peccei was just concluding an international lecture series on "world order and the need for global planning." His new position gave him the vehicle to bring NATO into the center of these processes.

In May 1967 and May 1968, Peccei coordinated two major conferences that pondered how to upgrade NATO as controller of the international flow of technology. The first, a Conference on Transatlantic Technological Imbalance and Collaboration, in Deauville, France, was cosponsored by the Scientific-Technological Committee of the North Atlantic Assembly and the Pennsylvania-based Foreign Policy Research Institute (run by U.S. Ambassador to NATO Robert Strausz-Hupe). The second, in Rome, the Conference on Strategies for Atlantic Technological Development, was sponsored by the Atlantic Institute and the Committee for the Atlantic Economic Cooperation, and was attended by 70 chief executives of leading corporations and banks on both sides of the Atlantic.

These conferences were key points at which the decisions were made to put an end to the startling U.S. technological advances.

As described by Peccei in *The Chasm Ahead*, the conferences were organized around the following theme: U.S. corporate leaders, such as David Sarnoff of NBC and John Diebold, in league with leading government agencies, had decided to steer the United States in a "post-industrial information economy" direction. Because of this, America was entering what Peccei called "the IBM age," while Europe was still in the "GM age." This was creating a "technological gap" between Europe and the United States that threatened to rip asunder the Atlantic Alliance and create chaos all over the world, since only the Atlantic Alliance was fit to govern world events. To prevent this "chaos," Europe would have to ditch its industrial development plans and follow the "information economy" path demanded by the Anglo-American faction inside NATO. Meanwhile, the United States would gut its space program.

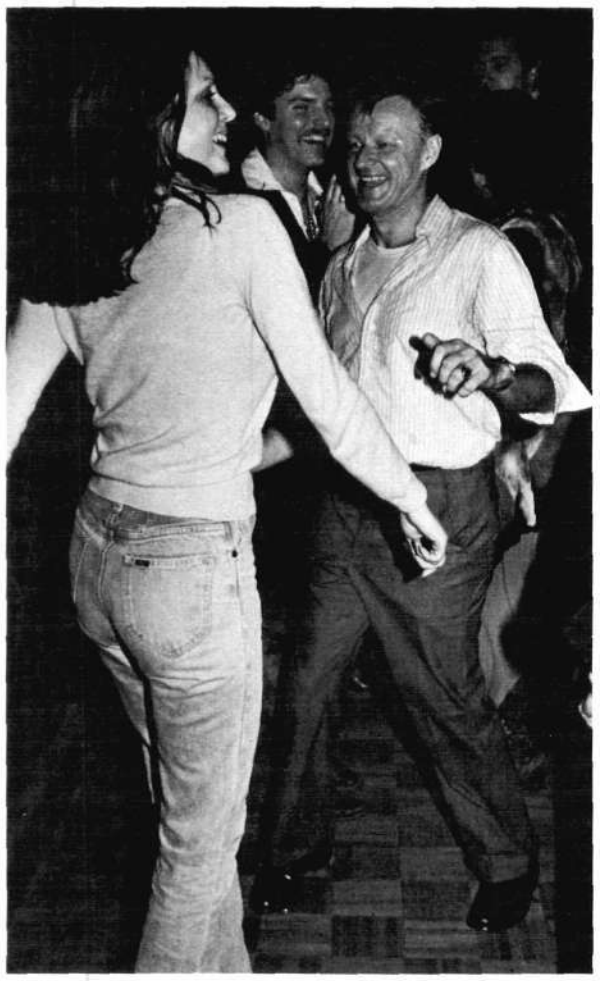


Photo by Guy Delort/Womens Wear Daily

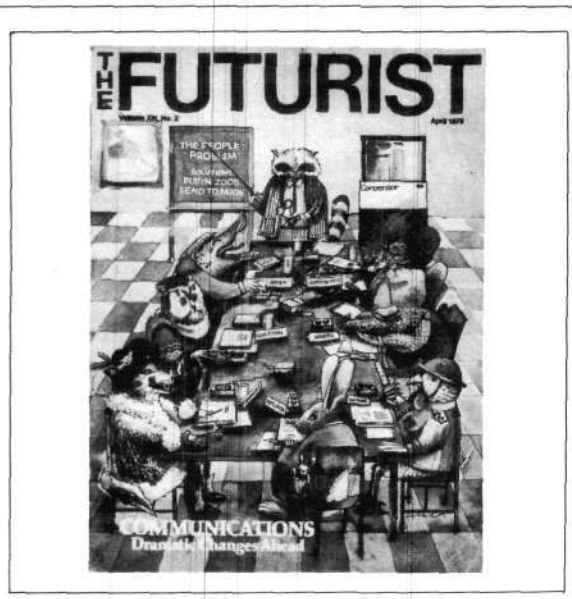
The replacement of "achievement orientation" by "amusement focus": National Security Advisor Zbigniew Brzezinski celebrating the opening of the film "Hair" with Katrina Meyers.

In totality, this program would mean the Malthusian triaging of industrial capital on a global scale. This would, of course, mean a collision at some point with the scientific-technological-military apparatus of the Soviet Union and the Warsaw Pact. So, suggested Peccei, again citing Brzezinski as his source, the Warsaw Pact would be offered "convergence" with the Atlantic Alliance as the alternative to "explosion." This "convergence" would lay the basis for what Peccei labeled a "one world" government that would run global affairs on the twin foundations of "crisis management" ("limits to growth" and "shock treatment") and "global planning."

Virtually simultaneously with these conferences, NATO began to create institutional subgroups to undermine the

progress of science and encourage the development of environmentalist movements. In 1966-1967, NATO created a Division of Scientific Affairs, with a subgroup called "Human Factors," which housed a special advanced psychological warfare unit under the title, "International Committee of Social Scientists." In 1968-1969, NATO created its "Committee on the Challenges of Man and Society," whose environmental subcommittee initiated a series of investigations into the role of solar power and other inefficient energy sources in Europe's energy future. The Committee on Challenges also was set up as a vehicle for research on the effects of scientific progress on populations and similar profiles.

While this new world strategy was being prepared within NATO, Peccei established the framework of "global planning" and "crisis management" institutions in a series of consultations with key officials. One was McGeorge Bundy, former National Security Council chief during the Cuba Missile Crisis. A second was NATO advisor Alexander King, then the director general of scientific affairs for the Organization for European Cooperation and Development. A third was Dr. Homer Perlmutter, editor of Tavistock's magazine *Human Relations*. Peccei also met extensively with White House officials and with the State Department Policy Planning Staff Council.



The magazine of the World Future Society: People are the problem.

Finally, Peccei traveled to the headquarters of the Tavistock Institute of Human Relations in Sussex, England in mid-1968, where the decisions on how to proceed in transforming NATO policy were finalized. The strategic attempt would be made to induce the Soviets into "convergence" by means of "disarmament" and similar efforts and through ideological/psychological manipulations centered around the offer of cooperation in "systems analysis." Bundy would offer the Soviets an "entry-point" into NATO's "new age" through the Vienna-based International Institute of Applied Systems Analysis (IIASA, formally founded in 1972), while King would target the Soviets through "multidisciplinary studies" in his International Federation of Institutes of Advanced Studies (IFIAS, founded with Rockefeller Foundation money in 1973).

The domestic job of brainwashing the populations of NATO countries, with special emphasis on the American population, would be coordinated by a "Club of Rome" to be founded by Peccei and King, with the Tavistock Institute functioning as the evaluator/controller of the process. The marching orders for this Club of Rome were given to Peccei at a meeting in the summer of 1968 in Bellagio, Italy, with, he writes, "the most respected gurus of long-range forecasting and planning." In a final "Bellagio Declaration," Peccei and the gurus attacked "blind reliance on science" and called for "the modification of the very structure of the human systems" as the required alternative.

Soon after this, in late 1968, the Club of Rome was founded at a meeting of those men Peccei assembled to be the core of what he called a future World Forum to oversee "global planning" and "crisis management." This was to be the "technocratic dictatorship" ruling over the "postindustrial information economies" described by Brzezinski and others. The core group would ensure that NATO would manage that global transformation.

Aside from Peccei and King, the original motivators of the Club of Rome included Hugo Thiemann, advisor to the Swiss Nestle's interests and head of the Battelle Institute in Geneva, part of the organizational nexus tied to the Tavistock-linked Battelle Memorial Institute in Columbus, Ohio; Max Kohnstamm, a Dutch international affairs expert and right-hand man to Jean Monnet; Dennis Gabor, a British physicist and Nobel Prize winner; and Jean Saint-Geours, a coworker of the Wellsian de Jouvenel, Peccei's mentor.

These men provided what was to become the executive committee group of the Club of Rome, along with Fritz Bottcher, a scientific advisor to the Dutch government; Eduard Pestel, formerly of the Technical University of Hannover and more recently Minister of Science and Culture of Lower Saxony in West Germany; and Saburo Okita, former head of the Japanese foreign aid fund and currently the Japanese foreign minister who is leading Japan into closer military alignment with NATO.

As this grouping developed its operational stage with the "Limits to Growth" psychological-warfare assault in the early 1970s, several U.S. representatives were added to bring the United States into the NATO/Club of Rome umbrella. Aside from the "Limits" report authors, Jay Forrester and Dennis Meadows, the Club of Rome International was expanded to include Senator Claiborne Pell (D-R.I.), ambassador to NATO and sponsor of several pieces of legislation calling for the creation of an "environmentalist world-order" under NATO control, and Sol Linowitz, former chairman of Xerox.

As the U.S. involvement in the Club of Rome was expanded in the 1972-1975 period with the eventual for-

mation of a U.S. Association for the Club of Rome, the following NATO emissaries were brought in to oversee the process:

- Harlan Cleveland, former U.S. ambassador to NATO during the 1960s, and a vice chairman of the Atlantic Council in Washington (NATO arm in the United States).
- George McGhee, former U.S. ambassador to NATO and ex-undersecretary of state for political-military affairs, and a director of the Atlantic Council.
- William Watts, director of Potomac Associates, the Washington think tank that assumed the mass-circulation rights to the "Limits to Growth" report. Watts is a director of the Atlantic Council.
- Donald Lesh, current executive director for the U.S. Association for the Club of Rome, one of the original creators of the European desk staff operations of the U.S. National Security Council, who worked under Henry Kissinger's associate Helmut Sonnenfeldt and later worked under Watts at Potomac Associates.

Well before the Club of Rome 1968 Bellagio Declaration's open call for "modification of the very structure of the human systems" to replace "blind reliance on science," the cluster of futurist think tanks around the Club of Rome had accelerated the artificial creation of the American counterculture. In 1966, a little-noticed article appeared in the *Journal of Humanistic Psychology*, the publication of the Association for Humanistic Psychology. Written by Dr. Willis Harman, an education/systems analysis specialist at the Stanford Research Institute in Palo Alto, California, the article lauded the "challenge to science" emerging from investigations into extrasensory perception, psychokinesis, mysticism, and "consciousness-expanding drugs." Harman pronounced the advent of "the new science," replacing mastery of "outer space and the material world" with exploration of "inner space" through "hypnosis, creativity, parapsychology, and psychedelic experiences."

This "new science" thesis was more significant than the usual content of the journal, which was founded by Aldous Huxley, psychologist Abraham Maslow, and other association promoters of the environmentalism, "sensitivity training," and drug experimentation that had proliferated in California in the early 1960s. Harman was about to conduct a monumental study for the Johnson administration's Office of Education titled "Generating Alternative Futures." The project elevated the "new science" effort to a plane of respectability, and served as a launching point for "Aquarian" strategists to take over influential positions in government, policy planning institutions, and corporate leadership throughout the nation.

The first of its kind anywhere in the United States, the project itself consumed two years of research and computer simulation analysis, utilizing highly questionable projections of future global resource availability. The study concluded that a horrific future is inevitable unless the "antimaterial value structure" of the emerging counterculture was imposed on a mass scale during the coming decades; America's historic commitment to scientific and industrial progress would have to be ended.

This project led to the formation of an early-1970s study group to pursue its implementation. Based at Stanford Research Institute, the special task force included Margaret Mead; British economic warfare specialist Sir Geoffrey Vickers; Rockefeller Foundation agronomist René Dubos; and United Nations systems analyst Erwin Laszlo, a "Limits to Growth" theoretician for the Club of Rome. The results were summarized in the 1974 volume, *Changing Images of Man*, which proposed that "the postindustrial society" required altering the population's "self-image" to replace the "scientific technological" conception of man.

UPI

Inner space: Transcendental meditation studied with sensors attached to a computer.

Delivered with increasing intensity by the mass media and the U.S. education system,[1] this was the "shock treatment" promised by Aurelio Peccei. Its consequences have been so destructive of skills and moral resources as to alarm many of its NATO sponsors. At this point, however, it is impossible to return to the 1950s *status quo ante:* nothing less than the thorough-going education of the U.S. citizenry at large in the philosophical principles of scientific method and technological breakthrough will succeed. Science must relinquish its defensive stance and become a weapon for growth.

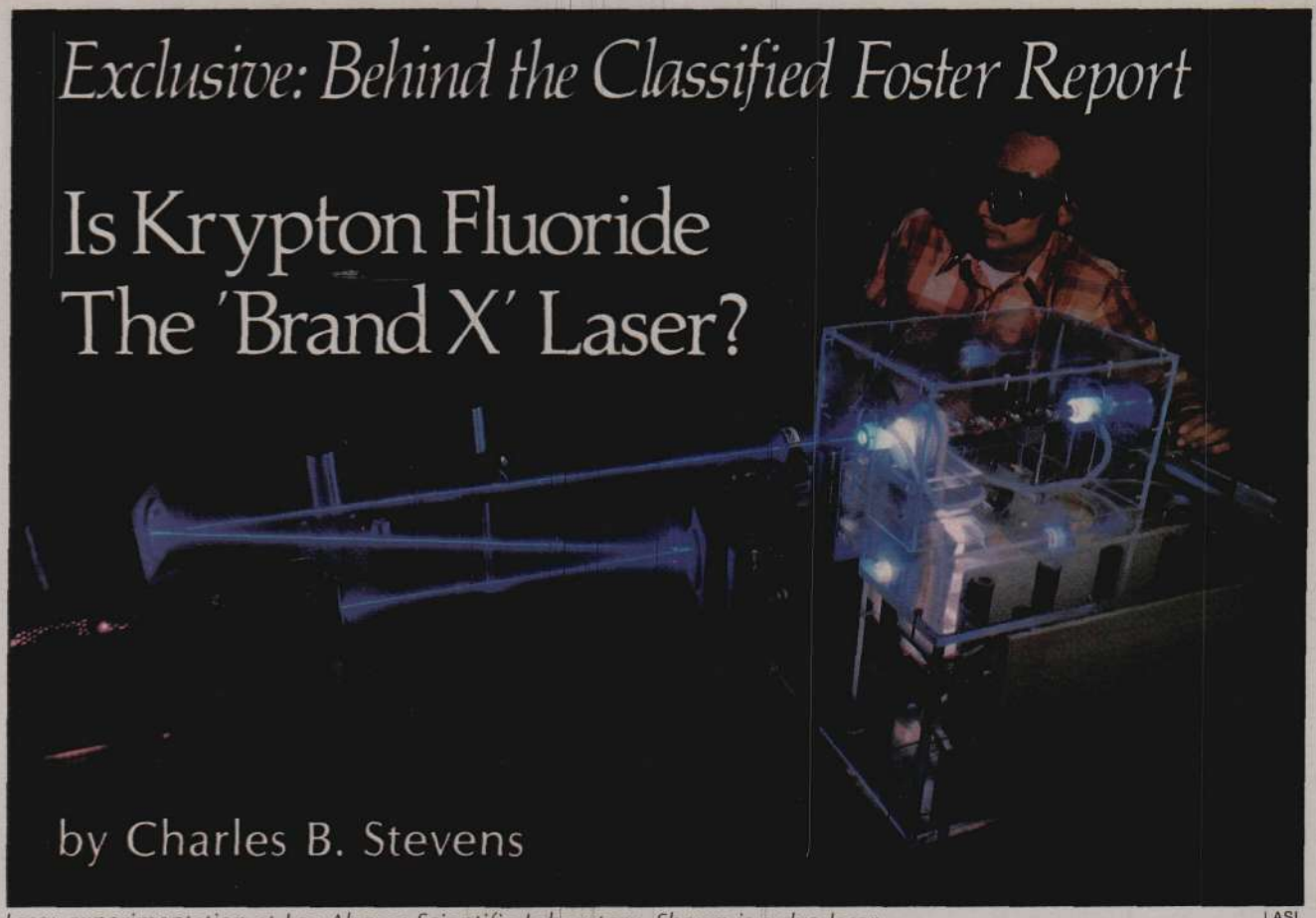
Mark Burdman, a counterintelligence expert for the Executive Intelligence Review, *has done extensive research on the Aquarian Conspiracy and its destruction of U.S. scientific capabilities.*

Note

1. The October issue of *Fusion* will feature an analysis of the scope and origins of the acute decline in American scientific and related education. Excerpts from the *Changing Images of Man* appear in the August issue of *Fusion*, page 20.

Exclusive: Behind the Classified Foster Report

Is Krypton Fluoride The 'Brand X' Laser?



by Charles B. Stevens

Laser experimentation at Los Alamos Scientific Laboratory. Shown is a dye laser. LASL

FOR YEARS, CRITICS of inertial confinement fusion have pointed to the lack of a driver technology that can both demonstrate inertial fusion in the laboratory and scale-up with the required efficiency for an economical electric power reactor. In the particular case of laser-driven inertial confinement fusion, where intense beams of laser light are used to compress fusion fuel to starlike densities and temperatures in order to ignite thermonuclear fusion, this problem has been referred to as the "brand X" laser dilemma.

Now, just at the point that U.S. scientists seem to have resolved the brand X laser problem by the development of the krypton fluoride gas laser (KrF), Congress has moved to cut the budget of the Department of Energy advanced laser fusion programs below the minimal levels needed to maintain the capability for future KrF development. Although the amount involved is but a few million dollars, the likely effects of the cut will be to retard the development of commercial inertial confinement fusion as well as to halt important scientific advances essential to national defense.

Why would Congress decide to cut off the inertial confinement program just when a major scientific problem has been resolved? The answer lies in the self-defeating austerity mentality now prevailing in Congress and in the particular circumstances of inertial confinement research and its relationship to the U.S. weapons program.

First, let's review some facts about inertial confinement fusion and its applications.

The hydrogen bomb is based on inertial confinement in which a fission atom bomb is used as the "match" to ignite fusion. Current research on inertial confinement fusion focuses on using an alternative match (intense beams of laser light, ions, or electrons) that would ignite only minute amounts of fusion fuel. Because of the miniaturization of the process, it is more amenable to useful energy applications and, equally important, to the scientific exploration of the fundamental processes involved.

Glass lasers are currently the major tools for inertial confinement fusion laboratory research, but they are inherently incapable of providing a practical basis for civilian energy applications because of the high cost involved in scaling up a glass laser system. The recently discovered krypton fluoride gas laser, however, is a system that could provide the basis for practical civilian energy applications because it can be cheaply scaled up to higher total energies.

Since the laboratory demonstration of laser fusion would immediately fulfill the goals of weapons applications, Congress has directed that the chief, near-term mission of the inertial confinement fusion program is that of weapons applications. For this reason and as a result of general pressures to curtail government spending, the majority of inertial confinement funds are directed toward

continued development of high-power laser facilities based on the known technology of glass lasers. Development of the more advanced lasers, such as the krypton fluoride gas laser, has been substantially postponed until giant glass laser systems achieve the laboratory demonstration of inertial confinement fusion, which is expected sometime in the mid- to late-1980s.

When Dr. John Foster, vice president for science of the TRW Corporation and chairman of the Department of Energy's Ad Hoc Panel to Review Fusion Energy Research, testified before the House Armed Services Committee recently, he called for doubling the inertial confinement budget and putting a substantial portion of the added funds into realizing large-scale advanced lasers like the krypton fluoride system. Foster based his case on the argument that development of civilian fusion energy must be a national priority. In this context, he noted, inertial confinement fusion provides a totally independent and essential backup to development of fusion power plants based on magnetic confinement fusion by the end of this century.

The House Armed Services Committee, which oversees the inertial confinement work, ignored Foster's recommendations, keeping the budget at last year's level. And when the Carter administration recommended in its fiscal year 1981 budget the elimination of construction funds for the flagship glass laser system, the Nova, at Lawrence Livermore Laboratory in California, Congress reacted by restoring the Nova funds with money from the minimal funding it had previously allotted to the advanced laser effort.[1] It was this latest move, in May, that put the krypton laser program in jeopardy.

The reasoning of these committee members goes something like this: The scientists tell us that the scientific basis for inertial confinement fusion is well understood since they have been successfully detonating H-bombs for more than 25 years. They told us that we could generate miniature H-bombs in the laboratory with glass lasers, therefore saving millions of dollars on underground weapons tests for further development of nuclear warheads and measurement of their effects. Now that we have spent tens of millions on building high-power glass lasers, they want us to go off in a totally new direction with the krypton fluoride laser. Let's not waste time and money on unknown technologies. Let's get the job done with glass lasers first and then we can see about funding these alternative systems.

The fact is that even within the terms of the House Armed Services Committee's defense-minded perspective, the development of the krypton fluoride laser is essential for inertial confinement fusion and for the national security. The important point here is that although the H-bomb part of nuclear weapons systems is the most predictable and reliable element in the defense arsenal, the fundamental processes involved in preparing and igniting inertial confinement fusion reactions are now comprehended only in a pragmatic manner. Cutting the advanced laser fusion program will obstruct scientific research that is key to both the future energy and defense needs of the United States.

Foster's argument about doubling the inertial confinement budget was backed up by the study his ad hoc DOE committee completed in spring 1979. The exact conclusions of the so-called Foster Report have remained a mystery, for the Carter administration summarily classified it as "top secret" and even went so far as to "withdraw" a public presentation given by a DOE official on its chief conclusions in order to prevent open discussion of its contents.[2]

The Foster Committee, formed more than two years ago by the DOE, consists of top-level managers from industry and government scientific-program directors. Chairman John Foster, who formerly directed the Lawrence Livermore Laboratory and the Department of Defense Development Research and Engineering division, is representative of the type of credentials held by the panel's members.

The Foster Report

In its first report, issued in summer 1978, the Foster Committee concluded that the commercial development of *both* magnetic and inertial fusion was essential for meeting the future energy needs of the United States. The panel also stated the need for a more detailed review of the inertial confinement program. In particular, the panel noted the difficult physics problems involved and that much of this research is classified because its fundamental processes are used for designing hydrogen bombs.

Based on the presentation on the Foster Committee report that was later "withdrawn" by the DOE and a thorough review of inertial confinement research papers published in open scientific journals, it is now possible to reconstruct, at least in outline, the chief arguments of the Foster Committee's suppressed report.

The findings go something like this:

First, although inertial confinement has not reached the same advanced scientific level as magnetic confinement research—where the demonstration of scientific feasibility is assured—it is particularly promising as a future commercial energy source and must be developed in parallel with magnetic confinement in order to develop power reactors by the end of this century. Inertial confinement fusion is so promising because it represents an entirely independent approach to harnessing fusion reactions that has been pragmatically demonstrated in the form of hydrogen bombs.

Second, significant progress has been achieved since the effort began in the early 1970s. As a result, the scientific demonstration can be confidently expected by the mid- to late-1980s—if researchers are given the proper tools and sufficient funds.

Third, what is lacking is the kind of technology development program needed to ensure that driver systems capable of meeting the needs of commercial power plants and overall reactor designs will be available at the point that scientific feasibility has been demonstrated.

Fourth, development of driver technology could, furthermore, be essential for attaining scientific feasibility.

Fifth, the panel concluded with a call for doubling the inertial confinement budget and putting the increased

funds into specific programs for developing advanced lasers, light ion, heavy ion, and electron beam drivers, as well as a reactor technology development program.

In substance the report focused on the connections between inertial confinement fusion and hydrogen bomb design and the progress in design of laser fusion targets (pellets containing fusion fuel). Although there have been major scientific problems in terms of coupling the laser energy to the target and projecting the resulting compression and heating of the fusion fuel, the panel found that progress has been sufficient to ensure success. In particular, laboratory research combined with continuing progress in H-bomb development and testing has advanced to the point that particular qualities of the inertial confinement fusion driver needed for scientific demonstration can be confidently projected.

All the evidence was not available at the time that the Foster report was completed, but the panel did discover that the krypton fluoride laser appeared to be precisely the tool to achieve scientific demonstration and provide the technology for power reactors. Developments since then have fully confirmed this initial evaluation.

How Inertial Confinement Works

In an H-bomb, the confining pressure is indirectly provided by the electromagnetic radiation output of an atom bomb. The majority of the initial energy spectrum of an atomic fission bomb consists of "soft" X-rays. A target consisting of hydrogen fusion fuel is placed next to the A-bomb. The soft X-rays traveling at the speed of light impinge on the fusion target before any blast effects are felt. These X-rays are absorbed by the surface layer of the target. As a result, this material is vaporized and rapidly expands outward. This is called *ablation*. In the same fashion as a rocket engine, ablation generates an equal and oppositely directed force (in this case, an inwardly directed force called an *implosion*). The great power of the atom bomb X-ray burst quickly transforms this inwardly directed force into an inwardly directed shock wave. The shock wave acts as a giant compression cylinder, driving the interior of the fusion fuel target to higher and higher densities.

The geometry of the target is arranged so that the compression shock will converge. When the shock wave finally reaches the center of the target, the hydrogen fusion fuel has been compressed to densities greater than that of lead and hundreds to thousands of times greater than that of liquid hydrogen. At this point, the shock wave collapses on itself, and its energy is transformed into heat. As a result, a minute amount of the core of the compressed fusion fuel is heated to the multi-million-degree temperatures needed to ignite thermonuclear reactions (about 50 million degrees Celsius). The energy from these initial fusion reactions is absorbed by the "cold" outer layers of the compressed fuel, in this way igniting the cold fuel.

In fact, this heating is so fast that a supersonic thermonuclear *burn wave* is generated, which roars through the compressed fuel so quickly that most of it reacts before the entire target blows up. For a typical H-bomb, all of this takes but a few millionths of a second, and the only force confining the fuel while it burns is the inertia of its own mass.

Laboratory inertial confinement replaces the necessarily gigantic atom-bomb "match" with a tiny though just as

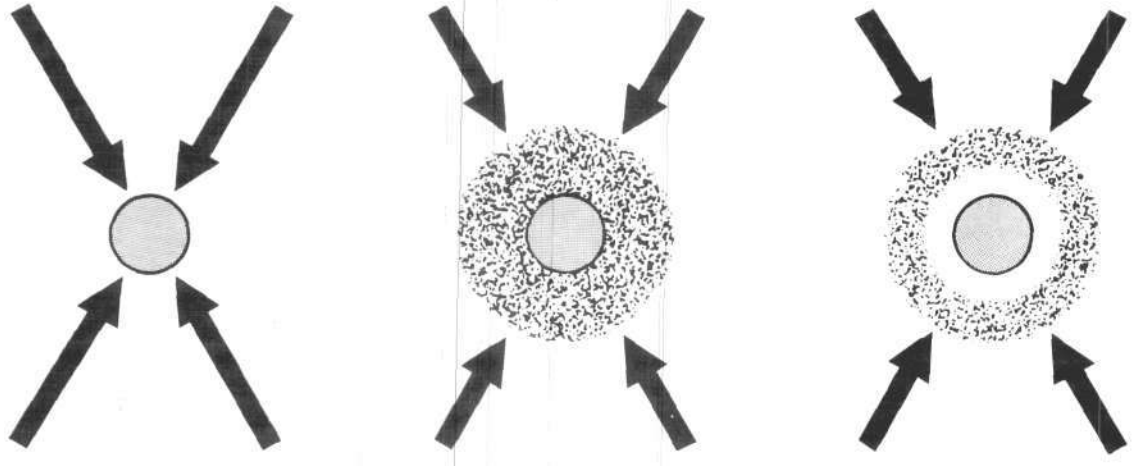


Figure 1
ABLATING IMPLOSION IN LASER FUSION

The basic phases of ablative implosion are shown here schematically. In the first phase, a, an ablating plasma is formed by the laser light hitting the surface of the fusion target. In phase b, the laser light is absorbed within the ablating plasma and the plasma then transports the resulting heat energy to the target surface so that ablation is maintained. If this transport is interrupted, as is shown in c, then the ablating plasma (also called corona) becomes decoupled from the target surface.

intense beam of laser light, ions, or electrons to generate the implosion and ignition of the fusion fuel.

There are three interrelated phenomena involved in the achievement of high fusion target energy gain. (Gain is simply defined as the ratio of the fusion energy generated divided by the total driver energy—atom bomb, X-rays, laser, electron, or ion beams—incident on the target.) The efficient absorption of the incident driver energy leads to the generation of an appropriate compression shock wave, which, in turn, efficiently compresses the fusion fuel to high densities and leads to the thermonuclear ignition of a core of the compressed fuel. At temperatures of hundreds of millions of degrees, this generates an intense thermonuclear burn wave that ignites the remaining compressed fuel.

Failure at any point of these distinct, though coupled, processes will either produce a complete dud or low or fractional target gain.

For example, the incident driver energy could simply be reflected instead of absorbed. Or, the incident energy, while being absorbed, might not generate an ablative implosion. In this case, the initially heated material from the surface of the target becomes isolated from the solid target surface and the incident driver energy is consumed in simply heating this material. (This is termed corona decoupling, where the corona is the initially heated material.) The result is the same as turning off the rocket exhaust in a spaceship. In order for the ablative process to continue, the incident driver energy must be able either to penetrate or be transported through the initial exhaust gases, thereby continuing to heat the actual surface of the target and maintaining the flow of exhaust gases (Figure 1).

Even if the absorption of the incident driver energy is completely successful and an effective ablation process results, the compression shock or shocks thereby generated may not succeed in compressing the interior of the fusion fuel target. The compression shock wave could become unstable and break up so that it no longer constituted an effective "compression" cylinder. Or, energy from the ablative process might penetrate the interior of the target before compression is achieved, interfering with carrying out an efficient implosion of the fuel. For example, if this penetrating energy significantly heats the precompressed fuel, efficient compression would become virtually impossible.

Finally, even if the ablative process is efficiently set up, producing an effective and stable compression shock, the shock wave could fail to be sufficiently intense when it reaches the core of the target to raise this region to thermonuclear ignition temperatures. Or, even if ignition is generated, the resulting thermonuclear burn could be so weak that it fails to generate a burn wave of enough intensity to ignite the remaining compressed fuel.

High-Power Lasers

In general, at the present time, researchers have only an incomplete, pragmatic picture of how inertial confinement works.[3] Therefore, it follows that no firm limits can be placed on the development of major advances in inertial confinement devices. Looking at it from the perspective of national defense, the only conclusion is that determination of these limits should have the highest priority. Given the existing theoretical-experimental impasse with H-bomb devices for research—chiefly because their minimal scale precludes the use of important experimental measurements—the best way to proceed is to develop a driver that most closely replicates what goes on in an H-bomb on a miniature scale. High-power lasers provide the most practical means for achieving this.

When intense electromagnetic radiation, such as a focused laser beam, is directed onto matter, electrons in the atoms that make up the material absorb some of the incident energy. If the incident laser beam is above an intensity of, say, 10 billion to 100 billion watts per square centimeter, a substantial portion of the atoms that make up the surface of the material becomes ionized in the process; that is, their electrons absorb enough energy to escape from the atom.

This is how an ablating plasma is formed.

One well-known property of a plasma is that it has a maximum density through which electromagnetic radiation of a given frequency can penetrate. This electron-number density is called the critical density, n_{cr}. The relationship between the earth's ionosphere (the plasma found above the earth's atmosphere) and shortwave radio transmission is a good example of how this works. Shortwave radio transmissions cannot generally penetrate the ionospheric plasma and are reflected so that they can be received throughout the world. On the other hand, shorter-wavelength, higher-frequency radio broadcasts using electromagnetic radiation of the micrometer wavelength (microwaves) can penetrate the ionosphere and, therefore, are used for communication with satellites.

In very general terms, what is going on is that the plasma has a "fundamental frequency" at which it interacts with electromagnetic energy. This fundamental frequency is called the *plasma frequency* and is a function of the plasma electron-number density:

$$f_{pe} = 8.98 \times 10^3 \, n_e$$

where f_{pe} is the electron plasma frequency in cycles per second and n_e is the plasma electron-number density in electrons per cubic centimeter.

The critical density n_{cr} is that plasma electron density at which the plasma frequency equals the frequency of the incident electromagnetic wave. If the incident wave's frequency is greater than f_{pe} at all plasma electron densities, it is possible for the wave to pass through the plasma. If it is not greater than f_{pe} the wave can be either reflected or absorbed, depending on the intensity of the incident wave and the nature of the plasma (that is, what sort of ionized atoms make up the plasma).

The theory of intense light-plasma coupling is one of the most challenging and complex problems in all of physics. While the critical density provides a useful reference point, the primary reflection and absorption pro-

cesses take place at plasma densities below that of n_{cr}, and these processes are nonlinear and complex.

In the case of the soft X-ray radiation, the primary form of the initial energy output from a fission atom bomb, the corresponding electron density that gives a plasma frequency in the same range would be 10^{23} to 10^{25} per cubic centimeter. This is very close to the atomic number density we find with most solid materials. Therefore, for the case of soft X-rays it could be expected that the radiation would readily penetrate the exhaust plasma to a point very close to the solid surface. This produces a very efficient ablative implosion.

On the other hand, if much shorter wavelength, "hard" X-rays were used to drive the implosion, the electromagnetic radiation would have a frequency in excess of that possessed by a solidlike-density plasma, and the X-rays would readily penetrate toward the interior of the target. This would heat the inner fuel before compression, preventing the achievement of efficient isentropic compression. This effect is called *preheating*.

Figure 2 is a general schematic giving the various regions of radiation-plasma interaction that would be encountered for radiation incident on a flat slab target. The section on the right represents the solid surface of the target. The middle section is made up of a high-density ablation plasma ranging from critical density to solid density. The radiation incident from the left does not penetrate this region. On the left is a region made up of ablating plasma with densities less than the critical density.

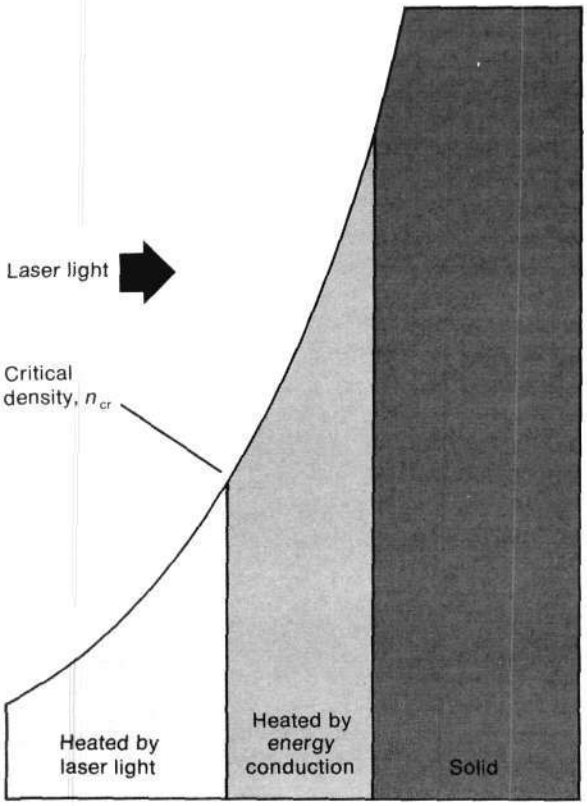


Figure 2
LASER IRRADIATION OF SLAB TARGET
This schematic of a slab target being irradiated with laser light shows three regions: first, an outer layer with density less than or equal to the critical density that is directly heated by the laser light—the underdense region; a high-density region that is heated indirectly by energy conduction; and the solid density region.

Why Short Wavelengths?

The original specification U.S. fusion researchers at Lawrence Livermore Laboratory made in 1963 to achieve laser fusion target gains greater than 1 called for 100,000 joules of laser light with a wavelength of 0.69 micron and an intensity of 500 trillion watts per square centimeter.

This meant that the laser would have to attain a power output of up to several hundred trillion watts with a pulse length of about 1 billionth of a second.[4] This 1963 observation is very close to present-day estimates that are informed by more than a decade of laser-matter experiments.

The crucial question identified at this early point in the development of the U.S. laser fusion program was what effect the laser light wavelength would have on both the efficiency and effectiveness of laser-matter interaction for driving ablative implosions. Pragmatically, one would call for duplicating the existing, successful inertial system, the H-bomb, by choosing wavelengths that would replicate those of soft X-rays, about 0.01 micron.

From a theoretical standpoint, however, use of short-wavelength radiation in the driver also makes sense. As noted previously, soft X-rays have the ideal wavelength for penetrating the ablating plasma and depositing the driver energy where it is needed at the surface of the target. Furthermore, the higher plasma densities at which the soft X-rays are absorbed are less conducive to nonlinear interactions. This is because plasmas at higher densities are more "collisional," exhibiting far fewer of the collective interactions that dominate less dense plasmas. As a result, short-wavelength radiation produces the most efficient and effective ablative-driven implosion.

Even if soft X-ray lasers were a technological reality (and they are not at the present time), handling electromagnetic radiation below 0.2 to 0.1 micron is quite difficult, and all of the advantages of coherent laser light, such as ease of transport and focusing of the light beam by using mirrors, lenses, and other optical devices, are lost. Optical technology gives a lower limit between 0.1 and 0.2 micron for the wavelength of the driver radiation; the krypton fluoride laser has a wavelength of 0.25 micron; and that of the existing high-power, neodymium-doped glass lasers is 1.06 microns.

As theoretically predicted, recent experiments with short-wavelength laser light have indicated that absorption efficiency and quality greatly improve with decreasing wavelength.[5] The original laser fusion experiments with laser light of only 1.06 microns have shown a tendency

toward the generation of "hot" electrons (an anomalously high temperature component in the ablating plasma that preheats the inner fusion fuel before compression), corona-core decoupling, and excitation of various plasma instabilities.[6]

Experiments with glass lasers at the Ecole Polytechnique in Paris, at Lawrence Livermore Laboratory in California, and the Rutherford Laboratory in Great Britain in which the frequency of the light is doubled by interacting the 1.06-micron light with crystals (at a cost of more than 50 percent of the original beams' energy) have shown an increase toward 80 percent absorption and a marked decline in the hot electron component.

Target Design Considerations

Considerations of driver wavelength are but one component in the design of an optimum laser for carrying out inertial confinement fusion research efforts. Laser efficiency and firing repetition rate are crucial to the prospects for commercial applications because they affect the cost of the system, but they are only of secondary or tertiary significance in terms of scientific research. Of more concern from a research standpoint are shaping the laser beam pulse, laser power output, and total beam energy.

The smallest H-bomb, the neutron bomb, probably uses at least a pulse of soft X-rays on the order of 10^{11} joules. The object of laboratory inertial confinement research is to reduce this driver input pulse by a factor of a million, or to a few million joules at the most. Inertial fusion researchers are looking into the possibilities of utilizing nonlinear plasma processes (for example, the results of more efficient absorption or ablation processes) in order to achieve the microscale inertial fusion ignition capable of being measured in the laboratory, as well as brute force methods. Once the basics are fully understood, it may be possible, for example, to radically reduce the necessary laser or particle beam pulse driver input. This could be accomplished by using extremely high-power density pulses or by transforming the pulse to soft X-rays (which the Soviet electron beam researcher L. Rudakov is already planning to do).

Nevertheless, it should be stressed that the shortest route to achieving these desirable results is the one that first achieves core ignition and burn by whatever means. From the very beginning of the Soviet inertial confinement effort, they have based their program on this strategy.

When the United States and Soviet Union first made their target designs in the early- to mid-1970s, the United States based its program on exotic high-power, short-pulse-length targets, while the Soviets, who at the time led the world in laser-plasma research, called for putting major emphasis on the target and not the laser beam. In particular, the Soviet laser pioneer Academician N.G. Basov called for using relatively low power densities and long pulse lengths for the driver beam. The U.S. and Soviet overall parameters differed by several orders of magnitude.

After several years of very difficult laser-plasma interaction studies, U.S. target designs have begun to look very much like the early Soviet ones. And the laser parameters called for are also converging on the Soviet projections.

The particular aspects of the early Soviet targets that have recently come into prominence in the openly discussed designs in the U.S. program are the use of high aspect ratios and multishells. The most efficient spherical target consists of a hollow sphere, and the aspect ratio is the ratio of the sphere's radius to the thickness of the shell that makes it up.

The benefit of using high aspect targets (very thin shelled spheres) is that they can be driven with lasers or particle beams of much lower power level. This is because higher aspect ratio targets increase both the surface area to which the driver is applied on the target and the implosion time. The problem, though, is that very thin spherical targets appear to be susceptible to hydrodynamic instabilities that cause the implosion to be unsymmetrical. If this is the case, the target fuel is not compressed to high densities or ignition fails to take place.

From a practical standpoint, the instability problem can be overcome by use of precision-manufactured targets and by going to shorter-wavelength laser light. Both U.S. and Soviet inertial confinement fusion researchers apparently believe they have overcome this instability problem, for they are now both proposing to use fairly high aspect ratio target designs; anywhere from 10 to 100 aspect ratios.

The second aspect, that of using several shells in one target, is extremely important. This design makes use of several high aspect shells and the benefit is that the implosion process can be broken up into several independent steps. For example, Lawrence Livermore researchers achieved implosions of fusion fuel up to several hundred times liquid density with double shell targets.[7] The outer shell protected the inner shell containing the fusion fuel from the effects of preheating caused by hot electrons in the corona plasma. When the outer shell collided with the inner shell during the implosion, it transferred only its hydrodynamic motion and not its temperature to the inner shell, which achieved the high compressions.

It is apparent that the Foster Committee became aware of these recent developments in U.S. target design. Although the full details are not available in the public literature, the basic outlines of what has happened can be determined from reviewing the annual reports of the Lawrence Livermore Laboratory Laser Fusion Program and reviewing Soviet laser fusion scientific papers. In fact, from the latest Lawrence Livermore Laboratory Laser Program Annual Report one can deduce the requisite driver parameters needed for thermonuclear ignition.[8] In terms of energy, this would be a laser pulse of about 1 million joules at a power level of about 100 trillion watts. This gives a pulse length of about 10 nanoseconds—about 10 to 100 times longer than Lawrence Livermore had previously projected.

High-power glass lasers have been the chief workhorses of the laser fusion effort worldwide since the beginning of major national programs in the early 1970s. Glass was

a known technology and the wavelengths involved were fairly short, about 1.06 microns for neodymium-doped glass. However, as researchers recognized from the outset, going to higher and higher total energy outputs would become increasingly difficult and costly.

The basic problem can be readily appreciated from the simple thermodynamics involved. In general, the only way to increase the total energy of a glass laser system's output is to go either to a larger number of independently generated beams or to a beam of larger cross section. Problems of alignment, timing, and optics limit the number of independently generated beams that can be used in laser fusion. Going to beams of larger cross section is limited by the fact that the neodymium-doped glass disk amplifiers must be kept relatively cool. If they are permitted to overheat, the glass either distorts or breaks, destroying the costly glass disk amplifier.

KrF Versus Glass Lasers

Although further developments in glass technology and cooling techniques cannot be precluded, the existing large-scale systems are beginning to show signs of approaching fundamental limits. In addition, the basic thermodynamic problem of glass prevents this system from being a practical candidate for commercial laser fusion and means that the cost of going to higher laser energies will always go up at least linearly. The need to cool the glass disk amplifiers means that significantly less than 1 percent of the total energy input into the laser ends up as useful laser beam output.

During the early 1970s, the only practical alternative to high-power lasers was the long-wavelength carbon dioxide laser, being pursued at Los Alamos Scientific Laboratory. Because the laser medium is a gas, cooling is not a significant problem; the gas can be jettisoned out an exhaust and replaced. Furthermore, efficiencies on the order of 10 percent are quite practical with carbon dioxide laser technology. As major advances in short-wavelength gas lasers were achieved later in the decade, other alternatives became possible. These included the hydrogen fluoride chemical system, the rare gas halogen systems, and the krypton fluoride (KrF) and xenon fluoride lasers. The chief means of energizing these laser systems is with high-energy electron beams. The KrF is capable of attaining efficiencies of more than 7 percent, has high repetition rates, and has an almost perfect wavelength of 0.25 micron for laser fusion.

Although the primary motivation for developing these lasers was their potential applications as laser weapons for antimissile and antiaircraft systems, their potential application to inertial confinement fusion was appreciated from the beginning. Lawrence Livermore Laboratory developed a program to realize a laser system based on KrF that would attain driver parameters near their original target design projections, that is, a very short beam pulse of about 0.1 to 1 nanosecond with a beam power of 100 trillion watts.

The KrF laser by itself could not attain the requisite power levels and short pulse lengths, because as a lasing medium the KrF gas does not possess the energy density or sufficient excitation lifetime to permit a short, high-power pulse. As a result, researchers proposed a hybrid

Gas Versus Glass Lasers

A laser is an apparatus for converting crude forms of energy—electrical, chemical, nuclear, or incoherent electromagnetic energy—into beams of coherent electromagnetic radiation of the same characteristic frequency. This coherent laser light is readily directed and focused to extremely high power densities by using simple optical materials such as mirrors, lenses, and filters.

In a laser, the crude energy is directed onto a lasing medium. The electrons contained in the molecules or atoms of the lasing medium absorb a portion of the incident energy and are excited to a higher energy state. The time span that these electrons remain in an excited energy state before they will spontaneously reemit the energy they have absorbed at a characteristic frequency is known as the lifetime.

If electromagnetic energy of the characteristic frequency is directed through the lasing medium within the medium's lifetime (anywhere from a few nanoseconds to hundreds of microseconds), it will stimulate the release of coherent electromagnetic energy.

High-power laser systems used in inertial confinement work this way. A very high quality, minute pulse of laser light is generated in a small laser, called an oscillator. This initial pulse is then directed through a series of large, excited lasing mediums called amplifiers, stimulating the release of light of the same frequency in these amplifiers. In the process, the initial pulse grows in intensity.

In high-power glass lasers, intense flashlamps surround large disks of glass that contain neodymium atoms. When the flashlamps are turned on, the neodymium atoms are excited to a higher energy state. As the initial pulse passes through a long series of these glass disks (an amplifier chain), a large, intense pulse is produced.

The basic physics of the excited energy state limits the energy density that can be extracted from the glass lasing medium. In order to increase the total energy of the laser beam, the *volume* of the amplifying medium must be increased, causing basic physical limits to the scale-up size possible for a glass laser. Also, glass laser systems are inefficient; much less than 1 percent of the incident flashlamp energy is actually converted into laser light.

Since the early 1960s, researchers have understood that lasing mediums

system that combined the KrF with a nonlinear laser beam-plasma interaction system that compressed the KrF laser beam into a high-power, short pulse.

This hybrid system, called Rapier, is only at the experimental stage. Its major drawback is that even if it works perfectly, 50 percent of the laser beam is lost during the nonlinear laser-plasma compression stage, which decreases the overall efficiency of the laser by one-half, bringing it down to below 4 percent.

New technological advances were made in developing the KrF, just as the Foster Committee was completing its report. Although these new developments do not lead to the extremely short laser pulse originally projected by laser fusion scientists (0.1 to 1 nanosecond), they meet the requirements for the longer-pulse, high-aspect ratio, multishell targets. Furthermore, the new KrF technology appears to have no significant impediments to being cheaply scaled up to higher total energies. Thus, the new KrF could readily proceed to higher total energies on target, if need be, in a brute force campaign to achieve high target gains.

A year has passed since the Foster Committee heard the original testimony on the KrF and in this time researchers have confirmed the capabilities needed to realize a successful krypton fluoride laser as well as initial cost and construction time projections. As a result, the KrF not only is the best candidate for meeting the needs of inertial confinement fusion in terms of wavelength and total energy, but also could achieve the program's scientific goals at 10 times less cost than glass lasers.

To pursue an aggressive experimental program in inertial confinement fusion, scientists need the appropriate tools. Although glass lasers and other drivers currently in use will continue to provide much of the information needed, the KrF laser is a new technology that can be realized within the next four to six years and provide the key parameters of energy and wavelength needed to ensure experimental success. The costs of pursuing the KrF at this time are very small, but the eventual costs to the nation for failing to pursue the KrF could be incalculable.

Charles B. Stevens is the fusion technology editor of Fusion *magazine.*

Notes

1. "Budget Has Net Cut for Laser Program," *Fusion,* May 1980, p. 65.
2. "New Foster Report Under Wraps," *Fusion,* Sept. 1979, p. 24.
3. Theoretical and technical aspects of inertial confinement fusion have been discussed fully in previous articles in *Fusion.* Specifically, for an overview of inertial confinement, including the deficiencies of computer models with respect to compression shock waves and thermonuclear ignition, see the articles on fusion in the March-April, February, and November issues of *Fusion;* on target designs that could be ignited with ordinary chemical explosives, see "The Secret of Laser Fusion," March-April 1979, p. 38; on isentropic compression (the technical term for efficient compression of matter to high densities), see "The Theoretical Impasse in Inertial Confinement Fusion," Nov. 1979, p. 33; on how advances in inertial confinement could provide the theoretical key to the way supernovas and other superenergy cosmological events take place, see Aug. 1980, p. 70.
4. R.E. Kidder, LRL Laser Research Program, COTM-63-7, 1963 (unpublished).
5. "LLL Proven Right on Laser Absorption," *Fusion,* May 1980, p. 67.
6. R.E. Kidder and J.W. Zink, *Nuclear Fusion* 12:325 (1972).
7. "LLL *Double Shell* Target Achieves Compression Advance," *Fusion,* July 1980, p. 68.
8. *Fusion,* May 1980, p. 25.

other than solid state materials could overcome the heat transport and efficiency problems of glass laser systems. This is particularly the case with gas lasers, in which the lasing medium is excited by an electron beam. With the discovery of the lasing properties of krypton fluoride gas (KrF) as well as other halogen compounds, in 1975 scientists achieved the possibility of an efficient gas laser with the appropriate wavelength for inertial confinement fusion.

The particular advance that has made KrF a promising candidate is *angular multiplexing.* With a simple KrF laser driven by an electron beam, the shortest pulse that can be extracted with the maximum efficiency (about 8 percent) is 300 nanoseconds. In other gas lasers a shorter pulse length can be efficiently obtained by passing a series of short pulses through the same excited lasing medium (*multipassing*). Using optical delay lines, the first pulse of laser light extracted from the excited gas is optically reflected along a path that is long enough so that the second, third, and other pulses can catch up, forming one powerful beam.

Because krypton fluoride has such a short lifetime (about 5 nanoseconds), a special form of multipassing, angular multiplexing, is used. A series of short pulses is directed through the KrF amplifier, passing through the medium almost simultaneously, with each of the initial pulses directed at a different angle through the KrF amplifier.

For example, since energy must be extracted for 300 nanoseconds in order to reach the highest efficiency, if researchers want a pulse of 10 nanoseconds duration, then 30 separate initial pulses will have to be passed through the KrF amplifier within that 300 nanoseconds. The overall system of angular multiplexing is well within the existing state of the art, in terms of materials and procedures.

The cost for building a 100-kilojoule KrF laser with a 10-nanosecond, 100-trillion-watt laser output is estimated to be between $20 and $30 million, and will decrease proportionately as the KrF system scales up. This is but a fraction of the cost projected for the 100-trillion-watt Nova glass system under construction at Lawrence Livermore Laboratory.

A 1-million-joule glass laser, the largest laser considered technologically achievable within the next decade, would cost nearly $1 billion or more to build and would not be readily capable of scale-up in energy beyond the 1 million joules. In comparison, a 1-million-joule KrF laser would cost between $200 and $300 million and could be scaled up.

NAS Panel Challenges Dietary-Disease Link

The Food and Nutrition Board of the National Academy of Sciences (NAS) issued a report May 27 debunking warnings from food faddists and medical professionals alike that Americans must eat less meat and fewer dairy products or risk coronary and other disease.

The report stated that in light of the available evidence, such concern with fat and cholesterol intake is unjustified: "The board considers it scientifically unsound to make single, all-inclusive recommendations to the public regarding intakes of energy, protein, fat, cholesterol, carbohydrate, fiber, and sodium. . . . The board makes no specific recommendations about dietary cholesterol for the healthy person."

A 15-member panel including nutritional, biochemical, and medical scientists, chaired by University of Wisconsin biochemist Dr. Alfred Harper, submitted the report. Harper has indicated a concern that the broad-based use of restrictive low-fat/low-cholesterol diets could lead to borderline nutritional deficiencies in individuals.

In an interview with *Fusion*, Harper said he has little doubt as to the nutritional superiority of meat and dairy products over grains as sources of proteins, partly because of the inability of grains to be an adequate source of trace elements necessary to good health.

A Question of Causality

A dissatisfaction with the scientific methodology used to infer the harmfulness of fats and cholesterol was apparent in the report. One argument for reducing American meat and dairy intake has been that Americans have a greater incidence of heart disease compared to populations with a less rich diet. However, several considerations demonstrate the causal inadequacy of conclusions based on such correlations.

Although serum (blood) cholesterol levels in fact seem to be good predictors of heart disease, the board stated, "no significant correlation between cholesterol intake and serum cholesterol concentration has been shown in free-living [nonhospitalized] persons in this country."

As the Food and Nutrition Board pointed out, citing seven large-scale studies of the effects of modified diet, dietary restrictions have at best marginal effects on heart attacks and "no effects on overall mortality."

Although beef and total fat consumption has been rising steadily in the United States since World War II, the rate of cardiovascular deaths has actually *fallen by 20 percent* since the early 1960s, and is currently falling at the rate of 2 percent per year. The decrease can be partially attributed to factors such as improved disease detection and treatment. But the overall basis of the decline remains a mystery. In fact, one might argue that the decrease reflects the increased health enjoyed by a population consuming more beef.

NAS Under Fire

The NAS report has drawn heavy criticism, none of which attacks the data or the arguments directly. One complaint is that no epidemiologists were on the Food and Nutrition Board. It should be noted, however, that the board members were mainly research scientists of proven merit in the physiologically based disciplines who were careful to note and utilize epidemiological data as well as biochemical findings.

Carlos de Hoyos

The American diet, especially the consumption of meat, has been under attack for more than a decade. Yet, between 1968 and 1976, the death rate for coronary heart disease fell by 21 percent, while beef consumption rose by over 10 percent per person in that period.

Others have charged that scientists on the panel were biased because of consulting affiliations with the meat and dairy industries. The critics fail to note that the same researchers also consult for cereal, grain, fruit, and vegetable companies, and had nothing pecuniary to gain by their conclusions.

In interviews, several panelists expressed disgust at the attacks on their scientific integrity. They attributed at least some of the criticism to the report's challenge to environmentalist propaganda against meat consumption.

The cholesterol report is the second time this year that the NAS bucked the environmentalist tide. Its study on *Energy in Transition: 1985-2010,* released this spring, includes papers that recommend a strong nuclear program including the breeder reactor and documents the extreme costliness of solar energy.

EPA Releases Spurious Study On Love Canal

In a frontal attack on the chemical industry, the U.S. Environmental Protection Agency (EPA) released a report in May claiming that the residents of Love Canal in Niagara, N.Y. had significant chromosomal aberrations and that the "chemical exposures at Love Canal may be responsible for much of the apparent increase in the observed [aberrations] and that the residents are at an increased risk of neoplastic disease [for example, cancer], of having spontaneous abortions, and of having children with birth defects."

There is no doubt that when the EPA released the report, the agency *knew that the report had no scientific validity.*

The report was based on a laboratory study by the Biogenics Corporation in Houston, Texas on the chromosomes from the white blood cells of the Love Canal residents. The study purported to demonstrate that the chromosomes of the individuals involved were malformed or broken at rates that far exceeded those for a normal population. From this, the report simply extrapolated the conclusion that the increase was caused by the exposure of the residents to the chemicals buried in Love Canal by the Hooker Chemical Company years earlier.

The report was invalid for several reasons: First, individuals tested were not chosen at random, but were volunteers who were worried about their health. This has an important effect on the incidence of chromosomal aberrations, since damage occurs because of viral infections (including colds, flu, and so on), antibiotic treatment, and even sunlight, and the damage is known to increase with age. To ensure an adequate number of healthy persons, any valid study would require an across-the-board sampling.

Second, and quite incredible, the study did not include a comparable population from another, noncontaminated area to serve as a control group. The comparison published in the report was based on data from a study done several years earlier in another laboratory. This means that the populations were not controlled in respect to diet, living standards, age, seasonal variation, and so on, all of which are known to contribute to the incidence of malformations.

Even worse, though, is the fact that the laboratory conditions are critical to the outcome of the study, since variations in the cellular growth media, techniques, and even laboratory lighting and temperature, will influence the results obtained.

Third, the lack of controls influenced another variable even more difficult to control, the subjective act

Carlos de Hoyos

Freedoms Foundation Presents Award to FEF

The Fusion Energy Foundation received the Freedoms Foundation at Valley Forge George Washington Honor Medal for its 1979 series "The Harrisburg Hoax" in an award ceremony June 25 at New York City's Copter Club. Jon Gilbertson, the principal author of the series on Three Mile Island, is shown here accepting the medal from Dr. Robert W. Miller (r.), president of the Freedoms Foundation.

In presenting the award, Mrs. Arthur Soberg, president of the Brooklyn Volunteer Chapter of the Freedoms Foundation, which sponsored the ceremony, noted that the series of articles "tells what happened there last spring, states the case for sabotage, and gives facts to refute the sensation-seeking news reporting that has lessened America's desire for the advancement of nuclear science."

Gilbertson thanked the Freedoms Foundation for its recognition that the fight for nuclear energy is essential for the nation's national security.

of reading the slides upon which the chromosomes are mounted. Normal procedure involves what is known as a *double-blind* technique, where the scientist does not know which population group in the study is represented on the slide he is evaluating. Classification of a chromosome as abnormal is highly subjective, and the double-blind procedure helps minimize any anticipations on the part of the observer.

Indeed, Dante Picciano, the chief scientist from Biogenics, even refused to allow independent investigators to view the data. Subsequent viewing of photos of the chromosomal preparations by an EPA panel led to the conclusion that Picciano himself was inconsistent in his evaluations and that there was *no evidence* of excessive chromosomal abnormalities for the residents of Love Canal.

Fourth, for most scientific papers there is a process of peer review, whereby a paper is evaluated and criticized *prior* to release or publication. This was not the case with the Love Canal study.

What's Going On?

Why did the EPA release a study that had such obvious inadequacies? There are two results of the EPA's action that suggest the answers. The Federal Emergency Management Agency (FEMA) was brought into play, managing all levels of the operation top down, from news conferences to evacuation and relocation of the residents. Under FEMA, Love Canal residents continue to be the object of sociological study, speculation, and media headlines.

In addition, the well-publicized Love Canal event has been used to fuel the antiindustry activity of the environmentalists as well as to attack the chemical industry head on.

It is generally agreed that Hooker was using the best techniques available for dumping wastes at the time, in full compliance with the law as it was then written. To find a company guilty of wrongdoing under these circumstances would condemn the entire industry to extinction; in effect, no standards would exist that, when followed, could remove the industry's future responsibility.

—Dr. Richard Pollak

4. The staff recommends that Pennsylvania's future (next 20 years) or additional electrical energy needs be met by non-nuclear means - primarily coal, conservation, cogeneration and renewable energy sources.

5. The staff does not recommend that new nuclear power be excluded as a future supply option.

A page from the Pennsylvania draft energy plan. Who does the governor's staff think they are kidding?

Penn. Energy Plan Excludes Nuclear

The Governor's Energy Council of Pennsylvania this May released a Draft Energy Plan for excluding nuclear power from the state's energy future. While the plan's specifics are sometimes self-contradictory, overall it mandates a de facto ban on expansion of nuclear power facilities and the permanent shutdown of Three Mile Island Units 1 and 2.

Titled "Pennsylvania Energy Choices: An Energy Policy Plan for Pennsylvania," the document states that "increasing economic uncertainties, coupled with tenuous utility financing capability, have made nuclear 'the first to go.' . . . The staff recommends that in Pennsylvania's future [for the next 20 years] additional electrical energy needs be met where feasible by nonnuclear means—primarily coal, conservation, cogeneration, and renewable energy resources."

The phrase "where feasible" is characteristic of the report, which cites the crushing costs of making up power lost by Three Mile Island's shutdown, yet supports the Kemeny Commission report on Three Mile Island although it "may well create more restrictions and financial uncertainties than utilities can afford."

As for "nonnuclear means," the report is replete with studies on "urban waste, biomass, energy plantations, wind and forests," but does not even develop a credible plan for the high-technology use of coal, a plentiful state resource. Instead, the report relies heavily on the recent Harvard Business School *Energy Future* study, projecting "a 20 percent contribution by solar by the year 2000."

The Pennsylvania Energy Plan does admit to one big problem: How do you convince people to invest in energy policies that don't produce anything? Rather than stressing investment in the energy *efficiency* that has pushed foreign industrial productivity far ahead of U.S. productivity, the report stresses energy conservation, advocating mandatory investment in cogeneration and "deregulation of electricity generation" to decentralize utilities and close off their capital markets access.

As for convincing the nuclear industry to go nonnuclear, the report blithely urges that nuclear advocates give up: "There is a real possibility, particularly in the United States, of losing three decades of technology as persons with very specialized skills are forced to seek employment outside the nuclear power field and as the dim prospects for renewed growth retard the recruitment and training of new scientists, engineers, and technicians. . . . Those who worked the hardest to make the nuclear dream a reality will have to concede on some things they deeply believe themselves to be correct about. Otherwise they will see their dream dissolve forever."

The Governor's Energy Council report states that its conclusions do not necessarily represent those of Governor Thornburgh. Thornburgh, who has continued to generate antinuclear hysteria over TMI, has not yet reported any dissension from the plan.

—Mary Gilbertson

AAAS-Brookings Conf.:

Nonscience Agencies Call R&D Tune

Three-hundred government, industry, and academic representatives at the annual American Association for the Advancement of Science conference on U.S. research and development policy held June 19-20 in Washington, D.C. heard Dr. Frank Press, director of the Office of Science and Technology Policy, and Dr. John C. Sawhill, deputy secretary of the Department of Energy, announce that the federal government has laid down explicit R&D guidelines mandating military, energy, and agricultural research as top priority.

In an era of budget cuts and inflation, they emphasized, this will mean pruning other areas and stressing short-term applied programs rather than long-term commitments to basic science.

University researchers were told that their funding will depend on their pursuit of "deep-ocean drilling techniques and economy auto research" as major priorities. Commented Dr. Edward Frieman, director of the DOE Office of Energy Research: "It's a gloomy environment for R&D at universities. We'll have to cut 1,500 from the national laboratories." Other speakers protested that U.S. basic research was being hindered by a lack of equipment.

"Synfuels is the key to energy development," said Dr. Sawhill; "the synfuels program must be carried out with the support of the bankers and the scientists, and the program will be mobilized like the space program." Omitting any mention of nuclear power in his prepared remarks, Press also emphasized synfuels while calling for the United States to take the lead in energy exploitation of biomass.

Other presentations stressed the recently promulgated memorandum by Jack Watson, White House liaison with the Federal Emergency Management Agency (FEMA) and James T. McIntyre of the Office of Management and Budget (OMB), urging top-down control and coordination by FEMA and OMB of local and regional technology applications.

The Washington-based Brookings Institution, which collaborated with the AAAS in organizing the conference, was represented by its director of economic studies, Dr. Joseph Pechman, who summarized the R&D funding approach: "I do not see a distinction between creating wealth and redistributing wealth."

IMC

NEW CHEMICAL PROCESS PRODUCES URANIUM FUEL

The first shipment of uranium oxide produced by a new process was sent recently from International Minerals and Chemical Corporation in Florida to be enriched into nuclear reactor fuel. The uranium oxide is the first produced from phosphoric acid at the IMC refinery, which began commercial production in May. The new process takes advantage of the by-products of IMC's phosphate chemicals plants by extracting the very small amounts of uranium normally present in these phosphates.

IMC shipping officials monitor part of the initial 30,000-pound shipment.

Keep Maine Yankee Operating!

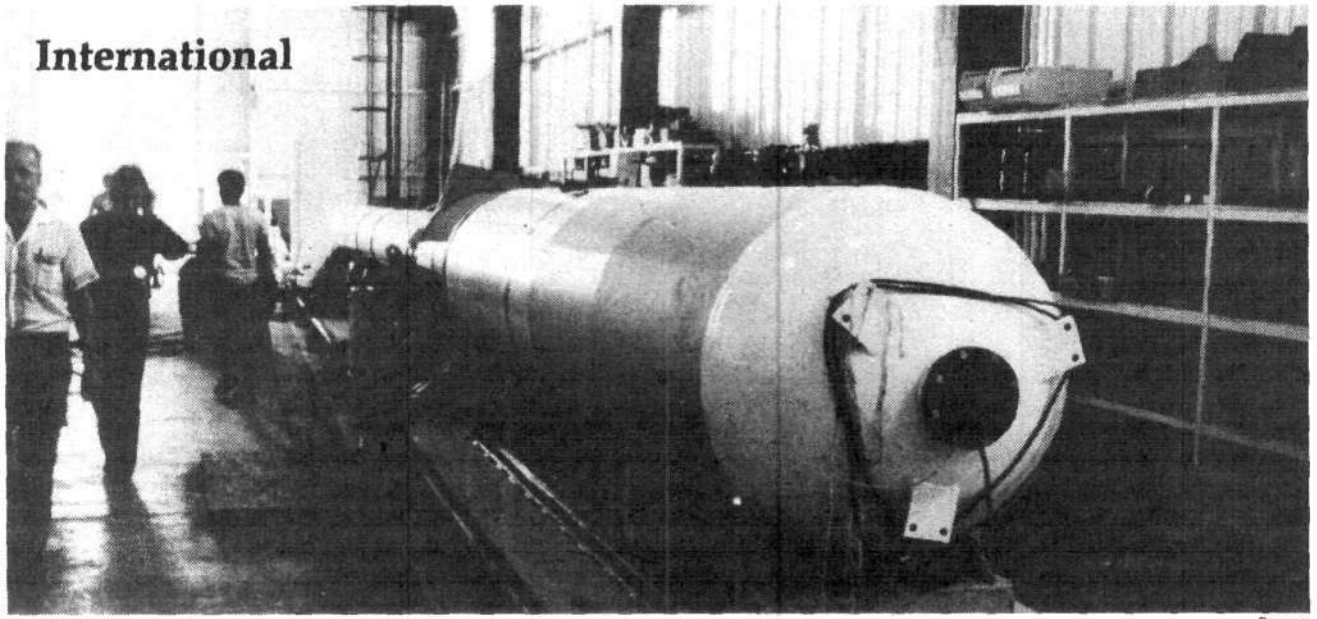
Maine is the first state in which a referendum will decide whether to shut down an operating nuclear plant, the Maine Yankee. The referendum was placed on the September ballot after 1,500 environmentalists from the East Coast gathered 55,000 signatures during several months of petitioning. We are pleased to reprint here the remarks of Abbot Fletcher, assistant program manager of the FFG program at Bath Iron Works, one of the leaders of the pronuclear fight. The FFG program is building 16 guided missile frigates for the U.S. Navy.

The Maine Yankee nuclear plant carries one-third of the state of Maine, provides power at 1.6¢ per kilowatt hour (coal is over 5¢ and oil is 7¢), and is the major reason Maine has the *lowest* power rates in New England. . . . Maine Yankee's contribution to the radiation exposure to the people of Maine is less than one ten-thousandth what we are otherwise exposed to (that is, cosmic rays, the food we eat, granite, watching color TV, and so forth).

Shutting down Maine Yankee will increase Maine's power bill $140 million dollars in 1981 and more in subsequent years. In 1981, this is an increase of one-third for each household. . . .

The real issues are twofold: First is reducing our extreme vulnerability . . . And, second, is finding alternate sources of safe, low environmental impact and low-cost energy to replace oil and to retain and enhance our quality of living. Nuclear power is the best contributor we have to helping solve these issues; and Maine Yankee with its superb record is a valuable contributor to these solutions. . . .

To keep Maine Yankee operating is to win on all counts.



Sygma

The neutron bomb debate: Traditionalist French military thinkers have opposed tactical neutron bombs as inappropriate given Soviet military doctrine. The latest advances, however, can be used in the civilian nuclear program to generate large amounts of fissile fuel cheaply. Shown here is a French bomb in the Pacific Island of Mururoa.

French Gain Reported in Nuclear Weapons

Researchers working on the development of French nuclear weapons have reportedly achieved a major scientific breakthrough in the course of their neutron bomb experiments in the Pacific. According to the June 7-8 issue of the French daily *Quotidien de Paris*, French scientists have overcome the barriers to construction of large-scale neutron bombs.

Previously it was believed that neutron bombs were limited to a size of 1 kiloton of TNT equivalent, and therefore capable only of tactical battlefield applications. This reflects considerations of the kind of fusion fuel used and how the fuel is burned and ignited. Tritium has a half-life of 11 years and is expensive; U.S. N-bombs are said to depend on tritium fuel. Other fuels such as lithium deuteride, used in ordinary H-bombs, have the disadvantage of absorbing and degrading fusion-generated neutrons.

In most seemingly practical configurations, such as a sphere, the unburned fusion fuel itself absorbs and degrades fusion-generated neutrons as the thermonuclear burn wave, which is generated at the core of a compressed fuel configuration, heats and ignites the cold outer layers of fusion fuel.

If this report is confirmed, French scientists have made significant advances in understanding either the dynamics of thermonuclear burn waves, thermonuclear ignition at high densities, development of totally new target approaches, or all three.

From a strategic point of view, *Quotidien de Paris* commented that this breakthrough will further ensure the national security of France from the energy standpoint as well as the defense standpoint, and supersede the debate on deployment of "tactical" neutron bombs with development of a new generation of strategic weapons. Another French daily, *Le Figaro*, was less sanguine about the contribution to France's security.

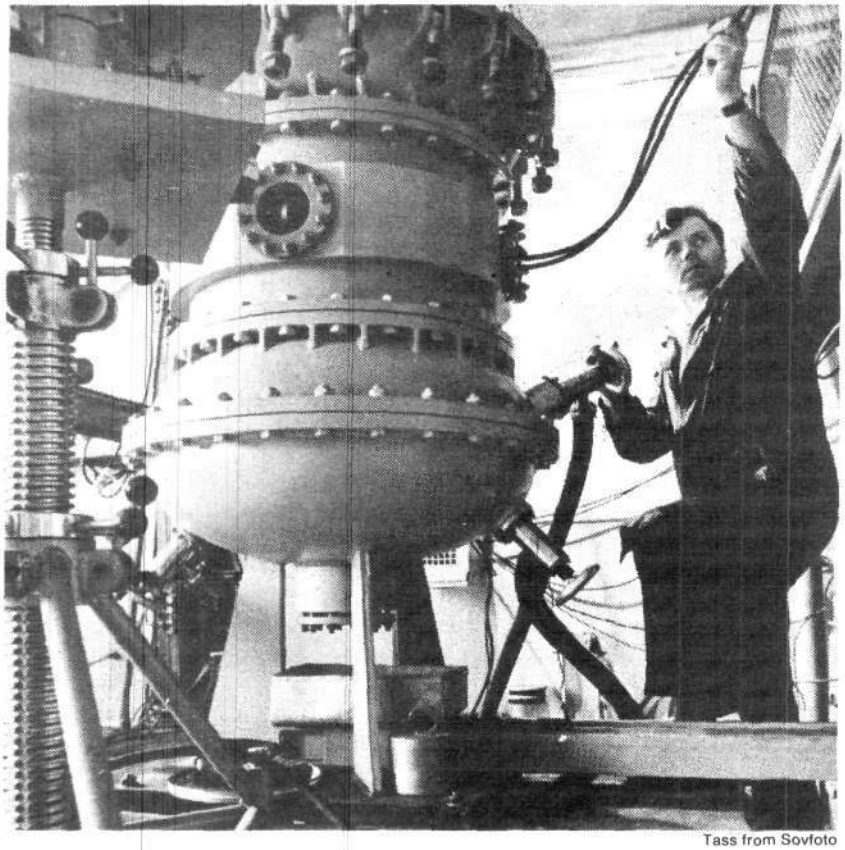
French Nuclear Program Alarming?

The May 1980 issue of *Bild der Wissenschaft*, the highest-circulation popular science magazine in West Germany, features an article on France's full nuclear fuel cycle program by Martin Urban that views the French program with alarm. *Bild* expresses unsubstantiated concerns about "radioactivity blowing over the border to Germany" and other dangers from alleged safety problems that might arise from the mass production of nuclear power reactors that France has pursued.

Considerable influence on the magazine's editorial policy is exercised by Robert Jungk, the most prominent West German opponent of nuclear power. To European environmentalists, what *Bild* describes as "the centrally directed, results-oriented atomic energy policy" has become a matter of the utmost concern. Unlike the U.S. situation, the environmentalist have been unable to stop or delay France's progress.

Tass from Sovfoto

Siberian development is at the center of the new Soviet energy plan. Above: Andrei P. Kirilenko; At right: an engineer at the Novosibirsk Hydrodynamics Institute preparing the explosion optical chamber. Welding by explosions has created more than 100 metal and alloy compounds here.



Tass from Sovfoto

Soviet Union Pressing Energy Development

Soviet Politburo member A.P. Kirilenko stressed the expansion of nuclear power in a speech on energy development June 3 to the government's Central Committee, which is now deliberating on the Soviet Union's new Five Year Plan. The danger of war "dictates the necessity for successful implementation of the development plans for Soviet electrical energy, which play a key role in the further growth of the country's economic and defense potential," Kirilenko stated.

Declaring that the Carter administration's economic sanctions against the Soviet Union will fail, he stressed the need to plan the energy base of the future: "This means expansion of the construction of nuclear power stations with fast breeder reactors," he said, "the development of work on thermonuclear fusion power, solar and geothermal energy, and the phenomenon of superconductivity."

Siberia is expected to make growing contributions to the Soviet Union's energy base. More broadly, its scientists and planners are promoting the Siberian emphasis on large-scale integrated industrialization projects and scientifically based investment decisions as crucial to drafting the 11th Five Year Plan. The Siberian division of the Soviet Academy of Sciences has issued a program called Sibir for the scientific development of Siberia as the basis of the region's economy, and are refining it through tests on the Novosibirsk econometric models.

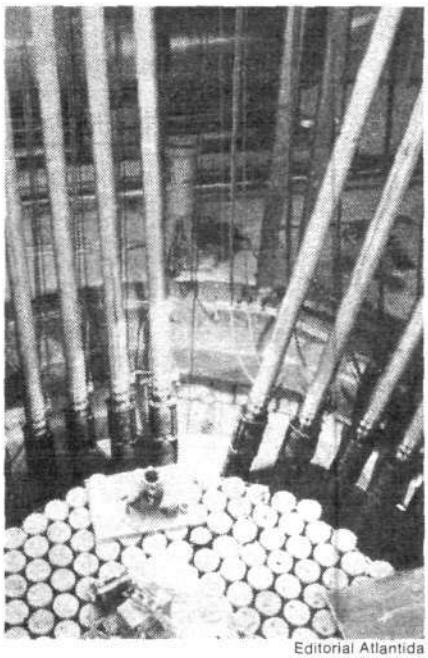
The West German-Soviet industrial cooperation accord reached at the end of May is expected to help shape Soviet energy planning. According to West German corporate executives, a decision to implement a gigantic new natural gas pipeline between the two countries could be taken in the middle of this year, pending the results of Chancellor Helmut Schmidt's discussions in Moscow at the end of June.

Argentina, Brazil Unite On Atomic Energy

Nuclear energy was in the forefront of the agreements reached between Argentina and Brazil during an historic meeting of their presidents May 14-17, pointing the way toward the integration of nuclear plans throughout South America.

On the nuclear front, the Argentine Atomic Energy Commission and Brazil's Nuclebras signed three contracts providing for joint applied nuclear research. Argentina will also provide Brazilian reactors with the zirconium tubes and sheaths for holding reactor fuel, while Brazil will sell reactor vessels. Since the West German Kraftwerk Union is building the nuclear plants in both countries and has heavily invested in Brazil's Nuclep facility, the largest nuclear engineering plant in the Third World, it is expected that the German firm will approve Brazilian manufacture of the metal core vessel for Argentina's planned 600-megawatt plant.

Proposals for a Sudatom organization to provide South America with nuclear integration comparable to that of Euratom, the Western European nuclear organization, were extensively discussed at the World Congress on Nuclear Law in Buenos Aires last October. The prerequisite "marriage"—to use Brazilian President Figueiredo's term—between the two powers in the region with active nuclear energy programs had been lacking. Now Argentina and Brazil are committed to helping all the remaining countries of South America (except Guyana) initiate nuclear energy programs. Figueiredo pursued his metaphor by announcing that Argentina and Brazil will now agree "how many children to have and how to educate them."



Editorial Atlantida

Fuel rod assembly at the Atucha nuclear plant in Argentina.

India Achieves Breakthrough On MHD Research

Indian scientists scored an important breakthrough May 22 when an Indian-manufactured magnetohydrodynamic (MHD) generator was successfully tested at Soviet facilities. The Indian team of scientists and engineers from the Bhabha Atomic Research Center was led by Dr. V.K. Rohatgi. Reporting the testing success, Rohatgi indicated that the generator is wholly based on Indian knowhow and independently designed and built by Indian specialists. The Soviet Union and the United States are considered the only two countries with significant MHD progress.

For India, the MHD program and its initial success point toward efficient use of the country's abundant but low-grade coal reserves. The next phase for Indian MHD work is establishment of a pilot plant similar to the U-25 in operation in the Soviet Union, followed by a commercial power plant at Tiruchi in the southern state of Tamil Nadu.

Environmentalist Roundup

'GE-3' Challenge Italian Nuclear Safety

A trio of discredited U.S. antinuclear spokesmen known as the "GE-3" has issued a widely circulated report challenging the safety of Italian nuclear reactor design. The group, called MHB Associates of San Jose, California (it stands for Minor, Hubbard, and Bridenbaugh), made front-page headlines here in the 1970s when they resigned in protest over alleged safety violations in General Electric's nuclear reactor design.

Creative Karma?

Subsequent investigations revealed that the trio's "road to Damascus" conversion into the antinuclear movement's Union of Concerned Scientists was accomplished via a quasi-religious transformation at a California-based consciousness-raising center known as the Creative Initiatives Foundation. (This foundation's personnel, by the way, won't talk to you on the telephone unless you tell the spokesman your "karma" first.)

MHB was invited into Italy by the Friends of the Earth and their small antinuclear party, the Radical Party. The Italian nuclear industry has attacked the report as "not a technical document" but an alarmist collection of false assumptions and misleading correlations.

NRC Backs UCS Group's Petition

The Nuclear Regulatory Commission has approved a complex legal procedure that could eventually shut down the Indian Point, N.Y. nuclear reactor, 30 miles north of New York City. The procedure, based on a pe-

tition from the antinuclear Union of Concerned Scientists, could also be a precedent for shutting down a number of other reactors located near urban areas.

"Procedurally, [the NRC] has done about everything we asked for," commented Union of Concerned Scientists spokesman Robert Pollard.

The NRC procedure mandates review of the "effects of the worst-possible nuclear accident—a core meltdown—on local residents," for the first time requiring reviewers to look beyond the usual 10-mile radius around the plant when considering the government and utility emergency evacuation plans.

The five NRC commissioners ruled on the petition in an unusual decision to review an earlier action of NRC reactor regulation chief Harold Denton where he agreed to decommission one obsolete Indian Point reactor but refused to order two newer ones out of service.

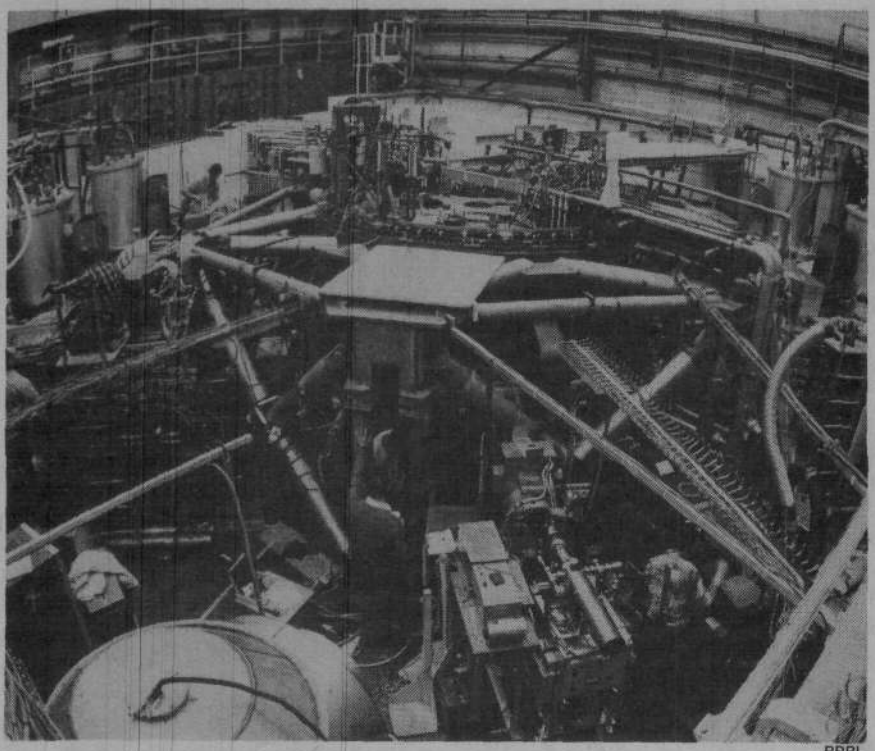
Seabrook Demo Costs Taxpayers...

One little-publicized aspect of the May and June 1980 antinuclear assaults by environmentalist groups against the Seabrook, N.H. nuclear facility is the cost to taxpayers of guaranteeing public safety at the site. When demonstrators attempted to occupy the Manchester headquarters of the parent utility, PSC, 58 people were arrested. The cost? PSC spokesman Norman Cullerot said: "I wouldn't be surprised to see the figure up to three-quarters of a million dollars."

More than 200 state troopers from five New England states joined 200 National Guardsmen and 100 private security guards hired by PSC to avert threatened acts of violence at the Seabrook plant site. The state of New Hampshire has appropriated $177,000 to pay the state police salaries; the remaining cost will be paid by the utility.

Despite the costly antics, demonstrators failed in their stated objectives to occupy the site or slow construction.

—William Engdahl



PPPL

The Princeton Large Torus reached new record temperatures in May.

PLT Reaches Record Temperatures

The Princeton Large Torus tokamak at the Princeton Plasma Physics Laboratory (PPPL) reached record temperatures close to 80 million degrees with an increased neutral-beam heating power of 2.4 million watts in May.

In summer 1978, the PLT was the first major magnetic confinement fusion system to go beyond the fusion ignition temperature of 44 million degrees Celsius while maintaining a stably confined fusion plasma. Using neutral beam heating supplied by the Oak Ridge National Laboratory in Tennessee, the PLT reached temperatures of 70 million degrees in 1978 (see *Fusion*, Oct. 1978).

The PLT retained the same stable plasma parameters of 1978 at the higher temperature: more than 30 trillion plasma ions per cubic centimeter density and 25 thousandths of a second global energy confinement time. The continuing success of the PLT further ensures that Princeton's Tokamak Fusion Test Reactor (TFTR), due to begin operation in 1981, will reach, and even go beyond, breakeven.

Exploring the Fusion Regime

PPPL scientists are continuing to explore important aspects of the "fusion regime" with the PLT as well as the Poloidal Divertor Experiment (PDX).

Although the spectacular results of the PLT demonstrate the scientific viability of the tokamak approach to fusion, it is actually the more mundane accomplishments of the PDX that are of immediate significance for developing a practical tokamak power plant design.

The PDX, an even larger tokamak than the PLT, is designed as one of the most versatile experiments in magnetic confinement research in the

world. It is demonstrating techniques for removing impurities and fusion reaction ash from tokamak plasmas with a "magnetic poloidal divertor." Impurity control is the most difficult question involved in actually constructing these machines, according to designers working on the U.S. Engineering Test Facility tokamak reactor and the international test reactor Intor, both of which are designed to demonstrate the overall technology needed for practical power plants.

Preliminary results from the PDX indicate that the poloidal divertor indeed works. Basically, the poloidal divertor is a "hole" in the confining magnetic bottle configuration that allows the surface of the tokamak plasma to be scraped off and removed in an attempt to achieve a pure hydrogen plasma. The PDX has shown that this can be accomplished while simultaneously maintaining a stable confinement of the remaining plasma. Furthermore, impurities such as oxygen and carbon are significantly removed.

Difficulties have arisen, though, in the case of titanium removal. While the titanium content of the plasma at first decreases, at a later point in the tokamak discharge the titanium content increases. It must be remembered, however, that this is only the beginning of impurity control experiments in the PDX.

Increasing Density

The PDX is also exploring methods of increasing the fusion power density relative to the strength of the confining magnetic field.

Changing the *shape* of the tokamak plasma is believed to be one of the most important methods to accomplish this. The PDX has carried out preliminary experiments in which the circular cross section of the tokamak donut is transformed into a D or an inverted D shape. Theory suggests that these configurations will allow the same plasmas to be contained with weaker magnetic fields, and the PDX results indicate that the inverted D is the most stable. More experiments are planned with further elongation of the D shape with increased neutral beam heating of 6 million watts by the end of the summer.

Winterberg Proposes New Pellet Design For Inertial Fusion

In a recent paper, Dr. Friedwardt Winterberg of the Desert Research Center in Nevada proposed a new approach to the design of pellets for inertial confinement fusion. Although Winterberg, who pioneered many of the concepts in inertial confinement fusion, has developed his new approach with impact driver systems primarily in mind, his pellets could, theoretically, be used by any inertial driver system. The importance of his proposal lies in its potential to drastically decrease the driver power-intensity level necessary for fusion ignition and burn.

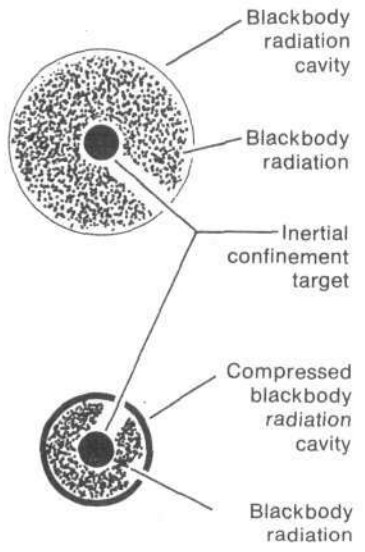
Winterberg's idea is to place the fusion fuel pellet in the center of a very thin-shelled spherical cavity in which blackbody radiation has been trapped. The driver energy—laser, electron, or ion beams or an impact fusion projectile—would not implode the pellet directly but, rather, the thin-shelled cavity of blackbody radiation. By arranging this implosion to compress the blackbody radiation adiabatically, the temperature of the radiation can be efficiently and rapidly increased.

Since the power intensity of radiation scales with increased temperature to the fourth power, the power intensity of the blackbody radiation thus increases greatly. This implosion system, therefore, acts as a radiation power amplifier, taking low-power radiation and the hydrodynamic energy of the imploding cavity and transforming it into high-intensity radiation, primarily of short wavelength.

Driver Power Level

The pellet at the center of the cavity is then imploded by the high-intensity radiation produced. Preliminary calculations indicate that the necessary velocity of an impact fusion projectile, for example, can be decreased from 200 kilometers per second to 50 kilometers per second, to achieve fusion ignition and burn. Roughly speaking, this means that the power level of the driver can be decreased by more than an order of magnitude by this amplification system. Obviously, corresponding decreases in the power levels of other inertial drivers would also result.

In fact, the benefits of using adiabatically compressed blackbody radiation in the fusion target are numerous and increase the possibilities for inertial fusion drivers of decreased technological difficulty. Chemical explosives, for example, could be used



WINTERBERG'S PELLET DESIGN
The Winterberg pellet design uses blackbody radiation trapped in a fusion fuel pellet to increase the temperature of the implosion. This design theoretically makes it possible to decrease the power level of the fusion driver (laser, ion, or electron beams) by more than an order of magnitude and also to use a less technically difficult driver system. In this schematic, the driver implodes the thin shell cavity of blackbody radiation, compressing it and increasing its temperature and amplifying its radiation power. This high-intensity radiation then implodes the fusion fuel pellet.

as the primary driver to implode the thin-shelled sphere. The primary driver no longer has to achieve an isentropic, stable implosion since the compressed blackbody radiation, like the soft X-rays suggested by Soviet fusion scientist L.I. Rudakov, will accomplish this.

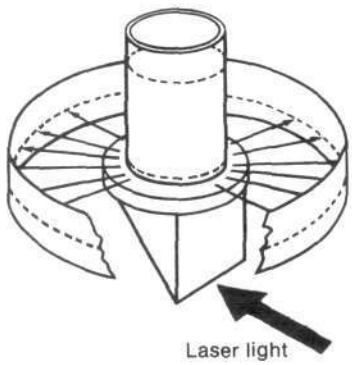
Winterberg's latest idea could, indeed, transform the entire spectrum of inertial confinement fusion research.

Multidimension Laser Developed

Working at the Lebedev Physics Institute in Moscow, Dr. Z. Gy. Horvath of the Hungarian Central Research Institute for Physics has developed a new laser system that emits coherent light across 360 degrees, in the shape of a circular plane or halo. As Horvath reported in the June issue of *Laser Focus*, his circular laser system could be applied for reference planes, atmospheric communications among several nearby terminals, and laser fusion.

Although to date lasers have operated in only one dimension—a "pencil" of laser light emitted by the system of mirrors used to amplify the beam—Dr. Horvath's system generates light in two dimensions, with the output forming a flat cylinder moving outward from the cylindrical resonator (see figure). A further possibility, applicable to laser fusion, is a three-dimensional spherical laser, the "laser lamp."

If such a laser lamp could be modified to direct its light inwardly toward the center of a hollow sphere in which the fusion target would be placed, it might lead to a real advance in inertial confinement fusion. Some of the advantages of such a hypothetical system would be the uniformity of the incident energy and the removal of unnecessary intervening mirrors.



MULTIDIMENSIONAL LASER DESIGN

The multidimensional laser system generates light in two dimensions in the shape of a halo. The circular plane of light forms a flat cylinder that moves outward from a cylindrical resonator.

Rochester Lab Makes Laser Advance

Fusion scientists at the University of Rochester Laboratory for Laser Energetics (LLE) have made a major technological advance with high-power glass lasers for inertial confinement fusion research, converting longer-wavelength light to the short-wavelength light necessary for fusion.

An important parameter that determines the efficiency with which fusion pellets can be imploded to star-like densities and fusion ignition temperatures is the wavelength of the laser light used. Simply put, the shorter the wavelength (that is, the higher the frequency) of the laser light, the more efficiently it is absorbed by the fusion pellet and the more suitable that absorption is for achieving high compressions of fusion fuel.

High-power laser systems used in inertial confinement research are chiefly based on the neodymium-doped solid state glass technology. The primary output of the neodymium laser is light of 1.06 microns wavelength. But fusion pellet designers currently believe that shorter wavelengths of 0.69 to 0.25 micron will be needed for driving the implosions of breakeven inertial fusion targets.

Shorter-Wavelength Experiments

Shorter-wavelength laser absorption experiments have been carried out at Lawrence Livermore Laboratory in California, the Ecole Polytechnique in Paris, KMS Fusion in Michigan, and the Rutherford Lab in Great Britain, using KDP (potassium-dihydrogen phosphate) crystals to convert the 1.06-micron glass-laser light to shorter wavelengths. These experiments have tended to show a marked improvement in the efficiency and quality of laser light absorption at shorter wavelengths. Plans have been developed to include KDP crystals in the large breakeven lasers scheduled to be completed by the mid-1980s, in particular Livermore's mammoth Nova laser, which will first attain an output of several hundred thousand joules and then be scaled up to 400 kilojoules.

Until the recent results at LLE, however, it was believed that less than half of the 1.06-micron laser light output of Nova could be converted to 0.53 micron (green light), and less than this converted to 0.35 micron (blue light).

Under the recently implemented Department of Energy policy of determining "lead laboratories" in specific areas of inertial confinement research, LLE had been directed to oversee research on methods of converting glass laser light to high frequencies (shorter wavelengths). A team consisting of Stephen Craxton, Stephen Jacobs, Wolf Seka, Joseph Rizzo, and Robert Boni has been carrying out experiments using the LLE Glass Development Laser (GDL) to explore various configurations. The GDL was the prototype beam utilized to develop the technology for the multibeam Omega laser system on which fusion pellet experiments are carried out.

In May the LLE team succeeded in converting 1.06-micron light to 0.35 micron at an efficiency in excess of 80 percent. This was accomplished at a power density of 1.5 to 2.5 gigawatts per square centimeter, using two 12-millimeter thick KDP crystals. Al-

though the LLE conversion system was based on the same fundamental principles as previous, less efficient systems, the configuration of angles used in the optics was far more complex.

Optical parametric mixing, used by the LLE researchers, is a process in which the coherent electromagnetic waves of laser light nonlinearly interact within an appropriate crystal such that the waves are added together to generate new electromagnetic waves of doubled frequency. A threefold increase in frequency is accomplished by mixing already doubled frequency light with the primary 1.06-micron beam.

Future Plans

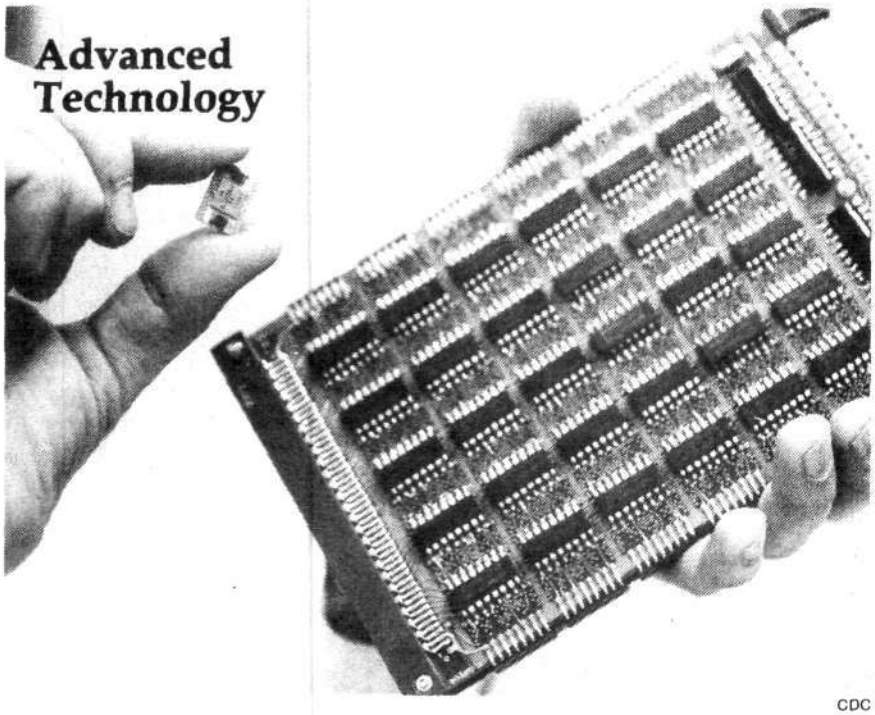
LLE scientists believe that 9-millimeter KDP crystals will achieve even better results. LLE plans to incorporate this conversion system for frequency tripling on six beams of the mainline Omega system to carry out full-scale pellet experiments with the shorter-wavelength laser light. If this LLE conversion system proves to be capable of scaling to higher power levels while maintaining the optical quality of the laser beams generated, it could mark one of the major technological advances in laser fusion research of the decade.

Impending Change in Classification Policy?

The U.S. Department of Energy is about to implement a major relaxation in the top secret classification of research in inertial confinement fusion, according to informed Washington sources. This action will result from the fact that major portions of scientific work at the U.S. national weapons laboratories at Lawrence Livermore and Los Alamos have been declassified "de facto" through the litigation and publication of the famous *Progressive* magazine article on the H-bomb.

A relaxation in the stringent guidelines that currently suffocate U.S. laser fusion research will be greatly welcomed by most leading scientists in the field.

Advanced Technology



CDC

This comparison of the large-scale integrated (LSI) circuitry (left) used in the CDC Cyber 205 and the equivalent logic of the CDC's first supercomputer model, the STAR-100 shows the advances in computer logic technology.

CDC Announces Powerful Supercomputer

Control Data Corporation announced the world's most powerful supercomputer system, the CYBER 205, in early June.

In its maximum configuration, the new system is capable of performing up to 800 million operations in a single second. This is up to eight times faster than any of the company's previous models and more than three times faster than any other computer currently available.

CDC has billed the computer as especially designed to solve the critical problems of the 1980s, in terms of matching the need for three-dimensional processing of huge volumes of data such as those associated with fusion research, nuclear plant safety, petroleum exploration, and structural analysis, as well as the billions of calculations required for more accurate 24-hour weather forecasts.

The predecessor of CYBER 205, the CYBER 203, is now being used in a variety of nuclear power plant applications and in laser fusion research. The new system offers a number of performance improvements over the earlier system, including: central memory capacity up to 4 million words; virtual memory capacity ranging to 2 trillion words, utilization of combined vector/scalar processing; utilization of both 64-bit and 32-bit arithmetic operations; and up to 16 input-output ports, each capable of handling 200 million bits per second, resulting in an expanded I/O bandwidth of 3.2 billion bits per send, highest in the industry.

In addition, the CYBER 205 is the only supercomputer in the industry using large-scale integrated (LSI) circuitry, which increases reliability and simplifies maintenance. The system uses only 29 different types of plug-in LSI circuit chips.

A CDC spokesman said that the new system was especially designed to handle the processing of data related to the search for new and alternate energy sources; management of the production and distribution of energy products; production of accurate, long-range weather forecasts and processing of other environmental data that affect agriculture, world food supplies, and prices; design and manufacture of aircraft and automobiles that are cost-effective and fuel-efficient; design and operational analysis of nuclear power plants to ensure increased safety; design and analysis of large-scale construction ranging from skyscrapers and bridges to hydropower dams and offshore oil drilling platforms.

In each of these activities, CDC spokesman said, huge volumes of information must be processed, sorted, and compared, and pertinent results must be selected for storage. For example, in the area of fusion technology, he said, supercomputer power is a necessity to handle the data generated in experiments and to simulate different aspects of the fusion process.

CDC said the CYBER 205 would provide the nuclear industry with the means for approaching problems never before considered for solution because of restricted memory space. "With the CYBER 205's 4 million words of central memory and 2 trillion words of virtual storage, it can provide three-dimensional simulations where one and two dimensions were the previous limits. Consequently, nuclear scientists now have a powerful tool for improving the design, analysis, and operational safety of nuclear power plants," the CDC spokesman said.

As for other applications, CDC described the petroleum industry's need for huge computing power to process seismic data from exploration activities and to simulate reservoirs for maximum oil production. "Studies show that current oil recovery techniques result in the recovery of only about 30 percent of the potential of a given reservoir. The three-dimensional processing capabilities of the CYBER 205 provide more refined simulations to improve initial, secondary, and tertiary recovery operations."

CDC also mentioned that the new supercomputer was ideally suited for simulating complicated aircraft systems and aerodynamic wind tunnels in research to make aircraft safer and more fuel-efficient; analyzing the effects of waves and winds on offshore drilling platforms; finding the stress points in a bridge or dam; and determining the general stability of a multistory building.

The new systems are produced at Control Data's Arden Hills, Minnesota facility and will be available for shipment in January 1981.

The July issue of Fusion *featured "Computers and Scientific Breakthroughs in the 1980s," which described the challenge of supercomputers and the frontier areas of science for which they are required.*

Photo by Larry Hinchner, courtesy of Lampson

'OVER-THE-TOP' REACTOR INSTALLATION WITH GIANT CRANE

"Transi-Lift," the world's largest transportable crane, took just 12 hours to lift and place this 387-ton reactor pressure vessel inside the containment building of the WNP Nuclear Project No. 1 at Hanford, Wash. The vessel was lifted 130 feet over the containment and lowered onto preset anchor bolts on the reactor pedestal with a tolerance of only a few thousandths of an inch.

The crane, designed and built by Lampson Universal Rigging of Kennewick, Wash., was also used to set other heavy equipment, such as the two 500-ton steam generators, inside the building.

Computer Applications To MHD Research

For 20 years, U.S. scientists have been conducting experiments on laboratory-scale devices to develop a magnetohydrodynamic (MHD) generator. MHD is a process of converting heat directly to electricity by the interaction of a plasma and an external magnetic field.

Optimizing this potentially efficient direct-conversion process has required an intricate balance between the magnetic field strength, the electrical conductivity of the plasma, and the speed of the plasma flow. To predict the efficiency of conversion as these parameters are changed experimentally, a series of computer codes has been developed to indicate with considerable accuracy the best combinations for the laboratory experimenter. Based on the physics equations that determine the turbulence of the fluid flow, these codes can predict the results of manipulating the experimental parameters, eliminating the need for trial-and-error experimentation.

MHD computer codes developed since 1964 by the STD Research Corporation in Arcadia, California, have also been able to do useful cross-checking of results obtained on experimental devices. For example, computer analyses of results reported on the Avco Mark VI-C generator and the experiment at the University of Tennessee Space Institute revealed significant discrepancies between reported data and computer predictions.

When these discrepancies were discussed with the experimenters, it was discovered that problems and malfunctions in the experimental apparatus had produced the anomalous results. Corrections were then made on the basis of the computer analysis.

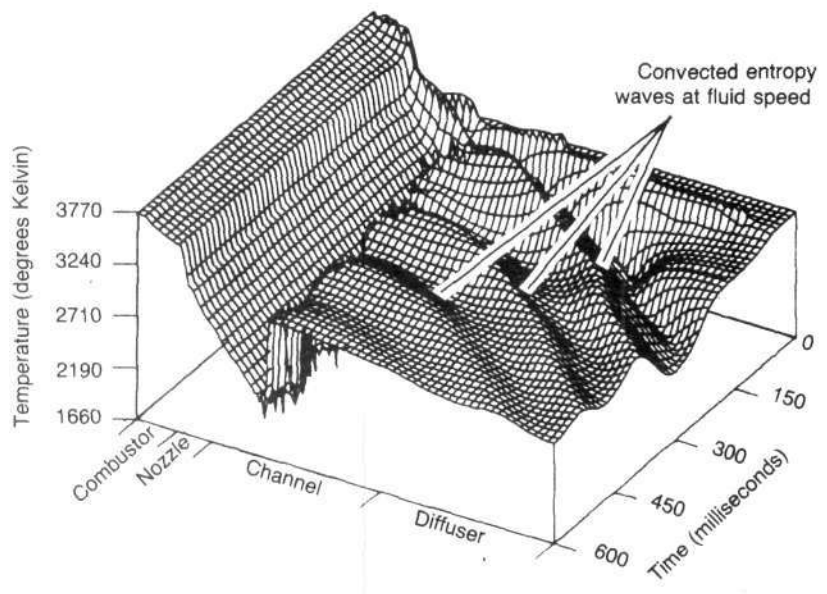
Projections for the 1980s

The STD computer codes have also been used to analyze how the existing laboratory-scale MHD generators should be scaled up for pilot plant operation, based on a multidimensional analysis of how the behavior of the plasma will change with the size of the device.

In the 1980s the first pilot plant, the 50-megawatt Component Development Integration Facility in Butte, Montana will take MHD into the precommercial stage. Unlike the scaling-up of conventional generators, accomplished by engineers during the last two decades, components for a scaled-up MHD generator cannot simply double in size.

Simulating how the behavior of the electrically conductive plasma—its velocity, mass-flow, and magnetic field strength within a changing physical geometry of the MHD channel—will change with size, the computer codes have been able to identify the critical, defining parameters to optimize the electric conversion process in power-plant-sized MHD machines.

Physicists involved in MHD theory can certainly make such calculations without a computer, and engineers could design a machine that will meet the scientific criteria. But the use of computer codes to optimize the complex interaction of the plasma in a magnetic field and the engineering design, making multidimensional physics systems into an operable machine, will simplify the process of MHD commercialization.



COMPUTER GRAPH OF MHD TEMPERATURE CHANGE

This three-dimensional graph generated by the STD computer codes predicts the temperature change as an MHD plasma travels down the flow train of the generator (from left): The MHD travels from the combustor, which burns the coal and produces the plasma; through the nozzle, which accelerates it; through the channel, where the electric power is produced; and, finally, out the diffuser. The computer results show that temperature waves are expected as an additional function of time. This graph can be used to cross-check experimental results.

Space Science & Technology

The Solar Polar Mission: A New Window on Fusion

Editor's Note: The U.S. House Appropriations Committee voted May 9 to terminate the Solar Polar Mission by cutting all its funding in the 1980 supplemental budget. NASA had already postponed the two-satellite launch date from 1983 to 1985 in an attempt to meet the committee's budget-cutting requirements. The committee's decision now goes before the full House vote. Your letters can help turn the situation around. Write your congressman and senator and write Rep. Jamie Whitten (D-Miss.), chairman, House Appropriations Committee, and Rep. Edward Boland (D-Mass.), chairman, Subcommittee on Independent Agencies, House Appropriations Committee, both at 2426 Rayburn, Washington, D. C. 20515.

* * *

The Solar Polar Mission, an international project for study of the nearest working fusion reactor to the Earth—the Sun—promises to provide essential new information for nuclear fusion power development. The mission is jointly sponsored by the National Aeronautics and Space Administration (NASA) and the European Space Agency (ESA) under a "memorandum of understanding" signed in 1979.

By launching two spacecraft to examine the Sun from opposite poles simultaneously, scientists will obtain the first three-dimensional view of the Sun and its atmosphere, or *heliosphere*. The probability that the Sun's polar regions have much less activity than other solar regions will allow scientists to observe and measure processes underneath the Sun's surface corona—processes revealing more about the thermonuclear processes within the star.

Moreover, since the Sun's spots, magnetic storms, and other activities affect the weather, climate, and radio communications on Earth, closer measurements and better understanding of the fundamental scientific processes of the Sun will eventually allow scientists to predict the changes in communications possibilities necessary for improving navigation and radio transmission.

The mission will be the first to send a craft outside the plane of the ecliptic (the plane in which the Earth orbits the Sun), which no spacecraft has had sufficient energy to do before.

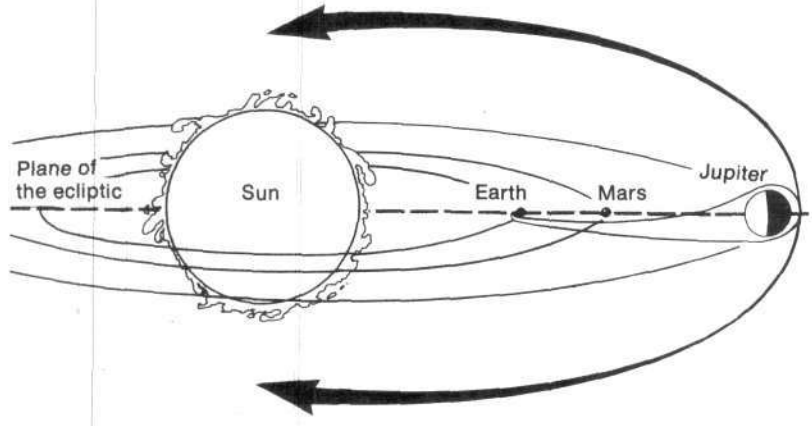
The two Solar Polar spacecraft, one built by NASA and the other by ESA, will include stationary instruments with their sights fixed on specific objects, and instruments mounted on a spinning platform to see in many directions.

NASA's Space Shuttle is assigned to launch the two spacecraft in a necessary first step to reach Jupiter. Jupiter's immense gravity will then boost them free of the plane of the ecliptic, and as the craft fly by the giant planet, they will also make X-ray measurements.

On their mission, the Solar Polar spacecraft are set to explore and add to information on:

Corona: In 1962, Mariner II verified earlier theories that a solar wind continuously blows outward from the Sun's corona, or outer halolike layer. Since then, scientists have learned that high-speed streams in the solar wind cause periodic magnetic storms on Earth. Scientists suspect that these streams originate from holes in the corona. Spacecraft observations of these coronal holes could allow them to predict geomagnetic and auroral activity as far as 10 days in advance, to help shortwave radio communications, navigation, and geological exploration systems that use magnetometers. Two of the Solar Polar Mission's instruments, the white-light coronagraph and an X-ray (ultraviolet) telescope, will give scientists a three-dimensional view of the Sun's corona.

Convection layer: Underneath the corona, closer to the thermonuclear reactions taking place in the core of the Sun, is a layer from which it appears the Sun's magnetic fields originate. Heat from the fusion reactions cannot escape to space as fast as it is



After NASA's Space Shuttle launches the two Solar Polar spacecraft, Jupiter's huge gravitational force will boost the spacecraft free of the plane of the ecliptic allowing them to travel to the Sun's poles. An artist's depiction of the Shuttle launching appears on page 35.

produced, and the resulting convection layer of circulating fluids and energy contains a great welling of activity. In connection with the Sun's rotation, which is faster at the equator than at the poles, the convection layer produces an important variety of effects, including sun spots, solar flares, and prominences. Instruments on the Solar Polar spacecraft will provide new insight into the workings of the Sun's convection layer.

Solar bursts: High-speed protons and electrons burst sporadically from the Sun. Traveling along magnetic field lines, they whip at near-light speed right through the solar wind. They are believed to originate in the huge, fiery eruptions on the Sun's surface, called solar flares. Some seem to linger near the Sun and then suddenly flash across space; at other times they stream instantly outward into space.

The Solar Polar Mission plans to "listen" to the radio waves emitted by these high-energy particles from the Sun, and try to track them as they travel through the solar system, interacting strongly with radio waves generated locally in interplanetary space. The mission craft will also listen to this form of turbulence and determine how the solar wind changes as it leaves the Sun or encounters obstacles such as the planets.

Interstellar space: Most of the matter and energy coming into the solar system from interstellar space is blocked from reaching the Earth, and can be studied only from a position outside the ecliptic plane. The solar wind blocks interstellar gases; the solar wind's magnetic field keeps out low-energy charged particles; and cosmic rays are also robbed of energy by the magnetic field in the solar wind. The Solar Polar Mission will be able to measure and track these phenomena while throwing open a new window on galactic space by detecting cosmic rays in their pristine state before they reach Earth. Techniques of triangulation by the experiments and other space-borne instruments near Earth can locate the regions of the sky where gamma rays originate and possibly link them to an identifiable object or objects.

—Marsha Freeman

Inappropriate Technology

House-Senate Cttee. Allocates $1.45 Billion for Biomass Fraud

As part of the Synthetic Fuels Act, the House-Senate Conference Committee has approved a $1.45 billion allocation for biomass projects over the next two years—a costly fraud that will cut the productivity of U.S. agriculture.

Biomass refers to the use of so-called renewable resources, such as crops, trees, and plant and animal wastes, in place of fuel or to produce new fuel. Examples include producing methane from dung (popular in China for the recycling of human waste), producing alcohol from corn, sugar, or other material by fermentation, and the use of corn stalks, straw, and so forth as a heat source.

Although proponents admit that biomass is far from economically sound, they hold that this bill will pave the way for the reduction of the U.S. need for imported oil. Some also even say that biomass will provide a solution to what they call the problem of "overproduction" in the farm sector, because it turns food into fuel.

At first glance there may appear to be some merit in schemes that make use of "waste." However, a closer look reveals that biomass is very expensive, highly labor intensive, and environmentally unsound.

Gasohol: Highway Robbery

Let's look at the highly publicized case of gasohol, where one part alcohol is mixed with nine parts gasoline, mainly for automotive use. Advocates propose to produce ethyl alcohol (ethanol) by fermentation in stills located on individual farms or at central points. The fermentation feed stock would be crops such as corn, or sugar from cane or beets.

Estimates of current costs indicate that the alcohol will cost up to two times the cost of the gasoline it replaces! Because this is hardly an incentive for large-scale use, the Synthetic Fuels Act includes subsidies to the gasohol producers. This means that taxpayers will be footing the bill for 50 percent of the cost of building the facilities to produce the alcohol, as well as for government tax write-off plans that will encourage speculative investment and further subsidies in the form of waiving of highway taxes (paid at the pump).

Since state and federal highway networks are built and maintained by these highway tax revenues (which range from 4¢ to 11¢ per gallon, depending on the state), the waiving of this tax amounts to a subsidy of 40¢ to $1.10 on each gallon of alcohol used.

Leonard Schruben, a Kansas State University agricultural economist, estimates that Kansas alone would lose $233 million per year. This is an unbelievable subsidy for what Schruben calls "gaso-hole."

Even with these subsidies, it is still too costly to produce alcohol for fuel purposes. Current technologies require between 1.2 and 2.0 BTUs (units of energy) to produce 1 BTU of alcohol from corn—a substantial net energy loss.

Other estimates are even more negative. Cloud Cray, head of Midwest Solvents, the second largest U.S. alcohol producer, stated that "Estimated conservatively, it takes 2.72 times the energy to produce 1 gallon of alcohol if you consider all . . . inputs to the process."

Fuel Instead of Food?

The physical limitations to the use of biomass on any extensive basis in the United States are also immediately obvious. If the entire corn crop of the United States were used to produce alcohol, it would meet only 6 percent of domestic passenger car needs. To meet all passenger car needs would

Photo by C. Srinivasen/United Nations

To the biomass advocates, this labor-intensive process is computed as "non-petroleum BTUs," with no thought to the overall inefficiency of replacing machines with human labor.

require 1.3 billion acres of corn production, four times the entire acreage harvested for all U.S. crops.

Calculations used by biomass advocates to present a more favorable picture involve using corn stalks and straw as fuel to operate the stills. Overlooked are the cost of harvest to bring these materials from the field to the plant (involving labor, machinery, and fuel); the ecological cost in the removal from the fields of biomass material that replenishes the soil and minimizes soil erosion and water runoff; and the cost of refertilizing the fields (fertilizer is a very energy-intensive product).

Biomass proponents are not fazed by these facts, arguing that "nonpetroleum BTUs" are being used to produce petroleum-substitute alcohol. Incredibly, this means that their non-petroleum balance sheet substitutes human labor for mechanical labor! For example, Dr. Miccolis of George Washington University noted in an evaluation of these data that by using 5,000 calories per day of human labor to replace machines, "a positive energy balance can be achieved."

Brazil is the example pointed to of this "positive energy balance." The facts are, however, that Brazil uses near-slave labor for the production and harvesting of sugar cane for biomass; workers are paid $3 per day for their heavy manual labor.

In addition, the pollution from the fermentation sites is a costly problem. Brazilian officials have admitted that Sao Paulo's distilleries pour into the rivers the equivalent of the untreated sewage of a city of 15 million people.

The Brazil Story

Perhaps most telling, Brazil is considering selling its alcohol and using the revenues to purchase oil instead of making gasohol. Despite its cheap labor and land, in 1978 it cost 91¢ per liter to produce alcohol, compared to 47¢ per liter for gasoline made from imported oil. Indeed, in January 1979, Brazil's Minister of Energy told *Chemical Engineering* that Brazil should export its alcohol, while the commercial director of Petrobras, Brazil's national oil company, called for a reconsideration of the entire alcohol program.

Nevertheless, the Brazil myth continues: Senator Birch Bayh of Indiana has repeatedly invoked the Brazilian experience in his call for a national commitment to alcohol fuels: "It is my fervent hope that we can learn something from the Brazilian government's efforts in this area. . . . Alcohol fuels work in Brazil, and they will work in the United States if given the chance."

Energy Throughput

For farmers not realizing a fair return on their investment of labor and capital because of depressed crop prices, biomass projects offer an apparent way to reduce crop surplus and thereby increase prices, as well as to provide another possible source of income. Aside from the fact that "overproduction" in a world where one-third of the population goes to bed hungry actually represents a failure of government foreign policy, the monetary realization for the farmer is purely illusory.

Any increase in crop prices would immediately increase the feedstock cost for the alcohol production; any increase in petroleum prices would raise the cost of planting and harvesting the crops and the cost of producing and transporting the alcohol.

In some instances farmers have been able to use biomass on farms to save on fuel bills, but this is only possible to the extent that a farmer has the personal incentive, time, and investible funds to do this. Even in these individual cases, however, the extent to which these efforts detract from this highly skilled farmer's primary productive output is the extent to which the U.S. agricultural sector's technology-proud history is being subverted.

The important points to drive home are these: Biomass is a costly, backward, and wasteful energy source. A single 1,300-megawatt nuclear plant with fewer than 200 workers is the energy equivalent of alcohol produced from 2.5 million acres of sugar cane harvested by 200,000 stoop laborers in Brazil (or 5 million acres of corn produced on a U.S. farm). As for where our oil can come from, oil-rich nations like Mexico desire to trade oil and gas for the food and technology they are short on.

Farmers and anyone else who doubts the high-technology, science-based solution to today's energy problem should go back and read Alexander Hamilton and other American System economists to find out how this country was built.

—Dr. Richard Pollak

Latest Model Results on West Germany:

German Economy 'Impervious' to Oil Price Hike

Editor's Note: Fusion has periodically reported on the development of the LaRouche-Riemann economic model, launched jointly in 1979 by a team of Fusion Energy Foundation physicists and Executive Intelligence Review econometricians. This column will summarize on a regular basis the results of the computer modelers' studies, which take the economy as a physical system and use Riemannian mathematics to identify the discontinuities essential in economic analysis, prediction, and policy planning. Economies are studied as a trajectory through a multidimensional phase space that incorporates the parameters of time, rate of energy throughput, total physical output of useful goods, and the ratio of reinvestible surplus to maintenance costs for capital equipment and labor—a ratio expressed in both volume and energy terms.

* * *

The latest LaRouche-Riemann study on the West German economy reached the startling conclusion that "the German economy is almost impervious to higher oil prices" in the future, even though the Federal Republic is twice as dependent on energy imports as the United States. The reason? As the study shows, the West Germans have invested in capital-intensive, energy-intensive industry while the United States has slid into the opposite pattern. Total energy consumption of West German manufacturing rose steadily through the 1970s, while American energy consumption fell, both per unit of output and per hour worked. In the West German economy, there was a concerted program of capital investment in the most energy-intensive sectors. Total energy intensivity rose, at the same time these sectors became more energy efficient.

In the U.S. economy, the opposite happened. Investment shifted away from energy- and capital-intensive sectors, and manufacturers substituted labor inputs for capital and energy. Total energy intensity fell, while industrial processes themselves failed to become more energy efficient.

The consequences are reflected in the 5.2 percent West German rate of increase of manufacturing productivity in 1979, compared with a 1.4 percent increase in the United States the same year. The gap is actually larger, because the output per manhour definition includes a higher U.S. proportion of output irrelevant to the productive cycle.

Computer-generated indices of the West German economy from 1962 through 1979 show that its net investible surplus rapidly recovered the pre-oil-crisis rate of increase after

The LaRouche-Riemann model projected West German capital investment for 1980-1983, based on the 1975-1979 trends, as an "optimistic" alternative. The projection assumes a sizable increase in oil prices above 1979 levels. Nevertheless, investment rises sharply to 42 billion marks in 1983.

1975. This index has been at or below the zero level in the United States since 1974, and in 1979 fell sharply into deficit (see *Fusion*, July 1980). Actual West German investment, net of depreciation, has risen nearly to the all-time 1960s peak after a deep slump during the oil-price crisis; this occurred while American net investment (in constant dollars) had fallen into a $50 billion deficit in 1979 instead of making up its $10 billion 1975 deficit.

The Future

The modelers presented a number of alternate projections into 1980-1983. The accompanying figure shows the 1975-1979 trend line projected into 1980-1983, with an 80 billion constant-deutschemark oil price increase added to the economy's overhead costs during these four future years. All parameters—net surplus, labor maintenance needs, net investment, and the free-energy ratio (net surplus as a proportion of capital and wage costs)—not only fail to go into a tailspin, but the economy's growth potential is only slightly below the same projection minus the oil surcharge.

The study, excerpted in the June 17, 1980 issue of the New York-based *Executive Intelligence Review*, comments: "We do not wish to give the impression that West Germany is a perfect economy. . . . Rather, that nation's problems and successes are both instructive. The functioning of the economy by all parameters—except living standards—fell drastically after the 1973 oil price rise, and then resumed growth at about the previous speed.

"There is nothing spectacular here. By our most optimistic scenario, the West Germans will have barely recovered their 1970 peak growth potential some time during 1982. But it can be stated emphatically that West Germany has slowly built up sufficient productivity and energy efficiency to make it immune from effects of even fairly substantial price increases."

The study also explores the export growth that has provided incentives for expanded West German investment to obtain economies of scale in capital goods industries.

—Susan Johnson

Nuclear the Safest. . .

Continued from page 21

cases is somewhat different, the overall effect is the same. Increases in temperature produce negative reactivity effects that immediately act to reverse the temperature increase. If the temperature increase is caused by a power increase, the reactor will automatically try to stop the power increase.

The obvious question one might ask here is how can you increase the power level of a reactor? How can you start it up if this negative reactivity always works to shut it down? The answer is that the reactor must be designed so that positive reactivity can be added in a completely controlled manner in order to make the sum of the two reactivities slightly positive, allowing the reactor to start up and reach various operating power levels. This is accomplished by slowly withdrawing banks of control rods and stopping the withdrawal when the desired power level is attained. If any abnormality occurs at any power level that causes even a slight increase in core temperature, the reactor will begin to shut itself down.

The Design Basis Accident

The last part of the defense in depth concept is the engineered safety systems. Here the designer assumes that everything else fails to prevent an accident. The designer selects the worst conceivable accident possible that is just on the borderline of being incredible (that is, not possible) and then designs the plant to withstand the effects of such an accident and to prevent any harm to the plant personnel and the surrounding area.

This just-short-of-impossible accident is termed the *design basis accident*. After tens of thousands of man-hours of analysis and investigation by hundreds of safety engineers throughout the world, the conclusion was that the design basis accident for a light water reactor (either a pressurized water or boiling water reactor) is the loss of coolant accident or LOCA.

In a LOCA, a massive rupture of the primary coolant system causes the water to depressurize, followed by rapid flashing to steam and a blowdown of this steam water mixture out of the ruptured pipe. The cause of the massive rupture is assumed to be a primary coolant pipe that breaks in half, although this could not actually happen, even if there were an earthquake, since reactors are also designed to withstand earthquakes. The blowing down of this steam-water mixture would soon cause the reactor core to heat up, the fuel to melt, and radioactive fission products to escape the core—if the reactor safety designer had stopped his work on the problem here.

Multilevel Containment Barriers

But to ensure that this doesn't happen, the safety engineer provides as many physical containment barriers as necessary to prevent the release of dangerous levels of radioactivity outside the reactor building. The accompanying figure illustrates these barriers, showing six levels of containment.

The first containment level is the fuel pellet itself, which is made of very hard, close-grained ceramic uranium oxide that traps most of the radioactive fission products within its grain boundaries during normal operations. To back this up, the fuel pellets less than ½ inches in diameter and 1 inch long are stacked in sealed 12-foot tubes of zirconium. Under normal operation, the pellets and tubes will contain almost all of the radioactive fission products during the entire three to four-year lifetime of the fuel in the reactor.

Even during normal operation, however, a few of the zirconium tubes will leak so that a very small amount of gaseous fission products will escape the tubes and mix into the primary coolant water. Therefore, the primary coolant system is contained in a pressure vessel with walls 10 inches thick and a piping system that acts as the third containment barrier. This barrier will contain any radioactive material that escapes the fuel tubes during normal operation and also will act as the major containment barrier if an accident damages the fuel. This primary system has several filter systems attached to filter out any radioactive fission products that are released to the coolant and collect

them in a controlled manner for later disposal.

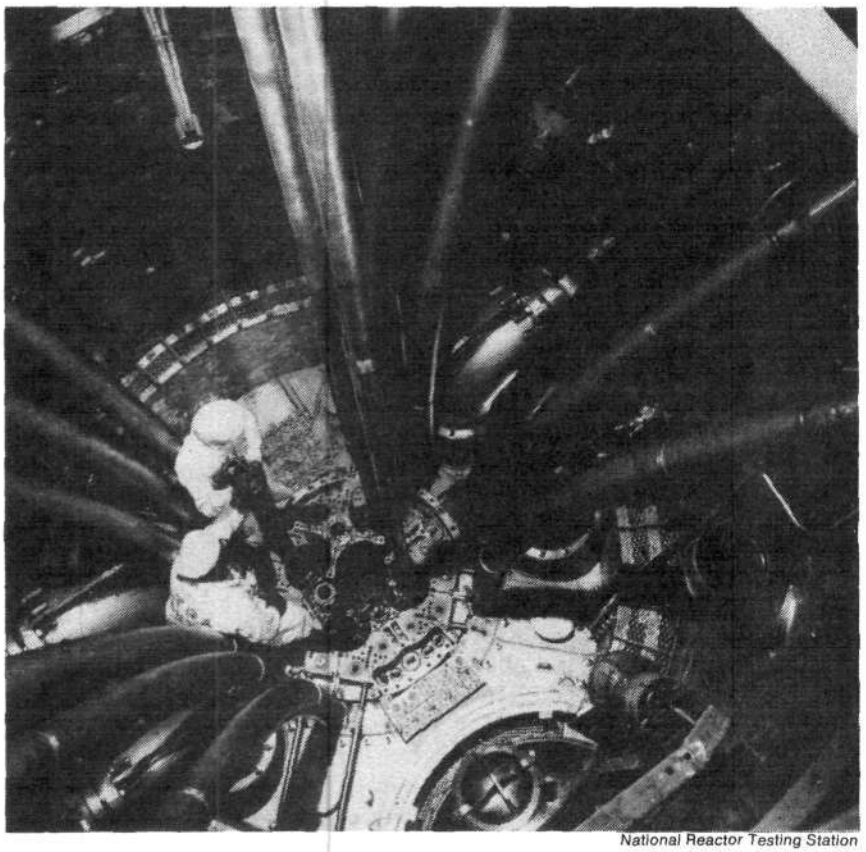
Under the assumed condition that the primary coolant system containment barrier has been breached in the required design basis accident, three more barriers are provided to contain any fission products that escape out of the ruptured pipes. First is the 7-foot to 10-foot thick layer of concrete shielding that surrounds the reactor vessel and the primary coolant system. Next is the containment building, which has two barriers: one is a sealed, steel shell nearly 4 inches thick designed to a pressure of 60 psi, which can contain any fission products, gaseous or solid, that leak out of the ruptured pipe. Outside this shell is more than 3 feet of concrete shielding, which will completely protect anyone outside the building from radiation trapped inside.

These barriers are designed to protect the surrounding public in the case of this very severe, design basis accident. The incident at Three Mile Island was similar to what is called a small pipe break or rupture, in reactor safety terminology, and was far less severe than the assumed design basis accident. Hence, given the existing safety precautions built into the TMI plant, there was never any danger to the public during that incident last year.

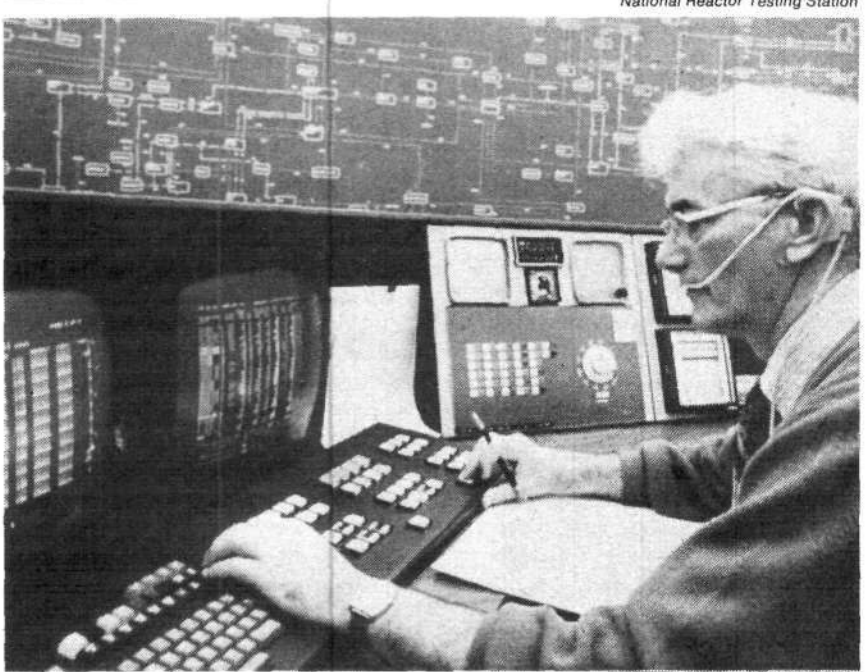
Core Cooling Systems

The other problem in safely containing radioactive fission products is, as mentioned earlier, that they give off heat long after the reactor is shut off and must always be cooled. In order to assure that cooling is always available, the other major line of engineered safety systems involves redundant, in-depth core cooling systems to guarantee that water is always available to the reactor core even under the conditions of the extremely severe design basis accident. In other words, the back-up core cooling systems are designed to keep the fuel from failing and melting under even these severe circumstances. If there is some severe failure or melting of the fuel, this back-up system will prevent the so-called core meltdown from occurring.

The first line of defense is, of



National Reactor Testing Station



Courtesy of Metropolitan Edison

Above: Performance testing in a high-neutron flux environment. Technicians loading fuel inside the pressure vessel of a pioneer U.S. test reactor at the National Reactor Testing Station in Idaho. The straight pipes are two of the nine input tubes that have space for inserting samples of reactor fuels and structural materials to be performance tested. The curved pipes contain detector instruments used to control reactor power.
Below: A view of the TMI control room.

course, the primary cooling system itself. In most loss-of-coolant accidents, as long as the primary pumps (or even one out of the four available) keeps running and make-up water is continuously supplied, the fuel will continue to be cooled indefinitely. The make-up water is automatically supplied to the primary coolant system by a set of large tanks, called accumulators, which are held at pressures somewhat below the normal reactor operating pressure. Therefore, if a coolant system rupture occurs and the pressure drops, these accumulators will automatically inject water into the reactor vessel when the pressure falls below that in the accumulator tanks.

The water make-up system is entirely passive, that is, it requires no pumps or valves to turn it on. Furthermore, the water in these tanks is borated; dissolved in it is a boron salt that upon entering the core will absorb neutrons and completely shut down the reactor, if for some reason the control rods have not shut it down.

Under certain hypothetical LOCA's, it is necessary to get water into the reactor core faster and at larger volumes than the accumulators can supply it. Therefore, there are two types of Emergency Core Cooling System pumps that will automatically turn on when certain preset pressures in the vessel are detected. There are both high-pressure and low pressure emergency pumps—several of each—which will supply water directly to the reactor vessel and core if needed. The high-pressure pumps are for small ruptures, while the low pressure pumps come on during large ruptures such as a design basis accident that requires large volume and flows. The goal of these systems is to get the reactor safely through the initial blowdown phase of such an accident while keeping the core fuel temperature down and preventing severe fuel failure.

Once the initial condition induced by the blowdown is brought under control by the back-up cooling systems, the reactor can then be brought down completely to low pressures (if it is not already, as would be the case in a large rupture) and switched over to natural convection cooling (no pumps required) through one of the nonruptured coolant circuits. (There are always two or more of such coolant circuits.)

What all this means is that reactors are designed with multiredundant cooling systems that guarantee that cooling water will be available to the core under any conditions.

Ending the 'China Syndrome' Hoax

The 1979 antinuclear film "The China Syndrome" promoted one of the chief environmentalist myths: The scare story is that even though the reactor is designed to prevent a core meltdown, it somehow happens and the molten core forms into a round glob of very hot fuel that melts through the reactor vessel, drops onto the concrete floor below, burns its way through more steel and many feet of concrete into the ground below, and eventually gets to China. Along the way, of course, this mythical fiery glob would give off fission products, contaminating all ground water and anything else it touches on its way down.

"A 'China Syndrome' is scientifically and physically impossible. . . ."

The fact is that such a "China Syndrome" is scientifically and physically impossible, as should be clear from the preceding discussion. First of all, the reactor is designed to contain and cool the worst conceivable accident possible, the design basis accident. Since the design basis accident is the worst accident that safety experts can conceive of happening, this should be the end of the story.

However, nuclear safety engineers do look at so-called hypothetical accidents also, just to answer all possible questions for themselves as well as for the various regulatory agencies. *Hypothetical* accidents are just what the term implies: accidents that cannot happen but are assumed to happen for purposes of analysis. Under such hypothetical assumptions, the core meltdown could happen only if *no* cooling water got into the reactor core for many hours or more. In this case, it is likely that as the fuel began to melt slowly, from the inside of the core outward, the molten fuel would start dripping onto the massive steel support structure, and, perhaps, eventually to the vessel bottom. The steel would be a relatively cold material so that the fuel would immediately solidify. Some of it would also splatter around when it hit the water in the vessel bottom, sticking to the steel walls or falling to the bottom of the vessel in solid drops. Since the fuel, in actuality, would be spread around the inside of the reactor vessel walls and other structural material, it would remain solidified and be cooled by conduction through the thick steel walls.

All this is to say that in any real reactor, even if meltdown were to occur, no molten glob melts through the vessel and out of the building. The molten fuel would disperse and solidify again, all within the reactor vessel containment boundary. (And this boundary is just number three of six different barriers.)

Of course, the hypothetical analysis does not stop here. Suppose we assume that none of the above happened and that a hypothetical molten glob of fuel finds its way to the vessel bottom. Such a glob *might* be able to melt its way through the 10-inch vessel, although this is by no means certain. Assuming that it does, this material would have to fall many feet to the floor of the containment building. The fall itself would cause the molten material to be broken up and splattered all over a large area of the building floor. This would ensure dispersal, which would guarantee that the material would remain solid and no longer capable of forming a molten glob that could burn its way through the thick concrete floor.

In sum, there is no "China Syndrome."

To be continued

Jon Gilbertson is the director of nuclear engineering for the Fusion Energy Foundation and a well-known nuclear safety authority.

Science And Nonsense

Editor's Note: The proliferation of pseudoscience and just plain nonsense masquerading as science in the popular press as well as the scientific literature has prompted us to devote a regular commentary on the press coverage of science. Readers are invited to send us relevant clippings and comments.

* * *

SUPPORTING THE SUPERNATURAL

An unsigned article April 12 in the British financial weekly *The Economist* reported that "according to modern physics, the universe began with a big bang, in which space and matter made a sudden explosive appearance—from literally nothing."

This has to be the case because according to the Second Law of Thermodynamics, *The Economist* said, a universe that has always existed would have run down, would have "died" by now. "The universe, like a clock, should be gradually but inexorably unwinding, depleting its reserves of ordered energy. . . . Eventually, nearly all the material of the universe should be burnt out, its reserves of energy dissipated into (disordered) radiation."

The Economist's conclusion? Science must ultimately submit to irrationality and magic: "Modern cosmology, then, is faced with two alternatives. Either some sort of cosmic regeneration, or time-reversal, must be accepted. Or the big bang was the beginning of the physical world as understood by modern scientists. If the big bang did mark the creation, what caused it? Astronomers and physicists do not address that question. Like Hume, they would argue that not all events require causes.

"If that is so, the big bang, the initial singularity from which the universe exploded, marked the interface between the natural and the supernatural. Whatever preceded it, if anything, is beyond the realm of science."

Looking at some of *The Economist*'s austerity policies, one wonders whether the editors also doubt the efficacy of science after the big bang.

* * *

THE SEARCH FOR WHAT?

The search for quarks, those illusive, nonobservable "fundamental building blocks of nature," has taken a new turn since 1977 when the quark called "bottom" was invented. (Bottom, of course, is supposed to fill some of the theoretical gaps left by previously postulated types of quarks.)

Today, according to various accounts, scientists at the Cornell Electron Storage Ring are looking for a new type of meson that would result from stripping "bottom" of its companion quark called "antibottom." We're waiting for the headlines that they've discovered "bare bottom."

* * *

'CHINA SYNDROME' FOR DNA?

Is there another Three Mile Island on the horizon, this time in the area of recombinant-DNA?

On May 28, CBS-TV presented an Aquarian-style morality play called "The Henderson Monster." Just as the movie "The China Syndrome" contained numerous factual distortions and half-truths—all of which conveniently contributed to the antinuclear hysteria that preceded and followed the sabotage at TMI, "The Henderson Monster" falsely portrayed the scientific basis and supposed dangers of the biological field of recombinant-DNA.

The soap opera story line of the TV movie paralleled the developments in Cambridge, Mass. in 1977-78 when recombinant-DNA research was blocked by environmentalist actions. Only briefly mentioning the exciting benefits that this technology holds for society, the movie instead focused on the contrived dangers of the process.

The personalities of the individuals involved were credible only to the most antiscience environmentalist. The biologist doing the recombinant-DNA research is callous, ambitious, a "Nazi-science" doctor; his protagonist is the drunken literature professor who chants "small is beautiful" at town meetings; the professor's wife is the sexually promiscuous research assistant to the biologist who finds peace when she rejects science and sides with the environmentalists to stop the research.

CBS chose as consultants for this monster Friends of the Earth, and the network told us that the show has received rave reviews.

Despite the successes of the recombinant-DNA researches, the environmentalist scare campaign to shut it down has not abated. Is this movie a tip-off to a new tack?

(Our thanks to Anne Marie Vidal for this item.)

* * *

NAS UNDER THE GUN

The antiscience mob is on the warpath against the National Academy of Sciences. For all its faults, the Academy is one of the few scientific institutions in the country that has not completely succumbed to the wave of kookiness in science that is expressed in the espousal of so-called renewable energy resources, the Ralph Nader-style deification of "safety," and the general attitude that growth and progress are the banes of modern existence.

When the Academy truthfully reported that solar energy is economically disastrous, the *New York Times* editorialized that it had been "had" by the Academy. The recent report from the Academy's Food and Nutri-

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What Is Energy?

Energy is hydro, oil, coal, gas, nuclear fission, and fusion. Except in very special circumstances, it is not solar, wind, or biomass. Why do I distinguish between these two types of energy sources? Don't they both provide energy? What is energy anyway?

Let's consider three examples:

1. Lightning strikes a tree in a dry forest. The tree ignites, and soon the whole forest is ablaze, releasing tremendous amounts of heat.

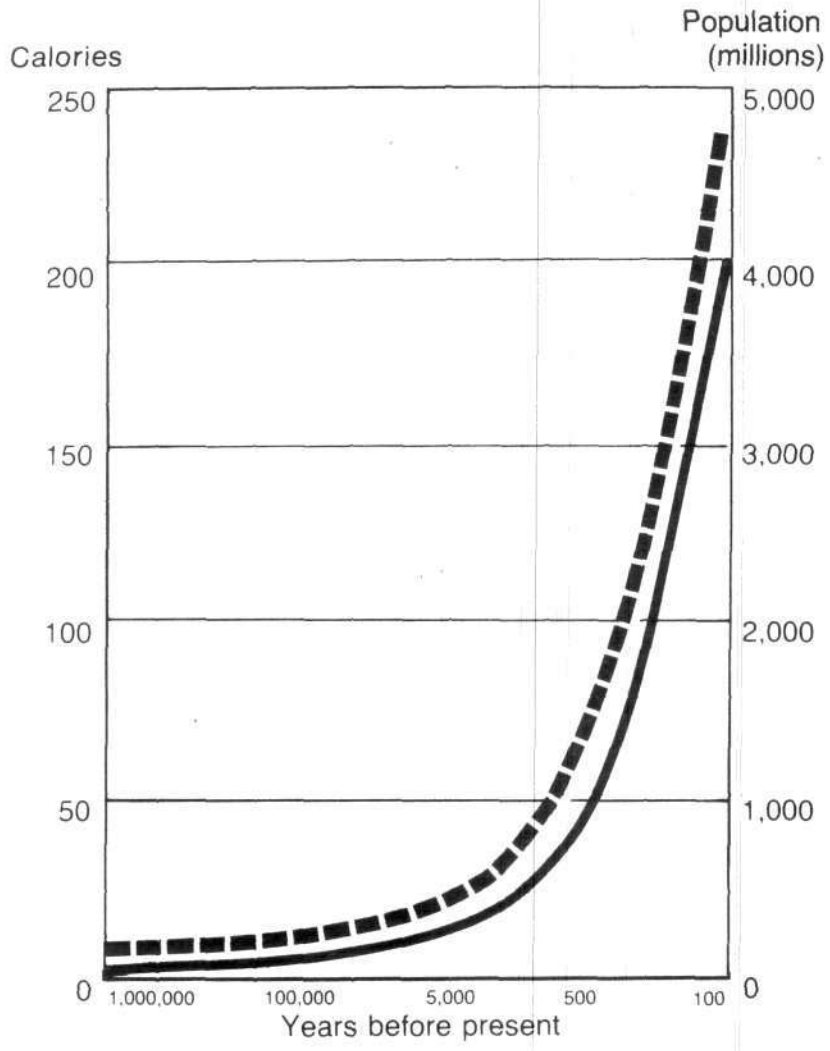
2. A 20-year-old electrical generator burns hundreds of tons of coal a day to provide electricity for homes and industries in an old Midwestern community.

3. A floating nuclear plant off the coast of India begins to provide heat and electricity to develop modern agriculture and industry for an area including several million people.

What are the differences among these cases? Obviously, in the first case, no *useful work* is being done with the large amount of *energy released* by the forest fire. In the second case, further *transformation (change in composition) of the form of energy* is responsible for useful work. In the third case, larger amounts of *more concentrated* types of energy are being used to *increase the efficiency* of useful work.

All these separate ideas can be combined into one: *Energy is the stored-up potentiality (the ability to develop) that can be used to transform nature in such a way that (1) useful work is done, or (2) a greater potentiality is created for future useful work, or (3)—most important—both things happen.* The *energy potential* is contained in the *organized structures* of the physical universe (for example, fuel). This energy potential is made into usable energy by the change of organization and work that occurs when it is used.

Therefore, the important thing about energy is that if the proper types are properly used, we can increase the amount of energy available in the future and the benefits from the use of each unit (piece) of that energy. To do that, however, we must use science to constantly discover new types of energy and new ways to effectively use that energy (technology). This means that we have to develop new types of energy faster than we use up existing energy sources. But at the same time we have to use existing energy fast enough to give the world population a high enough standard of living to make possible a high rate of scientific progress.



WORLD ENERGY USE: ENERGY ISN'T RUNNING OUT

The world population has constantly increased its use of energy. The graph shows how energy consumption per person has increased as the world population increased. The dotted line represents the world population; the solid line is energy use measured in calories.

Will Energy Run Out?

How does the history of energy use show us that it is self-developing and self-expanding? The accompanying

figure shows that the world population has constantly been increasing its rate of energy use by inventing new, more efficient types of energy. These new energy sources provide the basis for further growth by discovery and application of even more advanced energy technologies. This process of transformation of energy sources and their uses—from solar and biomass to wood, then coal, oil, and now fission and fusion—also provides the answer to the question: "But how much energy is there on earth or in the universe? Will we ever run out?"

These questions, put in this way, mean that the questioner is using the *wrong* set of ideas and facts about energy.

If we are stuck in a situation with no new science or technology, then we will eventually run out of energy. In this *fixed* (unchanging) situation, there will be a *limit* (boundary) to the amount of energy we can get from the resources available to us. But if we move up to a more advanced situation where there is a new combination of science, technology, and resources, then there will be a new, higher limit to the amount of energy we can get. Each new combination of science, technology, and resources moves up the limit on energy available for the population to use. The number of new situations is itself without limit or *infinite*.

Each new situation in the infinite number of situations possible is called a *transfinite* in relation to all the other situations. The importance of looking at the energy situation in terms of the transfinite is that it gives us a real measure of energy. The full measure of any energy source is in the transfinite process of creating the next, better forms of energy.

This measure of energy is so powerful and accurate that it also takes care of the objection to progress used by some miseducated people today. This is the argument that rapid growth or development creates a lot of waste. The technical name for this waste is *entropy*, a quantity related to the creation of unusable forms of energy (like friction heat).

This argument is not even usually true, since more advanced energy technologies (usually at higher temperatures) can be fit together with industrial processes to reduce waste and increase efficiency. One example is the use of heat from nuclear plants to desalinate (take the salt out of) water or make fertilizer. But even if some energy must be "wasted," that is not important compared to the process of development of new energy sources. What is crucial is the growing amount of extra energy available to drive the process of development. We call this extra energy *free energy*. The percentage of free energy available has been increasing as new, more efficient energy technologies—like nuclear fission—have been developed.

At each stage of history, it may be useful to do the simple type of counting of the energy used, created, and lost. But in each new situation the old numbers cannot be added up continuously and carried forward. In some ways this situation can be compared to running partway around a circular race track suddenly to find that the track has turned into a more complicated surface like a sphere (globe). Just as you would need a new set of measurements to measure your path on the sphere, so we need new measurements for the productivity of energy every time there is an important change in energy and other technology.

New Technologies

As long as science and progress exist, energy is not restricted by the so-called laws of conservation or entropy. These laws just provide a convenient means of counting during each stage of technology. Our real need, however, is the development and widescale use of new forms of energy, like nuclear fission and fusion today. These are the new technologies the youth of today will be improving and using in the future. Even more exciting, today's youth will be discovering new types of energy on earth and in space that have barely yet been thought of. We will be describing them for you in future columns.

—Dr. Morris Levitt

Books Received

McGraw-Hill Encyclopedia of Environmental Science. New York: McGraw-Hill, 1980. 858 pp., $34.50.

To Choose a Future. Ronald G. Ridker and William D. Watson. Baltimore: Johns Hopkins University Press, 1980. 410 pp., $33.50.

The Development of the U.S. Urban System. Edgar S. Dunn, Jr. Baltimore: Johns Hopkins University Press, 1980. 192 pp., $65.

The New Tyranny: How Nuclear Power Enslaves Us. Robert Jungk. Binghamton, N.Y.: Grosset and Dunlap, Inc., 1980. 200 pp., $10.

Robert Oppenheimer: Letters and Recollections. ed. Alice Kimball Smith and Charles Weiner. Cambridge: Harvard University Press, 1980. 376 pp., $20.

Morality In Medicine. Richard Warner. Sherman Oaks, Calif.: Alfred Publishing Company, 1980. 137 pp., $7.95.

McGraw-Hill Modern Scientists and Engineers. ed. McGraw-Hill Encyclopedia Science and Technology staff. New York: McGraw-Hill, 1980. 1,420 pp., $110.

World Guide to Battery-Powered Road Transportation. J.M. Christian and G.G. Reibsamen. New York: McGraw-Hill, 1980. 392 pp., $49.50.

Process Heat Exchange. Chemical Engineering Magazine. New York: McGraw-Hill, 1980. 488 pp., $34.50.

The Many Faces of Suicide. ed. Norman L. Farberow. New York: McGraw-Hill, 1980. 446 pp., $18.95.

The Quick Knife: Unnecessary Surgery USA. Duane F. Stroman. New York: Kennikat Press Corp., 1980. 178 pp., $12.50.

Scarcity and Growth Reconsidered. ed. V. Kerry Smith, Baltimore: Johns Hopkins University Press, 1979. 290 pp., $6.95.

The Management of Schisosomiasis. Patricia L. Rosenfield. Washington, D.C.: Resources for the Future, 1979. 136 pp., $6.75.

Manufacturing Processes. Herbert W. Yankee. New Jersey: Prentice Hall, 1979. 740 pp., $23.95.

Euclidean and Non-Euclidean Geometries. Marvin Greenberg. San Francisco: W.H. Freeman and Company, 1980. 400 pp., $18.

The Big Bang. Joseph Silk. San Francisco: W.H. Freeman and Company, 1979. 394 pp., $18.

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Plato's Academy

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tion Board (see National News, this issue) met a similar fate.

The *Washington Post* has gone so far in its rage as to call for an investigation of the Academy. After rehashing the "sins" of the Academy, a *Post* editorial pointed out that Philip Handler, the current president of the Academy will retire next year and that the search for a successor is now under way. "Considering its [the Academy's] importance to a much larger constituency, the qualifications and views of the candidates should be the subject of a much wider debate. The workings of that club require more scrutiny than they have ever received before."

Ironically, Handler recently editorialized in *Science* magazine that scientists should retreat from the political arena and immerse themselves in their specialties.

—*John Schoonover*

Books Received

Continued from page 79

Limiting Oil Imports. D. Bohi and M. Russell. Baltimore: Johns Hopkins University Press, 1978. 348 pp., $22.50.

Who Goes There: The Search for Intelligent Life in the Universe. Edward Edelson. New York: McGraw-Hill, 1980. 228 pp., $4.95.

Fundamentals of Plasma Physics. V.E. Golant, A.P. Zhilinsky, I.E. Sakharov. New York: John Wiley and Sons, 1980. 395 pp., $39.

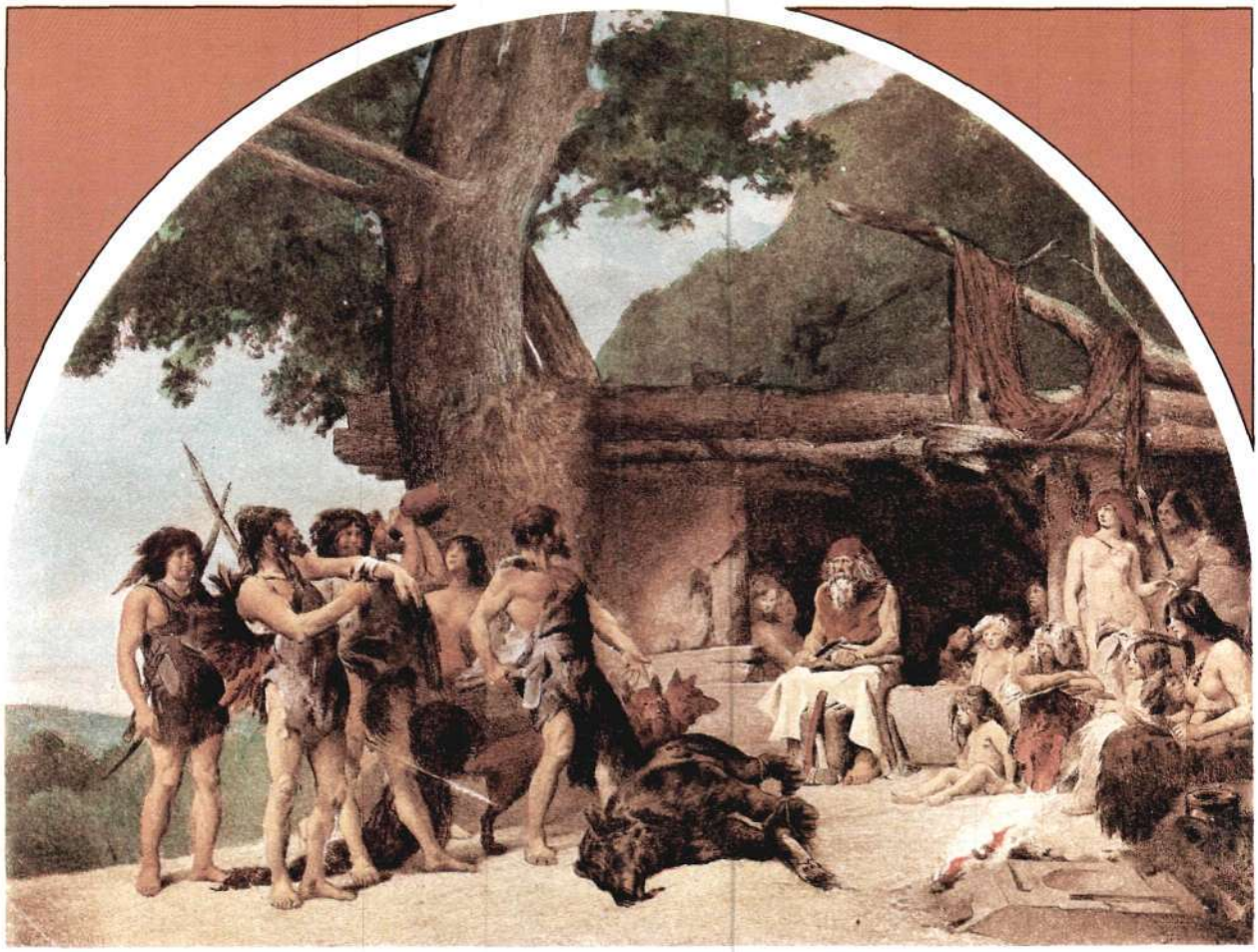
At Highest Risk: Environmental Hazards to Young and Unborn Children. Christopher Norwood. New York:McGraw-Hill, 1980. 248. pp. $12.95.

Language and Learning. Massimo Piattelli-Palmarini, ed., Cambridge: Harvard University Press, 1980, 379 pp., $20.00.

Science and Technology: A Five Year Outlook. National Academy of Sciences, San Francisco: W.H. Freeman, 1979, 544 pp., $15.00.

Competition in the Health Care Sector. Warren Greenberg, ed., Germantown, Maryland: Aspen Systems Corp., 1978, 383 pp., $26.50.

Coal: Bridge to the Future. Carroll L. Wilson, Cambridge: Ballinger Publishing Co., 1980, 220 pp., $12.95.



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