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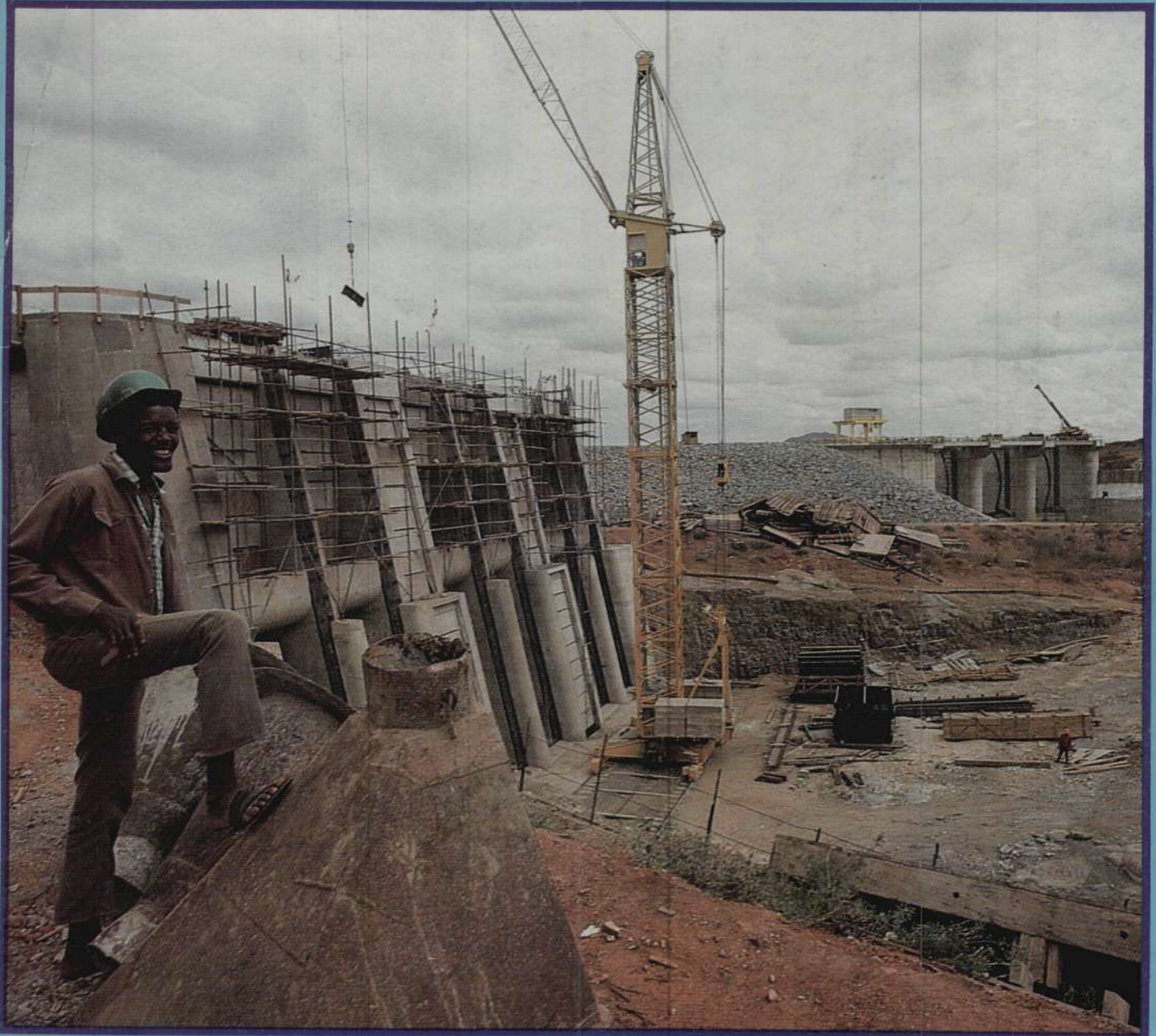
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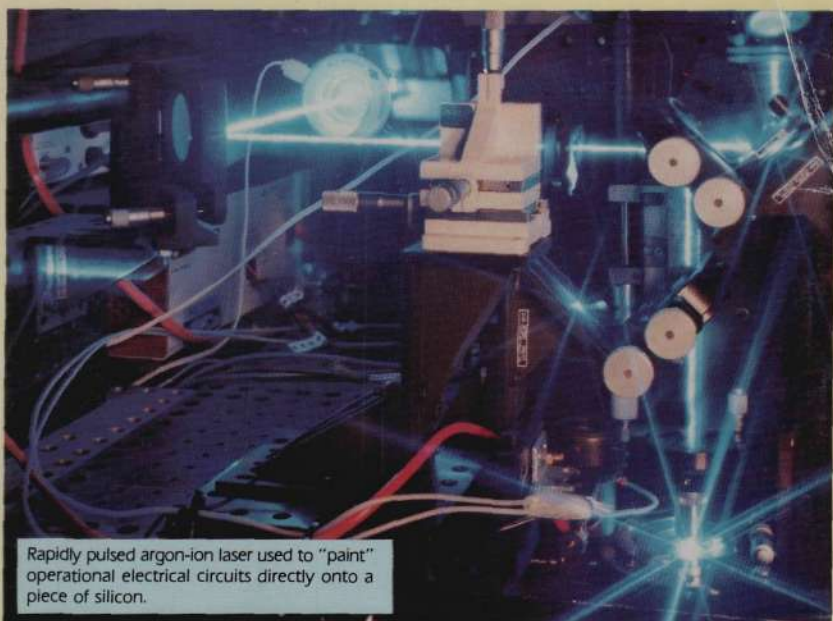
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SCIENCE • TECHNOLOGY • ECONOMICS • POLITICS

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On the cover: Construction work on the Gitaru Dam in Kenya. Photograph by Daniele Pellegrini, Photo Researchers, Inc.; cover design by Ernest Fullerton.

Congress Must Fully Fund the SDI

This editorial is adapted from testimony delivered by Paul Galagher, executive director of the Fusion Energy Foundation, to the House Appropriations Subcommittee on Defense Appropriations, May 15, 1985.

The full funding level for SDI requested by the President for fiscal year 1986, \$3.7 billion, is still dwarfed by demonstrable Soviet levels of manpower and expenditures on strategic, air, tactical and civil defense. The President's request, in our judgment, is the absolute minimum level necessary for U.S. national security in the most crucial, frontier areas of military technology development, which are known to be such by the Soviet leadership. The President has provided for an acceleration of the program to initial technology demonstrations. His request is the minimum level necessary to prepare to develop these ABM technologies, if the Soviets continue their provocative confrontation policy—as in their shooting down of a U.S. officer in East Berlin and their refusal to apologize or even forego new such killings as policy.

U.S. to Cut Back While Soviets Accelerate?

Those calling for cuts in the SDI program from both inside and outside of Congress have stated that their goal is to prevent the program from entering the stage of broad-scale technology demonstrations and tests, like the Homing Overlay Experiment (HOE) demonstration July 11, 1984. The proposed House cuts in the requested funds will clearly accomplish this goal.

These cuts would prevent the Shuttle-based demonstrations of sensing, pointing, and tracking technologies; the complementary aircraft-based technology demonstra-

tions; the demonstration of ground-based lasers and fabrications technologies for large, segmented optics; and other technologies essential to developing principles of midcourse, boost-phase, and terminal defense.

It is precisely this strategy of technology demonstrations under the SDI that has forced the Soviets to take the *potential* of this U.S. effort seriously, and that has generated the interest of our allies in contributing their own capabilities to the effort.

Furthermore, these demonstrations and tests of ABM technologies have been conducted by the Soviet military with increasing frequency for seven years! The continuous testing and upgrading of the Soviet ABM interceptor system and of capabilities for making it a mobile national system, is an undeniable fact. The Soviet *demonstration and testing* of capabilities for a national ABM radar tracking system is an undeniable fact.

U.S. satellite and other intelligence since the 1970s has shown this Soviet military testing: the firing of ground-based lasers at reentry vehicles; the firing of ground-based lasers at objects in space; the relay of ground-based lasers from mirrors in orbit to submarines; the propagation of high-power electron beams in the atmosphere; the demonstration of high-power X-ray lasers with various pumping modes at sites administered by the Lebedev Institute; and possibly both pointing and tracking and mirror fabrication from the Salyut space stations.

In fact, the design conceptions being pursued by the U.S. beam defense program for both the neutral particle beam and electromagnetic launchers were borrowed from previously developed Soviet design conceptions.

Soviet Defense Minister Sokolov, attacking the SDI in an interview on Soviet television May 6, stated that the Soviet

Union "is developing all of the advanced technologies for space," but has not yet used them to develop space weapons—Soviet code words for ABM weapons. Sokolov clearly implied to his Soviet audience that Soviet advanced technology ABM defense is nearing the shift to weapons development, testing, and deployment. If Congress would direct its attention to the Soviet policy discussions and writings other than those explicitly intended for the eyes and ears of the Congress, then Soviet ABM policy, including the suppression of the U.S. SDI, would become clear to them.

Soviet Beam Defense Deployment Documented

The Secretary of Defense, in the most recent issue of its report *Soviet Military Power*, has compiled for Congress the evidence that the Soviet strategic high-power laser and neutral particle beam programs can reach the *deployment of first layers of defensive weapons systems* during this decade. Even that first stage of deployment, if it is unilateral on the Soviet side, would irreversibly establish Soviet strategic superiority over the United States and hegemony over Europe and Asia.

ABM defense centered on high power directed-energy and plasma weapons has been stated Soviet military doctrine and policy since 1962. The history of the writing of the 1972 ABM Treaty shows that it was on Soviet insistence that ABM technologies using new and advanced physical principles were *exempted* in the language of that treaty. The Soviets have never shown the slightest willingness to deflect from that course, spending ultimately half of their military budget on defense.

In the face of that reality, a rollback in the fiscal year 1986 SDI budget to the levels of the "Carter years" research program would tell the Soviet command that it will achieve its goal—military dominance over the U.S. and decoupling of its allies by 1988-1989. Congress is being told to cut the SDI by washed-up former government military and scientific officials, weapons advisors, and designers from the era of Mutually Assured Destruction (MAD)—individuals and groups who publicly joined the Soviet leadership to declare war on the beam defense program immediately in 1983—and by representatives of international bankers who demand that the United States relinquish sovereignty over its own credit system and national budget.

Will Congress Achieve Soviet Hegemony?

Anyone proposing now that we should not rapidly expand the Strategic Defense Initiative to involve the entire Western alliance, exploit our lab, industry, and university capabilities fully, and at least match the Soviet beam weapons program in manpower and engineering experience, is proposing strategic disaster and capitulation by the alliance to the loud public demands of the Soviet Union. Anyone proposing to do this "for reasons of fiscal constraints," is simply finding an excuse to meet the brutal, daily repeated Soviet demand.

For Congress to be stampeded by this International Monetary Fund pressure is Soviet policy. On Soviet national television March 30, Russia's leading "U.S. expert," Georgii Arbatov, bragged to the Russian population that the SDI would be sabotaged: "In the next spiral of the arms race,

the Washington leadership has apparently made a very serious mistake. The . . . resources of the American economy have been overestimated and the scale of the arms race has exceeded its resources . . . it is an objective fact—the current level of military expenditure is a backbreaking burden for the U.S. economy. Appropriate modifications must be made."

The fact is that the fiscal 1986 SDI budget request would, for the first time, place the United States and NATO seriously into the defensive weapons technology race with the Soviet Union. Prior to the SDI, U.S. programs in this area, relative to the Soviet level of effort, were a joke, and the fiscal 1985 SDI program was reduced by Congress below the inflation-adjusted level of the previous programs. The fiscal 1985 program funds are now being obligated, and spent, at a rate greater than the defense budget as a whole—recent fraudulent claims to Congress notwithstanding.

Holding the Western Alliance Together

The potential of the Strategic Defense Initiative is now the *only* thing holding the alliance with Western Europe and Japan together against overwhelming Soviet strategic superiority in these theaters. Without the potential of the SDI, the deployment of the Pershing missiles in Europe

THE SDI BUDGET REQUEST AND CUTS PROPOSED BY THE HOUSE ARMED SERVICES COMMITTEE

Program	Year			
	1984	1985	1986	1987
	(in \$ millions)			
Surveillance and Tracking	366.5	546.0	1,386.4	1,874.9
House Proposed Cuts			-496.0	
Directed Energy Weapons	322.5	376.4	965.4	1,195.6
House Proposed Cuts			-240.0	
Kinetic Energy Weapons	195.8	256.0	859.7	1,238.6
House Proposed Cuts			-350.0	
Systems Concepts, Battle Management	82.7	99.0	243.3	272.5
House Proposed Cuts			-70.0	
Survival, Lethality, Key Technology	23.5	112.0	258.2	316.7
House Proposed Cuts			-84.0	
SDIO Program Management	8.0	9.2	10.0	
Total budget request		\$3.7 billion		
Total proposed cuts		\$1.2 billion		

The proposed House Armed Services Committee cuts in the fiscal year 1986 SDI budget request would remove the capability of realizing demonstration prototypes in this decade and prevent the realization of any significant level of industrial infrastructure for laser and optics hardware.

would not have been politically possible. The SDI is also the sole reason for the Soviet presence at the Geneva negotiations. These are well known facts among our European allies. They publicly state that they require two things: a full U.S. commitment to a program large enough to involve them in developing strategic, tactical, and air defense; and a full share in large-scale industrial technology spinoffs. West German military specialists have in fact begun to evolve a strategic design conception for the entire European theater side of SDI, which they have informally titled the Tactical Defense Initiative.

The European opinion, communicated to U.S. military officials, is that the "sleeping giant" of American technological and industrial strength can be focused by the SDI, for the first time since the NASA Apollo program, in order to accomplish a genuine economic and strategic recovery.

The United States has requested aid for this program from its allies, in the form of national spending and private industrial participation. The allies, with the present exception of France, have offered this aid. *Their participation and aid will be lost overnight if the expansion of the U.S. program is now canceled, for reasons that should be obvious to anyone who sees strategic programs in real terms, rather than through the haze of budgetary numerology.*

The SDI is a program developing the most advanced technologies known to man, the universal tools of the next century, into defensive weapons technologies with almost immediate revolutionary impact on industry. Those denying its "feasibility" are challenging the industrial wisdom of scientists, engineers, and high-technology firms throughout the West. They are also disagreeing with the leading laser scientists in the Soviet Union before March 23, 1983, when they were all placed under state orders to lie about the subject.

A Crash Program

In all past American experience, such breakthroughs have been achieved by crash programs, conducted by the largest possible scientific and engineering task forces. Each such program has been opposed and decried by government advisors of all kinds. Each led to success in its immediate objective, and leaps forward in U.S. industrial/technological strength.

If Congress cuts this program back, it is capitulating to Soviet demands and the blackmail of international financiers who are speculating in U.S. government deficit and debt instruments. It is also ignoring the clear evidence of Edison's electrification projects, World War II, the Manhattan and Apollo projects, and many other "crash programs" going back to the 1690s' smallpox vaccination program in the New England colonies—which was equally vehemently opposed.

The SDI is on record proposing to develop these technological breakthroughs for civilian as well as military purposes, through open as well as classified research, involving the nation's major universities and small firms as well as national labs and aerospace firms.

This effort depends on the fiscal 1986 budget request, not the pitiful previous levels of research funding, which were so impotent that until 1983 the Soviets contemptuously

published general reports of their own beam weapons research in their open literature.

In addition to the funding of the SDI itself at levels of \$5 billion or more per year starting immediately, Congress should be providing *industrial mobilization credits* of at least an equivalent amount to SDI spending, in order rapidly to develop the industrial base for the success of the program. The FEF has proposed detailed legislation for this.

The Question of National Sovereignty

Defense Secretary Weinberger stated in his internationally televised press conference on the SDI April 10, that International Monetary Fund "surveillance" of U.S. budgetary policy, including its defense budget, as demanded by the IMF and other agencies of the international private central banks and money center banks, would be an intolerable loss of national sovereignty and a threat to national security.

Yet, whether or not the Secretary is aware of this, the United States granted such surveillance to the IMF, in documents agreed upon by White House Chief of Staff James Baker at the IMF meeting in Washington April 15. The U.S. dollar was driven down by those international banks and private "central banks" from 3.45 deutschemarks to 2.97 deutschemarks during March and early April, in order to enforce that demand. When the demand for "surveillance" was met, the dollar was allowed to rise again, to 3.23 deutschemarks as of this week. At the same time, the drive for a defense budget freeze and massive cuts in the request for SDI funds was launched, by Robert Strange McNamara and Clark Clifford—both leading representatives of international credit agencies and investment banks—and by the Council on Economic Priorities, a project of the Rockefeller family and Chase Manhattan Bank since 1968.

The opponents of the SDI budget have absolutely no basis for their "estimates" of how, why, and what strategic defense will eventually cost. They are attacking the White House on behalf of the IMF and, in particular, Federal Reserve chairman Paul Volcker. Volcker has been coming before Congress demanding these defense budget cuts for four consecutive years, while himself ballooning the federal deficit through his interest rate policies and their effect on the U.S. economy. He would willfully sacrifice U.S. national security needs to the "conditionalities" imposed by the IMF on international credit, just as other nations have been forced to sacrifice the means of economic development and subsistence itself to these "conditionalities."

Furthermore, these opponents have consciously colluded with Soviet representatives to try to eliminate the SDI or roll it back to an impotent research program, while pursuing their own goal of taking the costs of international usury out of the U.S. defense budget.

Congress, in the U.S. national interest, must do the opposite. Congress must vote full funding for SDI technology research and development, and vote, in addition, industrial mobilization credits to allow this science driver to have full impact on the U.S. industrial base. The wealth produced and revenues flowing back to the Treasury from this effort will more than pay for the expenditures, and can start a genuine U.S. industrial revival based on the frontier of technology.

"It is essential that articles in the journal are of such a nature that they bring about the birth of new concepts. That would be very unlikely to occur with the referee system of judging papers for acceptance that is now in use in most scientific journals. The referees always base their reviews on what is known in physics, biology, or biophysics as it stands today; but often there is a greater understanding, new interpretations, new explanations for scientific phenomena that should become known and discussed. It is the IJFE editorial policy to give authors with a new concept a chance to defend their ideas and theses before acceptance for publication."

—Dr. Robert J. Moon
Editor-in-Chief

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The FEF's Tennenbaum: Spain should participate in the SDI.

100 SPANISH LEADERS ATTEND FEF BRIEFING ON SDI

An impressive grouping of Spain's leaders gathered in Madrid April 25 to hear a briefing on the implications of President Reagan's Strategic Defense Initiative for the defense of Europe. The briefing, sponsored by the Fusion Energy Foundation and the weekly *Executive Intelligence Review* (EIR), drew 100 representatives of the Spanish Defense Ministry, members of parliament, top representatives of the Spanish Navy and Air Force, laser scientists, technical experts from Spanish industries, diplomats, and the national press.

Dr. Jonathan Tennenbaum, who heads the FEF organization in Europe, gave an in-depth presentation on the latest scientific and technological breakthroughs in the U.S. beam defense program, while Michael Liebig, strategic expert for the EIR in West Germany addressed the question of the future of Europe and Spain, in particular. Liebig called on Spain to join West Germany and other European countries in a crash program to develop beam defense against Soviet short- and medium-range missiles.

The briefing also featured a 30-minute videotape on the beam defense program by FEF board member Lyndon H. LaRouche, Jr. This paid-political broadcast was shown on national television on election eve in 1984, when LaRouche was an independent Democratic candidate for President.

LT. GENERAL ABRAHAMSON HITS WASHINGTON POST LIES ON SDI

After the *Washington Post* asserted in a May 12 news story that the Strategic Defense Initiative Office had shelved directed-energy systems research in favor of a "two-generation" program based on kinetic energy weapons, SDI head Lt. Gen. James A. Abrahamson minced no words in letting the public know that the *Post* was wrong: "The *Washington Post* story on May 12 that claims that the SDIO has concluded that space-based lasers are 'beyond technical reach for the foreseeable future' is a misinterpretation of both fact and opinion. This negative conclusion is *not* correct. The SDIO is optimistic about many of the advanced technology systems, including lasers and other directed-energy weapon systems. We believe that our programs to date justify that optimism," Abrahamson said.

NBC network news went even further than the *Post* in a news piece that claimed that Abrahamson supports a "two-generation" approach to research and deployment, a point that Abrahamson specifically refuted in his press statement: "No [we don't need a two-generation approach] . . . a much better way is to have a mixture."

"The ultimate disservice of the *Post* article," Abrahamson said, "is to twist progress on several fronts into an implication for potentially increased costs."

U.S. MUST SHUT DOWN THE OSI, FREEMAN TELLS PRESS CONFERENCE

"All of the supposed evidence presented by the Office of Special Investigations against German scientist Arthur Rudolph has come either from the KGB or East German intelligence agencies. Our investigations have found that there are now hundreds of German-American scientists under investigation by the OSI. The Fusion Energy Foundation has called for congressional investigation of the OSI, and shutting it down."

With this charge, *Fusion* Washington editor Marsha Freeman put on notice a gaggle of press at a press conference of some 30 German scientists gathered at the space research center at Huntsville for a 40-year reunion of their work in the United States. "The witch-hunt against the leading space scientists of the United States is nothing less than a Soviet plot to destroy the military-scientific accomplishments of the United States," she said. Without these German scientists, Freeman said, the U.S. rocket program and space program would not exist.



Holding a photo of von Braun are his former colleagues Dr. Eberhard Rees (left) and Konrad Dannenberg (right), who worked with him at Peenemünde and Marshall Space Flight Center.

Among the press present was one Linda Hunt, author of an article in the April issue of the *Bulletin of the Atomic Scientists* titled "U.S. Coverup of Nazi Scientists," in which she attacks Wernher von Braun and Rudolph, who led the development of the Saturn V rocket and designed the Pershing 1.

THAI COMMUNICATION MINISTER ANNOUNCES KRA CANAL STUDY

Thai Communications Minister Samak Sundaravej announced in a press conference May 1 in Bangkok that a feasibility study for the construction of a canal through the Kra Isthmus would be carried out by the Mitsubishi Research Institute of Japan, the Fusion Energy Foundation of Washington, and the TAMS consulting firm of New York. The canal, crossing the Isthmus of Kra in southern Thailand, would link the Andaman Sea and the Gulf of Thailand. Plans drawn up for the project in 1973 show that the canal would save four days' shipping time, and that Thailand's east coast city of Songkla could be turned into a Southeast Asian superport.

TAMS carried out an engineering feasibility study for the canal in 1973, but the project was shelved after the 1973-1974 oil crisis. The Fusion Energy Foundation launched a renewed drive for the canal in September 1983, with a series of conferences. The Kra Canal project has now become a major issue of policy planning not only in Thailand, but also in Japan. The canal is one of the projects designated in the Global Infrastructure Fund proposal of Masaki Nakajima, former board chairman of the Mitsubishi Research Institute.

DIABLO CANYON BEGINS COMMERCIAL OPERATIONS

California's Diablo Canyon nuclear power plant in California began commercial operations early May 7, generating about 1.1 million kilowatts of electricity. The plant had been stalled for more than 10 years by environmentalist attacks, egged on by former California governor Jerry Brown. "We have achieved a goal that has been underway for some 17 years," said Ron Weinberg, a spokesman for Pacific Gas and Electric. "It's a tribute to persistence." He also reported "just a smile or two as we approached full power."

FUSION AIRPORT SLOGANS HAVE LONG LIVES

The Italian magazine *Espresso* ran an interview with Italian Science Minister Renato Altissimo April 21 and asked him about the alleged "danger nuclear energy represents for people who live near a nuclear plant." Altissimo replied, "I will answer with an American slogan: More people have died in Ted Kennedy's car than in a nuclear plant."

INDIA'S DEPARTMENT OF SPACE ANNOUNCES SATELLITE LAUNCH DATE

India will launch its first 150-kilogram satellite in the indigenously designed and built Augmented Satellite Launch Vehicle in September, the Department of Space announced. The three-month delay in launch is the result of heavy damage at the launch center at Sriharikota from a cyclone that ripped the coast of Andhra Pradesh last year.

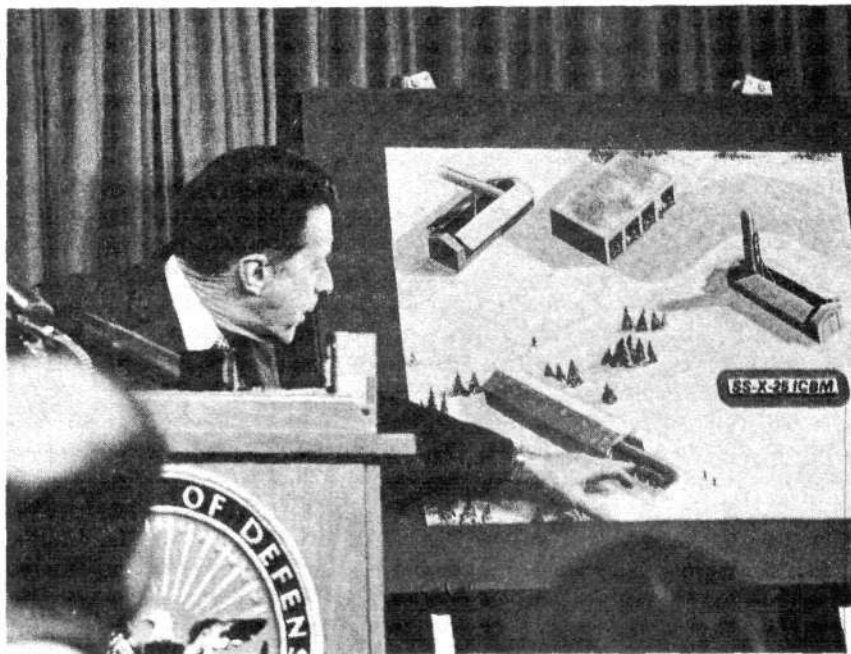
LOUSEWORT LAURELS AWARD TO NATIONAL ACADEMY OF ENGINEERING

This month's Lousewort Laurels award goes to the National Academy of Engineering for its recent report on the U.S. Steel Industry concluding that the industry "probably would never again reach the levels of production or employment it once enjoyed." The report, prepared by a study panel in conjunction with the National Research Council, suffers from the fatal flaw of thinking small. Emphasizing "inevitable shrinkage," the panel notes, "As any economy matures, its demand for steel decreases."



Samak Sundaravej, shown here addressing a Bangkok conference on the Kra Canal jointly sponsored by the Thai Communications Ministry and the FEF.





The Soviets seek a "monopoly" on missile defenses and are "actually developing prototype laser weapons . . . for ballistic missile defense by the late 1980s," Defense Secretary Weinberger told a Washington press conference April 2. Here Weinberger points to an illustration of a facility testing the SS-X-25 ICBM—a Soviet violation of SALT II.

Weinberger on Soviet Military Power:

Soviets Are Ready for Missile Defense 'Breakout'

In an early morning press conference April 2, especially designed to reach a Western European audience, Secretary of Defense Caspar W. Weinberger presented the fourth Pentagon edition of *Soviet Military Power 1985* and some startling facts confirming the Soviets' breakout of the 1972 Anti-Ballistic Missile Defense Treaty with both conventional and beam weapon systems.

According to data and photographs reported publicly for the first time by Secretary Weinberger, the Soviets seek a "monopoly" on missile defenses and they are completing a nationwide conventional ABM system that could "be operational in the late 1980s." Further, Weinberger said, "they have progressed beyond technology research and they're actually developing prototype laser weapons . . . for ballistic

missile defense by the late '80s," while simultaneously maintaining the largest offensive weapons buildup in history.

Soviets Preparing Beam Defenses

Contrary to some news reports, both the Secretary and the Pentagon publication described in stark detail Soviet programs for early deployment of advanced beam weapon missile defenses that the Soviet Union has been working on for more than 20 years.

Soviet Military Power reports: "By the late 1980s, the Soviets could have prototypes for ground-based lasers for ballistic missile defense. . . . The many difficulties in fielding an operational system will require much development time. . . . However, with high priority and some significant risk of failure, the Soviets could skip some testing steps and be ready to deploy a

ground-based laser BMD [Ballistic Missile Defense] by the early-to-mid-1990s. . . . Soviet programs for the development and application of directed-energy technologies to strategic defense have been very vigorous in the past and will continue to be so in the future, irrespective of what the U.S. does about new strategic defense initiatives."

Weinberger emphasized this point using illustrations of Soviet sites: "Some of the most important data in the book relate to laser technology. The Soviet Union's high energy laser program is now much larger than the U. S. effort. It involves more than half a dozen major research and development facilities and test ranges, and the one shown here is at Sary Shagan. It has about 10,000 scientists and engineers devoting full time to this project."

"The importance of it, of course," Weinberger continued, "is that they have progressed beyond technology research and they're actually developing prototype laser weapons. They've already got ground-based lasers that can be used to interfere with American and allied satellites. And they could have prototype space-based antisatellite laser weapons by the end of the decade. They could have prototypes for ground-based lasers for ballistic missile defense by the late 1980s. . . ."

"These are the systems that the Soviets are doing everything they can to block the Americans from proceeding in, and it's quite obvious why they are doing that. It's because they are not only doing it themselves, but they've made very great progress, and they clearly want a monopoly in this field. . . . And even as they move ahead

in the ground-based and eventually space-based laser systems that are the heart of the Strategic Defense Initiative, they are working also on systems that interfere with U.S. and allied satellites.

"Meanwhile, they're doing more than research. They continue to maintain the world's only antisatellite system."

'No Counterpart in the West'

In terms of realizing the key technological base for full-scale laser weapon deployment, the Soviets have apparently demonstrated one of the essential ingredients: a lightweight, mobile, and compact means of high-power electricity generation. As pointed out in *Soviet Military Power*, the Soviets "have developed a rocket-driven magnetohydrodynamic (MHD) generator which produces 15 megawatts of short-term electric power—a device that has no counterpart in the West."

The Soviet Union has long had the world's largest MHD development program. By actually constructing an MHD system that directly converts the high-power heat and thrust of rocket engine exhaust gases into intense pulses of electricity, the Soviet Union has perfected a compact beam power supply that can be used both on Earth and in space to power laser and particle beam systems.

In response to a question about the Soviet nuclear-bomb-powered X-ray laser program, Weinberger commented: "There are a lot of things that we were not able to put in the book. We have in the book . . . the maximum

amount that can be published in this unclassified form."

Offense and 'Civil Defense'

At the same time that the Soviets are spending more on strategic defense than the United States, the Soviet nuclear offensive buildup is awesome. For example, Weinberger revealed: "Activities at the ICBM test range indicate that two additional ICBMs are under development. . . . One . . . is likely to replace the SS-18," the monster battle queen of the Soviet nuclear missile force. This means that the Soviets will have developed and deployed four new types of ICBMs within the same period that it has taken the United States to develop and build one—the MX Peacekeeper.

Most sobering is the Soviet "civil defense" program, which is 100 times larger than that of the United States. In fact, while this nation is destroying its basic steel-making capacity by actually demolishing blast furnaces across the country, the Soviet Union is utilizing its twofold greater steel output to build a "comprehensive and redundant system, composed of more than 1,500 hardened facilities" for "175,000 key personnel" and "extensive sheltering in or near urban areas" for the general population, according to the Pentagon publication.

Soviets Violate 1972 ABM Treaty

Both Weinberger and the 4th edition of the U.S. Defense Department's official review, *Soviet Military Power 1985*, demonstrate how the Soviet Union is continuing its buildup of more conventional ABM, antimissile missile

defenses and the radars that guide them, in direct violation of the U.S.-Soviet 1972 ABM treaty.

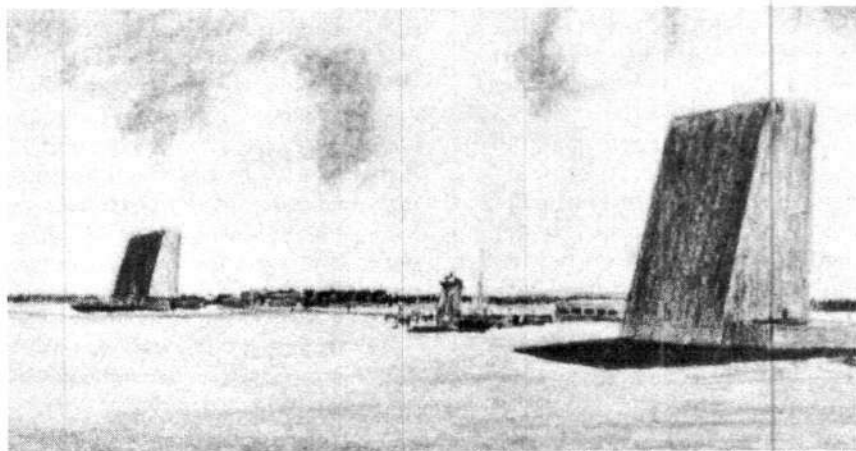
In particular, Weinberger refuted some published reports that the new Soviet radar is not an ABM radar: "The new large, phased array radar for ballistic missiles, early warning, and target tracking under construction at Krasnoyarsk that you see here, a whole series of those well inside the perimeters of the Soviet Union, is designed to close the final gap in their old radars and their modern, phased array radar network. . . ."

"This new radar violates the 1972 ABM treaty. It is not located on the periphery of the Soviet Union. It's not pointed outward—and this complete network of these radars to provide target tracking data for ABM deployments beyond Moscow, which of course is another of the violations of the treaty. It probably will be operational in the late 1980s."

Soviet Military Power elaborates on this: "The new, large phased-array radars under construction in the U.S.S.R., along with the HEN HOUSE, DOG HOUSE, CAT HOUSE, and possibly the Pushkino radar, appear to be designed to provide support for such a widespread ABM defense system. . . . In addition, the Soviets are deploying one surface-to-air missile system, the SA-10, and are flight testing another, the mobile SA-X-12. The SA-X-12 is both a tactical SAM and antitactical ballistic missile. It may have the capability to engage the LANCE and both the Pershing 1 and Pershing 2 ballistic missiles. The SA-10 and SA-X-12 may have the potential to intercept some types of U.S. strategic ballistic missiles as well. These systems could, if properly supported, add significant point-target coverage to a widespread ABM deployment."

In summary, Secretary Weinberger emphasized: "If the Soviets should get a kind of defensive system that we are doing the research on now, and I say they've been working on it a lot longer than we have and in some areas are ahead of us, then you have a very much more dangerous world in which stability would not be one of the factors that you'd be permitted to talk about any longer. . . ."

—Charles B. Stevens



Source: *Soviet Military Power*, Washington, D.C., Department of Defense, 1985, p. 46.

The Soviet large phased-array, early warning, and ballistic missile target-tracking radar at Krasnoyarsk—a violation of the ABM treaty.

Fusion by 1990: The Sandia Ion Beam Program Can Do It!

Recent experimental results at Sandia National Laboratories demonstrate that light ion beam accelerator devices can deliver considerably more than the power necessary for achieving high-gain fusion energy—millions of joules at power densities of 10,000 trillion watts per square centimeter. This means that commercial fusion energy with an inertial confinement fusion device can be realized by the 1990s, despite the general curtailment of the U.S. fusion research budget over the past eight years.

Dr. J. Pace VanDevender, pulsed power sciences director at Sandia, and Professor Ravindra N. Sudan, director of the Cornell University Laboratory of

Plasma Studies, discussed the experimental and theoretical advances underlying this happy prognosis at the April 17-19 conference at the Rochester University Laboratory for Laser Energetics.

Sudan showed that experiments with high-current ion beam pulses over the past decade have demonstrated that such pulses act contrary to the simple-minded pictures presented by anti-beam-weapon spokesmen like Kosta Tsipis at the Massachusetts Institute of Technology. First, instead of diffusing, high-current ion beam pulses tend to self-focus nonlinearly to higher power densities. Second, weak magnetic fields do not interact and change the

trajectory of such high-current beam pulses. Tsipis and other critics say that these results are "impossible."

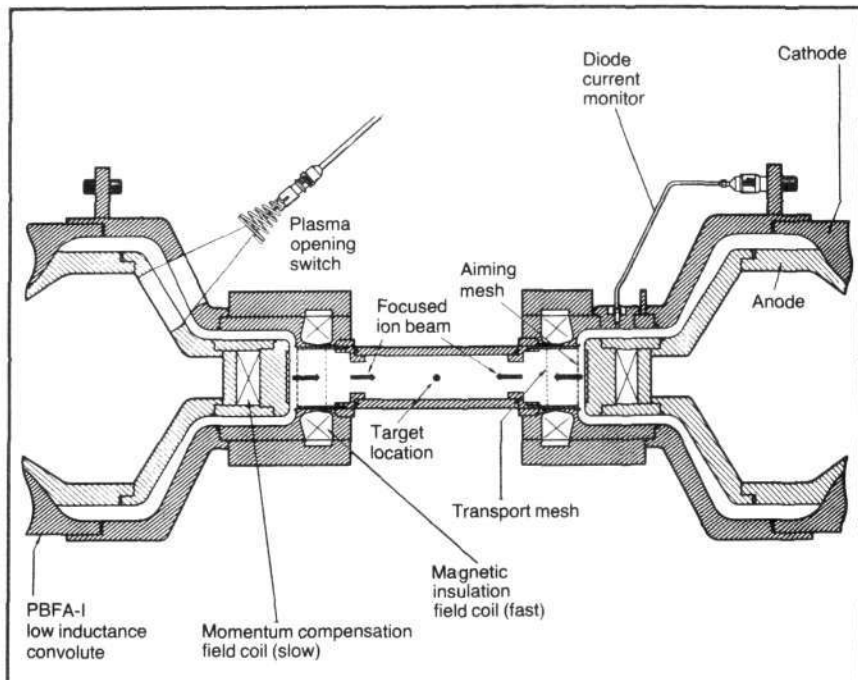
Well Beyond Breakeven

At the Rochester meeting, VanDevender reviewed experiments on Sandia's Proto I device in which 1.5 trillion watts per square centimeter were delivered to a target in May 1984. This spring, Sandia's Particle Beam Fusion Accelerator I, PBFA I, delivered an 8-trillion watt pulse onto a spot 4.0 to 4.5 millimeters in diameter. This demonstrated that the Sandia light ion beam focusing process maintains itself as the current is increased.

Proto I puts out a 1.4 million volt and .4 million amp beam; PBFA I operates at 2 million volts and 4 million amps. PBFA's successor, PBFA II, will demonstrate scaling with voltage, because its lithium ion beam will have 30 million volts and 5 million amps. PBFA II will begin operation in January 1986, and fusion target experiments are scheduled for early 1988.

The recent experimental successes demonstrate that PBFA II has the potential for exceeding its original design specifications by a factor of 100. Thus, PBFA II will be able to go well beyond fusion breakeven, for which it was originally designed.

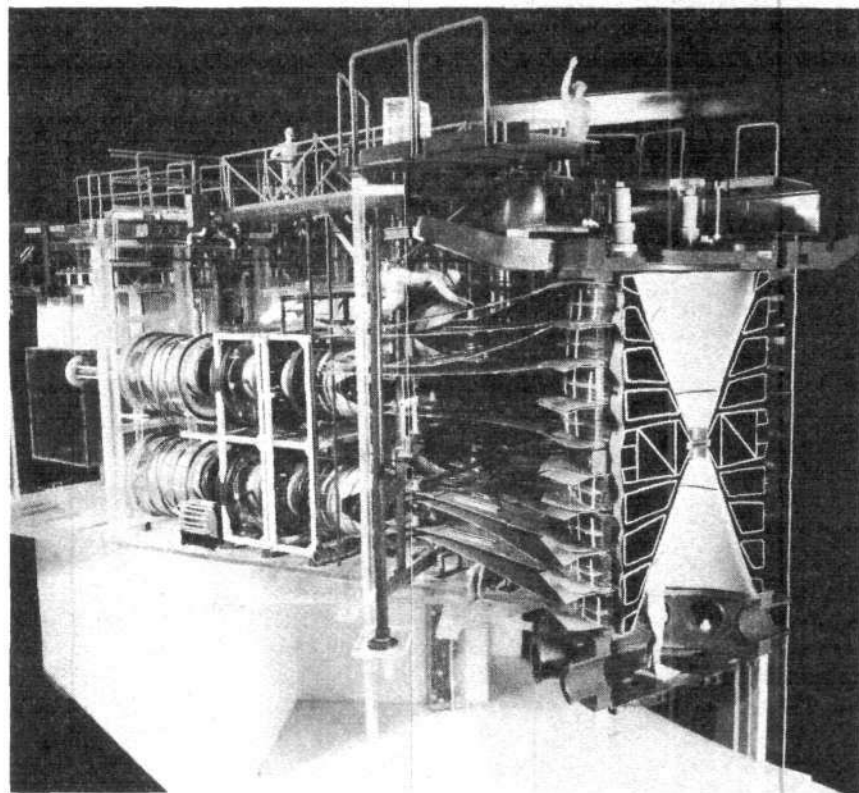
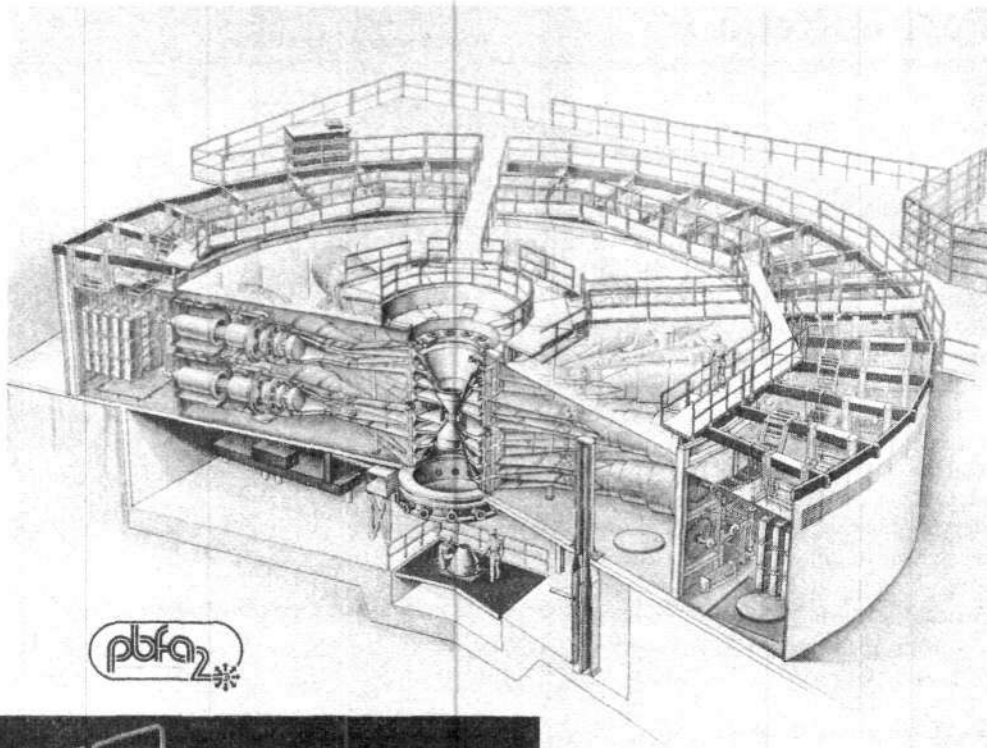
The Sandia program is among the youngest in the fusion field. Beginning in the early 1970s and making use of electron beam accelerators, which were otherwise being utilized to produce intense bursts of X-rays in order to simulate nuclear weapon effects, the Sandia pulsed power effort has placed itself at the forefront of fusion research and on the brink of realizing commercial fusion. In little more than a decade, Sandia converted the inherently high efficiencies and low costs of oil- and water-insulated pulsed-power capacitors and Blumleins into the frontline fusion program, although it has just a minute fraction of the program's resources.



PBFA'S LIGHT ION BEAM DIODE IN CROSS SECTION

This diode, tested on PBFA I, consists of a negative cathode (left-hatched area) and a positive anode (right-hatched area). The geometry and magnetic fields of the diode produce ion beams that propagate toward the target at the center. The aiming mesh is transformed into a plasma as the ion beam passes through it. This plasma acts as a virtual cathode to focus—but not stop—the ion beam as it travels toward the target.

At right, artist's cutaway drawing of Sandia's PBFA-II fusion accelerator, the device expected to reach better than breakeven before 1990. The target chamber is at the center. The model (below) of the PBFA-II shows the oil section (containing Marx generators) at far right; the water section (containing cylindrical components of pulse forming lines section and flat, leaf-like transmission lines); vacuum interface (with conductor stack conductors separated by lucite rings); and diode area at far right.



Sandia National Laboratories

sion energy are generated in the resulting microexplosion; hence, the term high gain.

In many ways, the Sandia particle accelerators are no more complicated than an ordinary spark plug and look very much the same—on a much larger scale. The accelerator experiments begin with a large, high-voltage pulse of electrical current lasting tens of billionths of a second. This is delivered to two pieces of metal that are separated by a vacuum—a kind of glorified vacuum tube diode. One metal piece is called the anode because it has a positive electric charge, and the other the cathode because of its negative charge.

Ordinarily, when the high-voltage, high-current electrical pulse arrives at the diode, electrons would be accelerated from the cathode to the anode and positive ions would be accelerated from the anode to the cathode. Because the electrons are thousands of times lighter than ions, they make it across first, thus generating an electron beam. A thin foil, properly placed at the anode, permits the electron beam to pass out of the machine.

Alternatively, if a magnetic field is

The scientist most responsible for this is the former director of pulsed power at Sandia, Dr. Gerold Yonas, who is now the deputy director and chief scientist for the Strategic Defense Initiative.

How the PBFA Works

In order to achieve high-gain inertial

confinement fusion needed for commercial power generation, it is necessary to deliver energy pulses containing millions of joules at power densities of several hundred trillion watts per square centimeter to a small target containing hydrogen fusion fuel. Hundreds of millions of joules of fu-

placed across the cathode—a method originally suggested by fusion scientist Dr. Friedwardt Winterberg at the Desert Research Lab in Reno, Nev.—the lighter electrons will become trapped and prevented from proceeding to the anode. In this case the positive ions will make it across first, and a high-current, intense ion beam will be formed.

In addition to properly arranging the geometry of the diode to permit the formation of a focused ion beam, a transparent plastic mesh is introduced between the cathode and anode. This mesh is transformed into a plasma—the ionized state of matter—when the electric pulse arrives at the diode. The plasma mesh acts as a “virtual cathode,” which evens out the intense electric field within the diode and therefore results in an even acceleration of the ions. Thus, the chief moving parts of the Sandia particle beam accelerators are a plasma!

Another plasma-engineered improvement is to use intense bursts of extreme ultraviolet radiation to pre-ionize the surface of the anode. This allows the more efficient and rapid formation of the ion beam when the electrical pulse arrives.

Commercial Prospects

Although many technical hurdles remain for converting the scientific demonstration of light ion beam fusion into a practical, economical power plant, the pulsed-power technology upon which this approach to fusion is based has made major advances over the past decade, and the Strategic Defense Initiative should accelerate this rate of progress. Pulsed power has always operated with high efficiencies—better than 30 percent of the input electrical power is converted into ion beam output. Already advances in high-power switching are clearing the way for achieving the rapid refiring rates needed for power plants.

The most significant problem to solve is that of propagating the ion beam over a sufficient distance in order to decouple the beam generating diode from the fusion microexplosion, and here the continuing work on the beam defense program is pointing to solutions. In any case, the future for light ion beam fusion is bright.

—Charles B. Stevens

Los Alamos, EG&G Report New Data for Muon-Induced ‘Cold’ Fusion

Los Alamos National Laboratory in New Mexico and EG&G in Idaho report that the latest experiments with muon-induced fusion have increased the number of fusion reactions produced by just one muon from 100 to 160. And the scientists carrying out these experiments expect to soon increase this number to more than 300.

More significant, the Los Alamos experimental results are demonstrating new atomic and molecular processes not predicted by the currently accepted theory, indicating that the efficiency of muon-catalyzed fusion can be substantially increased above even these levels. Simultaneously, accelerator scientists at Lawrence Livermore National Lab and Los Alamos are developing new technology and techniques that promise to decrease the energy cost of muon generation by as much as a factor of 100. The combined result would produce substantial energy gain for muon-catalyzed fusion.

Scientists from Los Alamos National Lab and EG&G presented the latest results from experiments with muon-catalyzed fusion at the Washington, D.C. spring meeting of the American Physical Society in April.

How Muon Fusion Works

Until a few years ago, it was believed that no more than one fusion reaction could be catalyzed by one muon. But last year, experiments sparked by a new theory developed by Soviet scientists, showed that a single muon would catalyze more than 100 fusion reactions.

Ordinarily, generating nuclear fusion reactions requires heating hydrogen fuel to tens of millions of degrees Celsius. But by using muons—short-lived, heavy electrons that are produced in charged particle beam accelerators—as a catalyst, “cold” fusion can be produced in molecules at temperatures of less than a few thousand degrees.

When ions are accelerated to ex-

tremely high velocities and energies and collide, they disintegrate into a large number of subnuclear entities often misnamed “elementary particles.” These collision-generated entities are usually short-lived. Chief among them are mesons, which rapidly decay into muons, which have lifetimes no more than a few millionths of a second. The muon then decays into a stable electron.

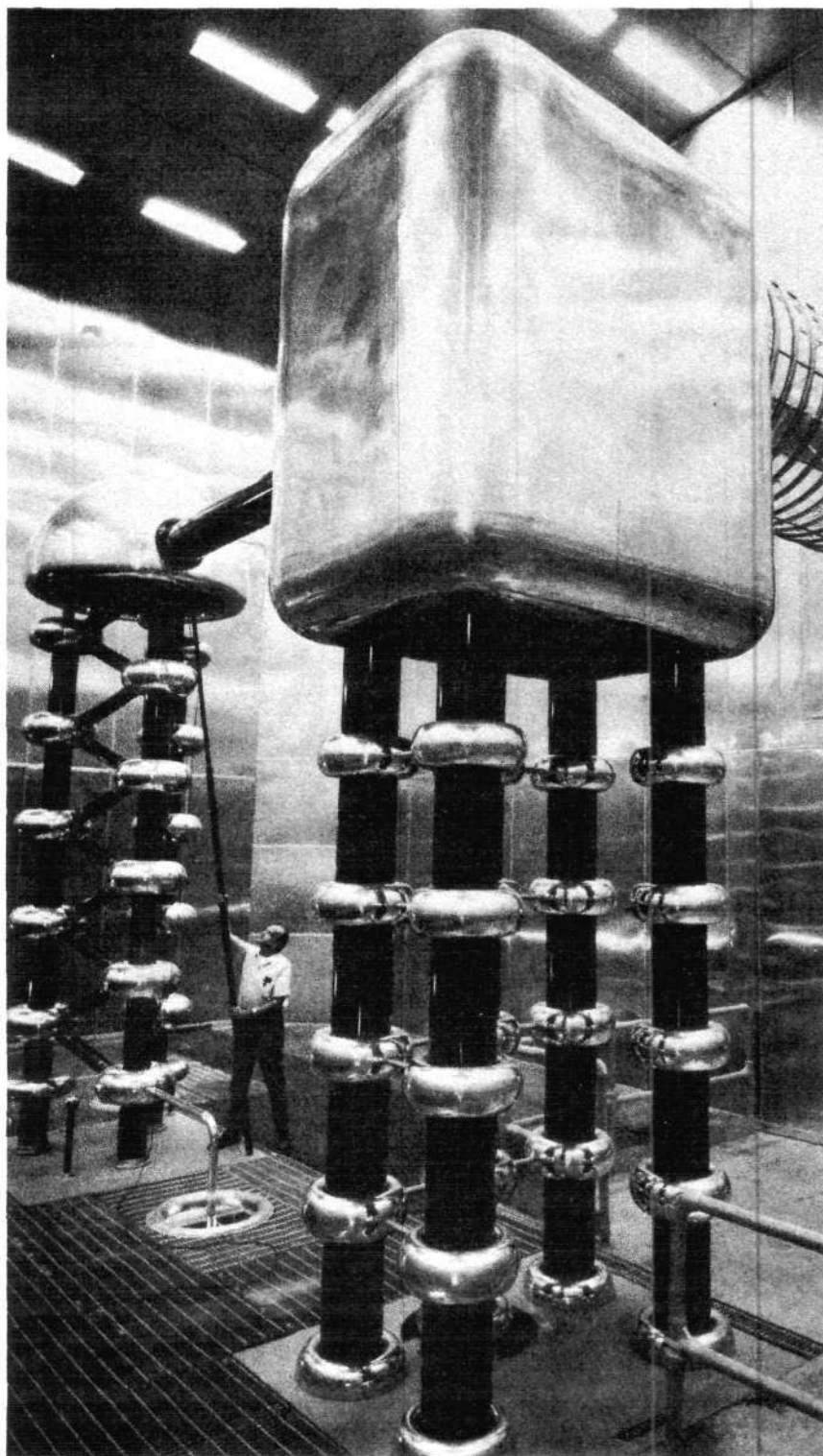
Before it decays, however, the muon acts like a heavy electron, weighing about 200 times more. When the muon takes the place of an electron in an atom, its atomic orbit is hundreds of times smaller, because of its greater mass. This makes the atom much smaller. For example, if people had muons instead of electrons in their atoms, they would be only about a half an inch tall.

In the experiments at the Los Alamos Meson Physics Facility, the accelerator-generated muon beam is injected into a metal chamber containing liquid hydrogen fusion fuel; that is, the heavy isotopes of hydrogen, deuterium and tritium.

The muon replaces an electron in a tritium atom. This small atom then resonantly penetrates a deuterium-deuterium or deuterium-tritium molecule within 5 billionths of a second. The smaller orbit of the muon causes the two nuclei of the deuterium and tritium in the molecule to come closer together, producing nuclear fusion within a trillionth of a second. The small orbit of the negatively charged muon “shields” the two positively charged nuclei from their large, mutual electrostatic repulsion.

Latest Research

In determining the efficiency of muon-catalyzed fusion—the number of fusion reactions generated per muon—both the dynamics of the formation of muon atoms and molecules, and the various paths by which the



Los Alamos National Laboratory

Particles receive their first boost in energy (to 750 keV) in this Cockcroft-Walton generator at the Los Alamos Meson Physics facility.

muon can leak out of the reacting chamber must be fully explored.

It was initially believed that upwards of 1 percent of the muons would be

carried out of the reaction chamber by fusion reaction products in a loss process called alpha sticking. But the Los Alamos experiments now show that the

alpha sticking fraction is less than one third of 1 percent.

In terms of atomic and molecular processes, the Los Alamos investigations have confirmed the Soviet theory of rapid, resonant molecular formation. And it has been found that the rate of molecular formation continues to increase with increasing fuel temperature and density. In particular, the molecule formation rate increases with increasing concentration of tritium.

Most significant, Los Alamos scientists have discovered new, beneficial molecular processes that are not predicted by the Soviet theory. It was previously believed that muonized atoms would have to significantly slow down by colliding with other atoms before they could resonantly penetrate hydrogen molecules.

This slowing down took up valuable time in the short life of the muon. But Los Alamos results show that muonized atoms do not have to slow down to penetrate molecules.

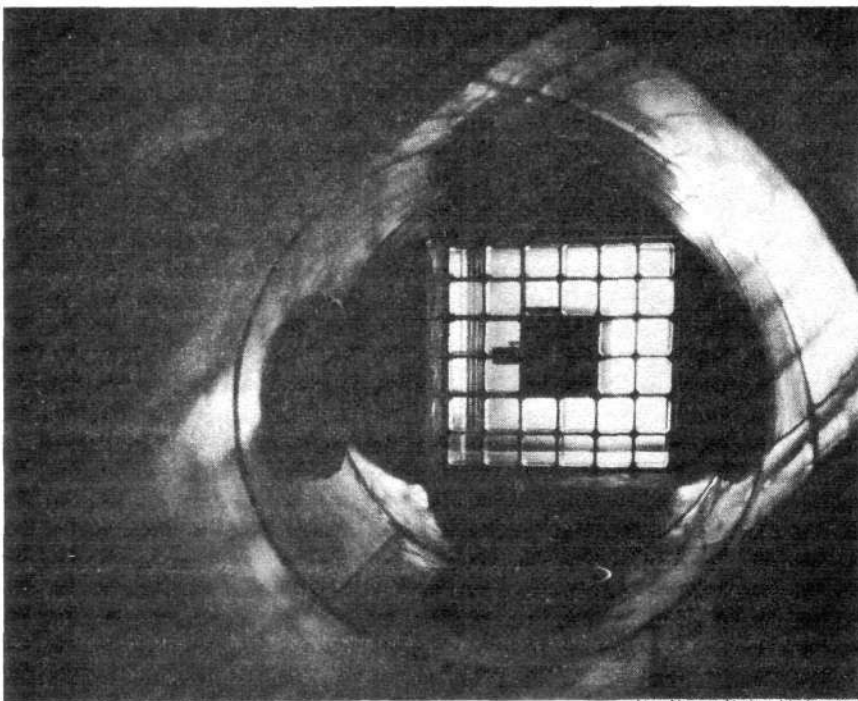
More generally, these careful Los Alamos measurements are detecting an altogether new array of atomic and molecular processes involved in muon-catalyzed fusion—many of which already appear to have the potential to lead to major improvements in the efficiency of muon fusion.

Future Prospects

Although many practical problems must be overcome to attain economical muon-catalyzed fusion energy generation, the Strategic Defense Initiative is already producing significant technological spinoffs that are making progress toward this goal. For example, Dr. Steve Jones of EG&G reported on efficient, high-current particle beam accelerators like the Los Alamos RFQ, and there are innovative muon-production techniques being investigated by Lawrence Livermore's Dr. George Chapline, the scientist who received the Lawrence Prize for developing the X-ray laser.

It is likely that economic feasibility will first be demonstrated for using muon-catalyzed fusion as part of a fission fuel breeding facility. There both the muon fusion and the accelerator-generated neutrons would be used to "breed" fuel for existing nuclear fission electric power reactors.

—Charles B. Stevens



Los Alamos National Laboratory

Aurora put out 10,500 joules of .248-micron "blue" ultraviolet laser light within 500 billionths of a second—a power of approximately 20 billion watts. Its efficiency and high repetition rates make it a prime candidate for laser fusion and missile defense. Shown is the first burst of blue light from Aurora.

Aurora Laser Hits Record 20-Billion Watts

The Aurora laser at Los Alamos National Laboratory has achieved a record output of 10,500 joules at a power level of about 20 billion watts. This advance, announced by Dr. Damon Giovanielli, deputy associate director for fusion research and applications at Los Alamos, can immediately lead to the high-power systems needed to harness nuclear fusion energy and provide a reliable defense against nuclear-tipped missiles.

In addition to furnishing the technology for these major applications, the Aurora krypton fluoride excimer, "the largest ultraviolet laser of its kind in the world," will also provide the essential tool for research on the scientific frontiers of laser chemistry, X-ray laser development, and nonlinear spectroscopy.

Giovanielli presented the details of

this advance in efficient, low-cost, short-wavelength lasers at the April 19 technical symposium at the University of Rochester on "Lasers and Particle Beams for Fusion and Strategic Defense."

How Aurora Works

The Aurora is an electron-beam-driven excimer laser in which krypton (Kr) and fluoride (F) gas at high pressures are irradiated with a high-power electron beam. The incident electrons cause the Kr₂ and F₂ molecules to ionize and re-form as excited KrF molecules or "excimers." Because of the high energy density of the KrF excimer, it lases at a high-frequency, short-wavelength—.248 millions of a meter—which is virtually at the limits of what ordinary optics (mirrors and lenses) can reflect and transmit.

The shorter the wavelength of a las-

er, the longer the distance over which it can be tightly focused and the more intensely it will interact with matter. As a direct result of these properties, and the fact that it can reach 10 percent operating efficiencies with extremely high repetition rates (hundreds to thousands of shots per second), the KrF excimer laser is one of the best candidates for both laser fusion power plants and missile defense.

In the latest experiments, Aurora put out 10,500 joules of .248-micron "blue" ultraviolet laser light within 500 billionths of a second—a power of approximately 20 billion watts. Los Alamos scientists plan to upgrade the laser's power 48-fold in the near future using the concept of *multiplexing*. The idea is that the single 500-billionths-of-a-second laser pulse will be broken up into 48 10-billionths-of-a-second pulses that can be optically directed to arrive simultaneously at a target. In this way, the laser pulse is "compressed" in time 48-fold, and its power density is increased 48 times.

Missile Defense Applications

Dr. Robert Hunter of Western Research Corporation, the chief contractor on Aurora, reviewed at the Rochester meeting how optical multiplexing will primarily be utilized in laser fusion applications, while Giovanielli outlined another approach to pulse compression that is slightly less efficient, but has major applications to missile defense—*phase conjugation*.

Using the nonlinear interaction of an incident laser pulse with a gas, the gas can be transformed into an optically reflecting medium in which the "mirror" moves at the speed of light. This results in both laser pulse compression to higher powers and improvement in the beam's optical quality. Furthermore, this phase conjugation process can result in a shifting of the laser light wavelength in order to attain the best wavelength for propagation through the Earth's atmosphere.

Phase conjugation can be also be self-initiated. For example, the KrF laser is operated in a low-power mode with a diffuse pulse output spread over

Continued on page 19

National Labs Announce Advances In the Ultimate Laser: FEL

Major advances in work to perfect the ultimate laser, the free electron laser or FEL, were announced by scientists from Lawrence Livermore and Los Alamos national laboratories at an April 17-19 symposium at Rochester University. The Livermore results indicate that a large, ground-based FEL prototype beam weapon, utilizing orbiting mirrors, can be built before the end of this decade. Los Alamos revealed that their compact FEL would be capable of being placed in space, but a prototype will probably be ready sometime later than that of the ground-based Livermore FEL.

The Livermore FEL is actually a laser amplifier that greatly multiplies the power of a conventional laser input. The Los Alamos system is a true FEL, which needs no other input. Both are based on converting highly accelerated electron beams into laser light.

The Livermore FEL amplifier experiments are designed to demonstrate that laser light can be extracted rapidly,

in a single pass, from the electron-beam, while the Los Alamos system is based on relatively slow extraction of the laser light from an electron-beam passing continuously through the FEL. Livermore appears to have demonstrated the crucial concept of a "tapered wiggler," which is a prerequisite for significant amplification.

Space Basing

The Los Alamos FEL, because of its relatively slow extraction, has a potentially high efficiency and can therefore make a compact system capable of being based in space. Recent Los Alamos experiments have achieved 10 megawatt outputs, demonstrating the principles of the pure FEL concept at high powers.

What makes the FEL the ultimate laser is that it has the potential of mastering the entire electromagnetic spectrum, providing an efficient means of defense as well as revolutionizing science and industry with its capability for molecular engineering.

When an electric charge like an electron changes the direction of its motion, it generates an electromagnetic wave. For example, if many electrons—in other words, an electric current—are made to move back and forth between the ends of a 1-meter-long metal rod, this will generate an electromagnetic wave. In very general terms, the electromagnetic wave will have a 1-meter-long wavelength. To make shorter wavelengths, the antenna—the rod—must be made smaller.

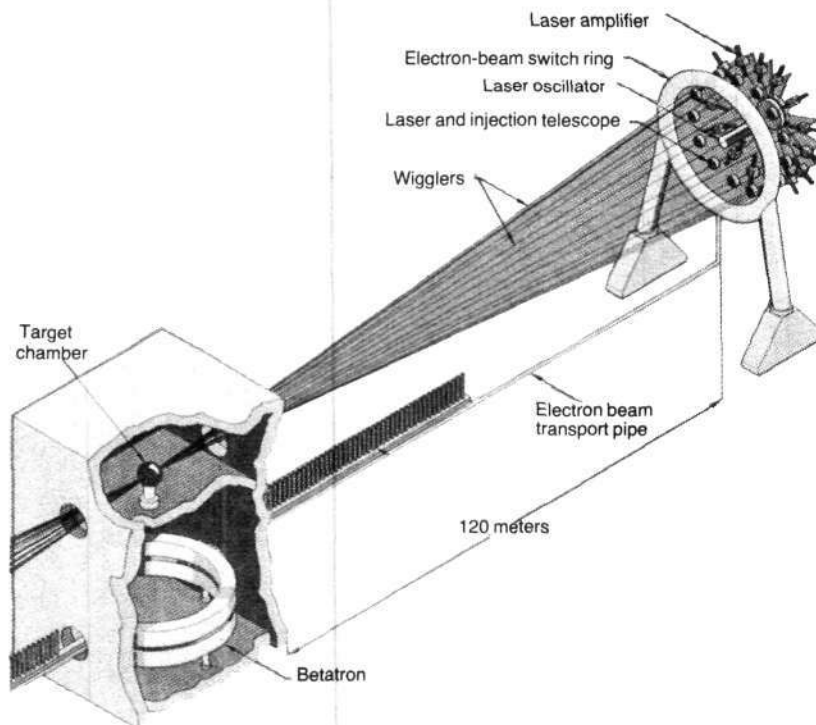
In the FEL, a free electron beam is used instead of an antenna. Magnetic fields cause the electrons to oscillate (wiggle) back and forth. But when the electrons are relativistic, traveling at nearly the speed of light, the electron beam is relativistic and the size of the wiggle is relativistically contracted. This relativistic contraction shortens the effective wavelength of the emitted electromagnetic radiation. The same phenomenon would occur if a regular antenna were moving at near the speed of light, but it is much easier to accelerate free electrons to light speeds.

The Livermore and Los Alamos FELs

The main difference between the Livermore and Los Alamos FELs is that the Livermore system is not truly a free

LAWRENCE LIVERMORE'S DESIGN FOR A FREE ELECTRON LASER FUSION POWER PLANT

In this schematic drawing of a hypothetical power plant, up to 15 FEL amplifiers converge on a fusion target. The wigglers consist of laser pipes surrounded by magnets. The laser preamplifier subsystem consists of up to 15 small krypton-fluorine lasers. The electron source is a betatron. Preaccelerated electrons enter the betatron from a linear-induction accelerator, are accelerated, and exit into a switch ring. Magnetic switches in the ring divide the relatively long accelerator pulse into as many as 15 electron beam pulses. These shortened pulses are then magnetically guided into the wiggler.



electron laser; instead, it is used only to *amplify* a laser beam generated by a more conventional laser, such as the KrF (krypton fluorine). The Livermore FEL amplifier is designed so that the input laser beam can extract a great deal of energy from the relativistic electron beam in a single pass through the FEL wiggler.

In contrast, The Los Alamos FEL is a true free electron laser. Only a small portion of the input relativistic electron beam is transformed into electromagnetic radiation. This laser output is then trapped between two mirrors and the beam is recirculated so that many passes are made through the lasing wiggler chamber. When the pulse reaches sufficient power levels, it is optically switched out of the chamber.

The repetitive extraction and build-up process of the Los Alamos FEL makes it potentially far more efficient and compact.

Recent Breakthroughs

The Livermore FEL has scored a number of recent breakthroughs. Utilizing the Experimental Test Accelerator,

earlier this year Livermore scientists demonstrated the principles of high-power FEL amplifiers in experiments at microwave wavelengths.

More recently, Livermore has carried out experiments that appear to demonstrate that a "tapered" wiggler works. Because the Livermore system is based on a large extraction of the electron beam's energy in a single pass, the electrons are going to be significantly slowed down as they move through the wiggler.

The FEL wavelength output depends on the electron velocity and magnetic field strength. Therefore, to keep the output at the same wavelength as the electron slows, it is necessary to increase the wiggler magnetic field strength—that is, to actually decrease the "wavelength" of the electron oscillation. This means that the actual wiggle of the relativistic electron beam follows a tapered, conical path that relativistically is transformed into an even-wavelength cylindrical path.

On the much larger Livermore Advanced Test Accelerator, scientists have

recently demonstrated a new method of guiding and focusing electron beams. Normally, magnetic fields are used in the accelerator to guide and focus the electron beam as it is accelerated to high velocities. With the newly developed Antigone concept, a low-pressure gas is introduced into the accelerator vacuum chamber and a small, pulsed laser is then used to generate a thin, cylindrical plasma in this gas.

The plasma both guides and focuses the electron beam through the accelerator. The same principle has also been demonstrated for propagation of the relativistic electron beam through the atmosphere itself. Thus the Livermore FEL could do double duty: first as a laser to intercept missiles in their boost phase, then as a particle beam weapon in which the beam is directed onto warheads as they approach the United States.

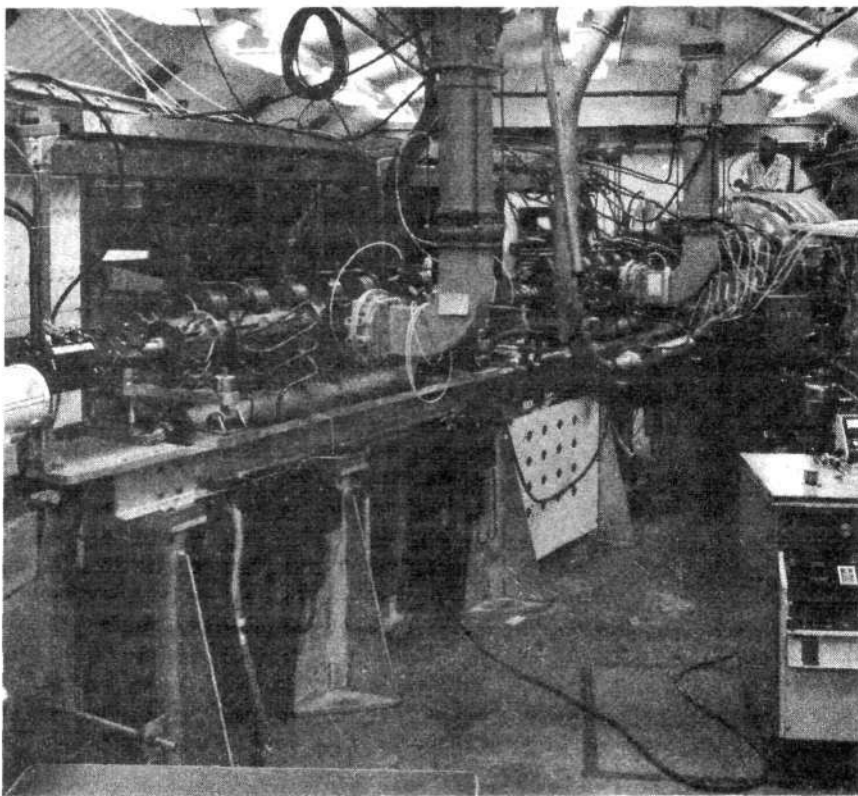
The Livermore ATA will be used to demonstrate high power FEL operation at infrared wavelengths within the coming year. The next stage will then be the construction of a prototype beam weapon. The same general technology can, with some modifications, be used to build laser fusion power plants (see figure, page 15).

The Los Alamos FEL

The Los Alamos FEL has also demonstrated high-power lasing—upwards of 10 million watts—at the microwave wavelength. Plans for construction of an even more powerful FEL, capable of being tuned to infrared wavelengths, were presented at the Rochester conference. The next step would be the construction of a prototype space-based weapon.

The Los Alamos FEL is not dependent on a conventional laser input and can thus be "tuned" to a wide range of frequencies. It also has intrinsically higher potential efficiencies. These are the prerequisites for revolutionizing current industrial technology. The primary form of energy used in industry today is heat, which is incoherent infrared radiation. The Los Alamos FEL will provide the means for accessing efficiently the entire range of the electromagnetic spectrum—at least that of X-rays to radio waves—coherently and at high power densities.

—Charles B. Stevens



Los Alamos National Laboratory

The Los Alamos free electron laser has achieved 10-megawatt outputs, demonstrating the principles of the pure FEL concept at high powers. Its efficiency and compactness make it a candidate for space basing.

New Laser Technology Upgrades SLBM Effectiveness

New developments in the use of lasers to communicate with submerged submarines will soon make it possible to upgrade the effectiveness of U.S. submarine-launched ballistic missiles (SLBMs), and at the same time allow the near-term deployment of "pop-up" missile-defense systems from submarines.

Strategic Defense Initiative chief Lt. Gen. James A. Abrahamson, testifying before the Senate Armed Services Strategic and Theater Forces Subcommittee in March, reported that the HOE missile-defense system demonstrated by the U.S. Army in June 1984 could be used as a postboost intercept system deployed from forward-based submarines.

"It is important to recognize that we have already demonstrated the practicality of several layers of strategic defense," Abrahamson concluded.

An essential, though not widely reported, contribution to this effort is the work of Dr. Lowell Wood, Lawrence Livermore National Laboratory's leading beam-weapon scientist. Working in collaboration with Dr. John Marling, Wood developed a new means of detecting low-power laser light, so that a small, space-based xenon-chloride laser developed by Northrop will be able to communicate with submerged submarines.

When combined with the Navstar guidance satellites, this new communication system will vastly improve the fighting capabilities of ballistic-missile submarines, by the kind of defensive deployment implied by General Abrahamson, and by raising U.S. nuclear offensive capabilities to a level more commensurate with that of the Soviet Union.

Ballistic Missiles and Communications

Land-based intercontinental ballistic missiles (ICBMs) are now far more militarily effective than SLBMs, because they are far more accurate and easily commanded by secure communication systems. The very elusiveness that makes submerged submarines relatively invulnerable, also makes it more difficult for them to communi-

cate and determine their exact location at any given time.

For this reason, only ICBMs currently offer a versatile means, through rapid retargeting, of destroying hardened military targets in a dynamic military engagement. SLBMs represent primarily a long-response, retaliatory force, which could at most pin down a defender's missiles until the more accurate ICBMs arrived. Therefore, it is evident that the current U.S. strategic nuclear force, which is dominated by SLBM warheads, is primarily designed as a retaliatory force, whereas the Soviet Union has a predominance of ICBMs in its nuclear inventory.

The United States is now developing the new Trident SLBM that, in conjunction with the currently deployed Navstar satellite system, will bring SLBM accuracy up to the level of land-based ICBMs. Signals from several of the Navstar satellites provide the means for blind-launched SLBMs to get a fix on their own location and that of their targets, with an accuracy of less than a meter. The SLBM determines its location when it emerges from the ocean and receives the Navstar satellites' signals. It then can zero in on preprogrammed targets with an accuracy equaling that of land-based ICBMs.

To make SLBMs the equal of ICBMs in dynamic war-fighting, however, it is essential that there be a secure means to communicate that will not make the subs open to easy detection. One method pursued for several years was that of utilizing extremely long wavelength electromagnetic waves that could penetrate the Earth and ocean. But this system is highly vulnerable to attack, since it relies on a massive antenna. Its communication data-rate is very small.

For a long time it has been recognized that lasers could provide the means for reliable and high data-rate submarine communication. Tuned to the proper blue-green wavelength, laser light pulses can penetrate the atmosphere, clouds, and a significant depth of ocean. Originally, the idea that was pursued was to utilize an ex-



U.S. Army

With the aid of a new laser communication technique, the HOE (Homing Overlay Experiment) can be used as a postboost intercept system deployed from forward-based submarines. The U.S. Army HOE is shown here streaking through the sky in June 1984 in a test flight. Minutes later it destroyed its ICBM target.

tremely high-power, ground-based or air-based laser, which would have its beam relayed to a submerged submarine by a space-based orbiting mirror. This system was abandoned, however, when it was realized that it would be highly vulnerable and costly; the Navy returned to the long-wavelength electromagnetic antenna approach.

Then in the late 1970s, Wood proposed that by utilizing a new method of laser light detection, small space-based lasers could achieve submarine communication at low costs and with a high degree of reliability.

Wood is the "young scientist" Dr. Edward Teller has referred to as the

Continued on page 19

An Electron-Beam 'Weapon' To Zap Pollutants

"Star Wars is right here. We're putting technology similar to what's being developed by the Department of Defense to good use—zapping pollutants." This is how Robert McKnight, chief environmental engineer for Indianapolis Power and Light Co., describes the new electron-beam smokestack cleaning system, ready to be "turned on" this month at the coal-fired E.W. Stout electricity plant in Indianapolis.

The new electron beam process is a \$6.2 million pilot project, designed to remove 90 percent of the sulphur dioxide and nitrogen oxide emissions more effectively and cheaply than the conventional limestone wet scrubber processes. In addition, the electron-beam technology produces immediately usable nitrogen fertilizer as its only by-product, instead of the usual sludge that requires storage and disposal.

Full application of the electron-beam technology in the fossil fuel power sector would totally eliminate the basis for outcry over acid rain—although it's important to keep in mind that a high percentage of this acid rain originates not from industry but from volcanic and other sources.

When the switch is thrown this month in Indianapolis, this will be the first time such a revolutionary system is put in use on a generating station. In Japan, Nippon Steel has successfully removed 90 percent of nitrogen oxide, and 80 percent of sulphur oxides on its test steel mill stacks.

'Speed Up Mother Nature'

The electron beam process was developed by Ebara International Corp. and tested in steel and other manufacturing plants in Japan. Ebara's president, Norman Frank, says it is intended to "speed up Mother Nature."

The technology is simple. Combustion gases from the boiler are first routed into a "spray tower" where water and ammonia are added. The mixture then moves into the process chamber, a three-story steel alloy structure. At the top of the chamber, two electron beam guns hit the gases, and produce a chemical reaction between the sul-



Indiana Lt. Governor John Mutz addressing the groundbreaking ceremony for the electron beam flue gas treatment process. The electron beam process is cheaper and more effective than conventional scrubbers, and it creates fertilizer as a by-product.

phur, the nitrogen gases, and ammonia.

The result is a valuable mixture of ammonium nitrate and ammonium sulphate immediately usable as convenient powdered fertilizer. The solid by-products are removed in the pulse jet baghouse, and sent by pneumatic conveyor system to a storage tank for transfer to a fertilizer facility. The clean flue gas is sent to the smokestack.

The Ebara system is easier to add to existing power plants than conventional wet scrubber technologies. The demonstration model structure shown in the photograph was built within the last year. However, because the electron-beam apparatus is not being mass produced, the current system is still relatively costly.

SDI will Bring Down Tech Costs

The Tennessee Valley Authority estimates that the current costs would be about \$427 a kilowatt of power plant capacity—with the electron-beam-gun costing \$6.17 per watt. In comparison,

current limestone scrubbing systems cost \$175 to \$185 a kilowatt. If the electron-beam-gun cost decreases, the Ebara process will go down to \$157 per kilowatt and lower. This depends on mass production of the electron-beam-gun apparatus coming down to less than \$1.50 per watt. A gearup of the Strategic Defense Initiative and its technology spinoffs would bring the costs of such technologies way down.

As Ebara president Frank commented, "When they [electron-beam-gun manufacturers] can make more than one or two at a time, then it will bring down the price."

In addition, the fertilizer by-product can be sold for \$70 a ton. The Indianapolis plant will produce about 6 pounds of fertilizer a day. Many developing nations have been requesting information on the process because of the fertilizer advantage, and in hopes of the technology cost savings to come from the SDI mobilization.

—Marcia Merry

Laser Technology Upgrades SLBM Effectiveness

Continued from page 17

one who convinced him that beam weapon defense against ballistic missiles was feasible. Wood has made major contributions to laser fusion and X-ray laser development, and heads the most outstanding group of scientists currently researching the means to make offensive nuclear weapons obsolete.

A Laser Filter System

The key to making cheap, invulnerable laser-submarine communication possible was developed by John Marling while working at Livermore with Wood. It is based on the fact that cesium atoms are highly responsive to particular wavelengths of light. By combining a series of light filters with cesium gas, Marling realized the scientific basis for developing an extremely sensitive atomic resonance laser light detector.

The detector consists of a blue filter through which light passes, permitting only the desired blue-green-range wavelength to enter. This filtered light then passes through a cesium gas cell. The cesium absorbs only the .459-micron laser wavelength radiation, and it

reemits this absorbed radiation in the infrared wavelength range. Since infrared wavelengths had been filtered out by the first blue filter, the only infrared radiation within the cell would derive from absorbed laser light.

Therefore, by placing an infrared filter at the exit of the cell, all of the blue-green wavelength range would be filtered out, leaving just the infrared signal wavelength deriving from the cesium atoms that had been excited by the .459-micron laser light.

The result is that a deeply submerged submarine is able to detect a faint modulated signal from an orbiting, moderate-power laser, despite bright sunlight, turbid waters, or heavy cloud cover.

In addition to encouraging and collaborating with Marling, Wood mounted a campaign on Capitol Hill to generate congressional support for the idea, at a time when Navy officials were extremely skeptical. *Aviation Week and Space Technology* reported Jan. 21 that Lockheed Missiles & Space Co., teamed with Northrop, has been selected to design a xenon-chloride .459-micron laser that is space-qualifiable.

The communication system could be deployed by 1990.

Communications and Defense

The requirements for quick-response communications are far greater for defending against ballistic missiles than for the offense. Rapid retargeting and launch commands are essential to successful interception of barrages of offensive missiles and warheads. The HOE system is based on using a small interceptor rocket, which is deployed by a ballistic missile. The interceptor rocket contains homing devices and guidance computers; it destroys the offensive missile by colliding with it.

Quick-response, Navstar-redirected SLBMs provide the means for achieving pop-up interception of ICBM warheads as they travel through space. More significant, the same SLBMs could deploy pop-up nuclear powered X-ray lasers, which could destroy offensive missiles in their boost phase. Each X-ray laser module could destroy scores of missiles, each of which carries many warheads, before they leave the territory of the Soviet Union.

—Charles B. Stevens

Aurora Laser Hits Record

Continued from page 14

hundreds of square miles. When a missile comes within this diffuse beam, some of the laser light is reflected back through the laser. This reflected light sets off the phase conjugation, and the laser output is then compressed and focused onto the missile. This integration of detection, pointing, and tracking within the laser weapon itself has many operational advantages.

Giovanielli also revealed for the first time that short, high-intensity laser pulses provide new, more efficient means of killing missiles and other offensive nuclear systems. The intense laser pulses produce intense bursts of microwaves, X-rays, and high-energy electrons on the surface of the target. These energy forms readily penetrate the interior of the missile and destroy delicate electronic controls.

Both fusion and strategic defense require about 200 to 400 times more laser energy—that is, pulse outputs of 2 to 4 million joules. As Dr. Reed Jensen, Los Alamos advanced laser program manager, put it, "we know how to do it."

The economics of KrF lasers, as discussed at the Rochester meeting by Hunter, are quite good. Multi-million-joule KrFs can now be built at costs on the order of a \$100 per joule. If the full power KrF attains the sort of repetition rates now being demonstrated in small-scale models—hundreds of shots per second—one could build ground-based systems with both orbiting and pop-up mirrors before the end of this decade. This would give us an economical and robust defense against nuclear-armed missiles and planes.

—Charles B. Stevens

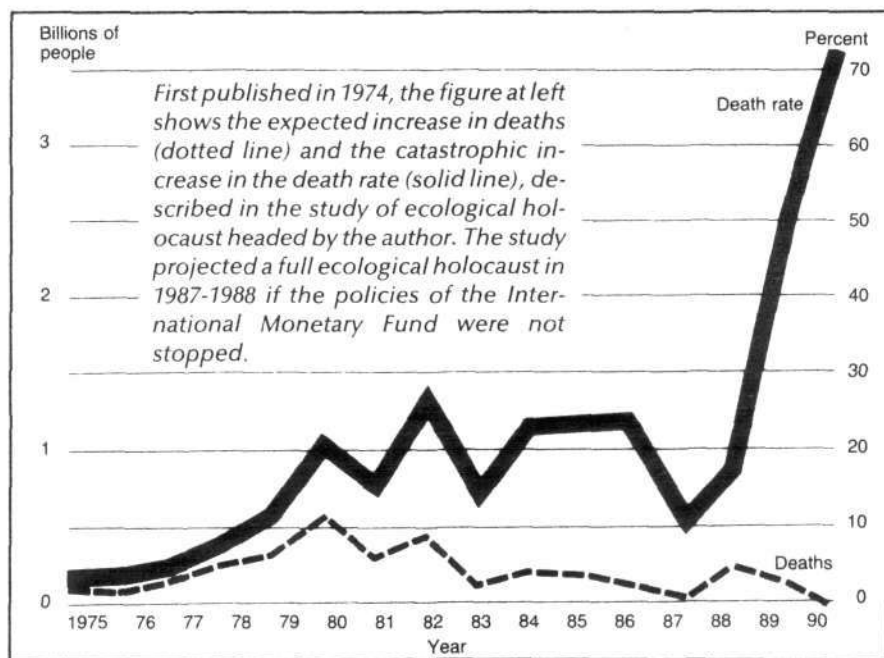
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Unless every resource at the disposal of the international scientific community is mobilized to launch and win a war on disease on the front-line battlefield of Africa, the biosphere itself cannot survive.

Biological Holocaust Races Toward the Point of No Return

by Warren J. Hamerman

The beginning outbreak of disease pandemics is now threatening the lives of hundreds of millions of people worldwide. These pandemics are only one feature of a biological-ecological holocaust that includes simultaneous eruptions of human, animal, and crop disease; abrupt shifts in weather patterns, such as the onset of severe droughts; severe changes in the land surface, such as desertification; and gross perturbations in the large-scale energy flow cycles of the biosphere, as evidenced in sudden shifts in wind patterns.

These phenomena are not merely "unfortunate coincidences." They are part of a single process set in motion by the Malthusian economic policies imposed on the world economy by the International Monetary Fund (IMF) and the World Bank, beginning in the early 1970s. By drastically lowering the energy and food consumption levels in certain areas that they chose to "triage," the IMF and World Bank have brought into being a devastating new situation—full-scale holocaust on the continent of Africa. These Malthusian policies have unleashed *genocide on a scale 100 times*

worse than Hitler!

The scope of the impending holocaust is staggering. Immediately, several heads of state in Africa have warned that millions of the children in their nations will die of disease or famine before the end of the summer. Killer diseases are running rampant throughout the continent, and in other Third World areas where nutrition and health levels have plummeted under depressed economic conditions.

Cholera. Reports from refugee camps in Ethiopia and Sudan are that cholera—for which there is a 10 cents per person cure—is now killing thousands and perhaps hundreds of thousands in the refugee camps monthly. The governments involved have refused to confirm how many are dying, so there are no official figures, just estimates from relief workers.

A minimum of 22 countries of Africa, with a combined population of 311.9 million, are now combating serious cholera epidemics. Since the first appearance of cholera in Africa in 1817, and up through 1970, cholera had never broken out in the interior of the continent. However, in



Victims of drought in Upper Volta in 1973. FAO

1971, cholera raced across Guinea, Mali, Chad, and Niger, northward to the Maghreb and Dakar, Senegal. It spread south of the Equator, appearing in Abidjan, Nigeria, in Zaire, and in East Africa—Zambia, Kenya, Mozambique, and even South Africa. Before 1980, the mortality rate from cholera was 1 to 2 percent, but in the past five years, mortality has jumped to the range of 10 to 15 percent.

Malaria. The World Health Organization conservatively estimates 160 million active cases in Africa alone. The spread of a drug-resistant form of malaria (resistant to chloroquine), *plasmodium falciparum*, the lethal form of malaria, could create a catastrophe.

AIDS (acquired immune deficiency syndrome) is spreading rapidly through the heterosexual communities of Central and East Africa. Scientists at an international conference on infectious diseases in Cairo in early May reported that the disease is spreading as quickly among African heterosexuals as it is among American homosexuals. Nine African countries are seriously affected—Zaire, Rwanda, Burundi, Uganda, Congo, Kenya, Zambia, and Tanzania. In the cities of Zaire, one in every ten persons is carrying the AIDS virus. In Uganda, a research team found 20 percent of the population in one study to be AIDS carriers, with men and women equally affected.

Diarrheal diseases. Massive outbreaks of diarrheal diseases in Asia, Ibero-America, and Africa constitute one of the major killers of weaning-age children.

Hepatitis B. Eighty-five percent of the populations of Africa and China (who generally do not have access to cures) test positive for the lethal strain of this disease. Although not everyone who tests positive will come down with the disease, the pandemic potential is enormous under conditions of generalized breakdown in health.

Trypanosomiasis (sleeping sickness). An uncontrolled epidemic is raging in Africa, with between 22 and 40 different strains of the disease already isolated. Chagas, the related disease in the Americas, is also spreading.

Measles. The fatality rate in Africa for children has jumped from the normal 3 to 10 percent range to the 50 to 70 percent fatality range in the refugee camps.

Yellow fever, meningitis, schistosomiasis, influenza, leishmaniasis, and giardiasis. All are exhibiting severe growth patterns. Plague, which is endemic in key disease epicenters, remains a pressing danger, particularly given the collapse of basic sanitation services and the presence of drought conditions, which force plague-bearing rodents into populated areas. In addition, African rift-valley fever, once just an animal disease, recently became a severe human disease.

Many additional diseases fit this pattern, particularly if one considers animals and plants, as well as man. *Rinderpest, African swine fever, hoof and mouth disease* and *hog cholera*, for example, are on the rise. What becomes primary in looking at this picture, however, is the simultaneous panorama of disease spread, which threatens to take the "bio" out of biosphere. For example, in the Central African area, where tsetse flies are endemic, there is an area already more than several million square miles in total, and growing, where animals cannot survive. This zone is grossly underpopulated by both man and animals, and as the rap-

A Conscious Genocide Policy

Supporters of the IMF conditionalities for the Third World know that the results of these policies will be genocide; that is their purpose. Proponents of "population reduction" programs for the developing sector from Bertrand Russell to his environmentalist followers today have stated, often bluntly, that outbreaks of disease are the most effective way of rapidly reducing the population.

The white population of the world will soon cease to increase. The Asiatic races will be longer, and the negroes still longer, before their birth rate falls sufficiently to make their numbers stable without help of war and pestilence. . . . Until that happens, the benefits aimed at by socialism can only be partially realized, and the less prolific races will have to defend themselves against the more prolific by methods which are disgusting even if they are necessary.

—Bertrand Russell, *Prospects of Industrial Civilization*, 1923

At present the population of the world is increasing at about 58,000 per diem. War, so far, has had no very great effect on this increase, which continued throughout each of the world wars. . . . War has hitherto been disappointing in this respect . . . but perhaps bacteriological war may prove effective. If a Black Death could spread throughout the world once in every generation, survivors could procreate freely without making the world too full. The state of affairs might be unpleasant, but what of it?

—Bertrand Russell, *Impact of Science on Society*, 1953

idly advancing desertification encroaches, this once-fertile area will devolve into pure dust.

Cholera, malaria, and AIDS are perhaps the most publicized of the arsenal of pandemics now assaulting Africa's human population, its fauna, and its flora. At stake is not merely the survival of the continent. Unless every resource at the disposal of the international scientific community is mobilized to launch and win a *war on disease* on the front-line battlefield of Africa, the biosphere itself cannot survive.

A Crisis That Was Predicted in 1974

Contrary to media reports, the current crisis is not an unhappy accident but the lawful outcome of deliberate Malthusian policies. The perpetrators of these hideous policies are not unaware of their crimes; they are quite willing to admit that they view disease and famine as a convenient, effective, and low cost method for culling what they consider to be excess human population (see box).

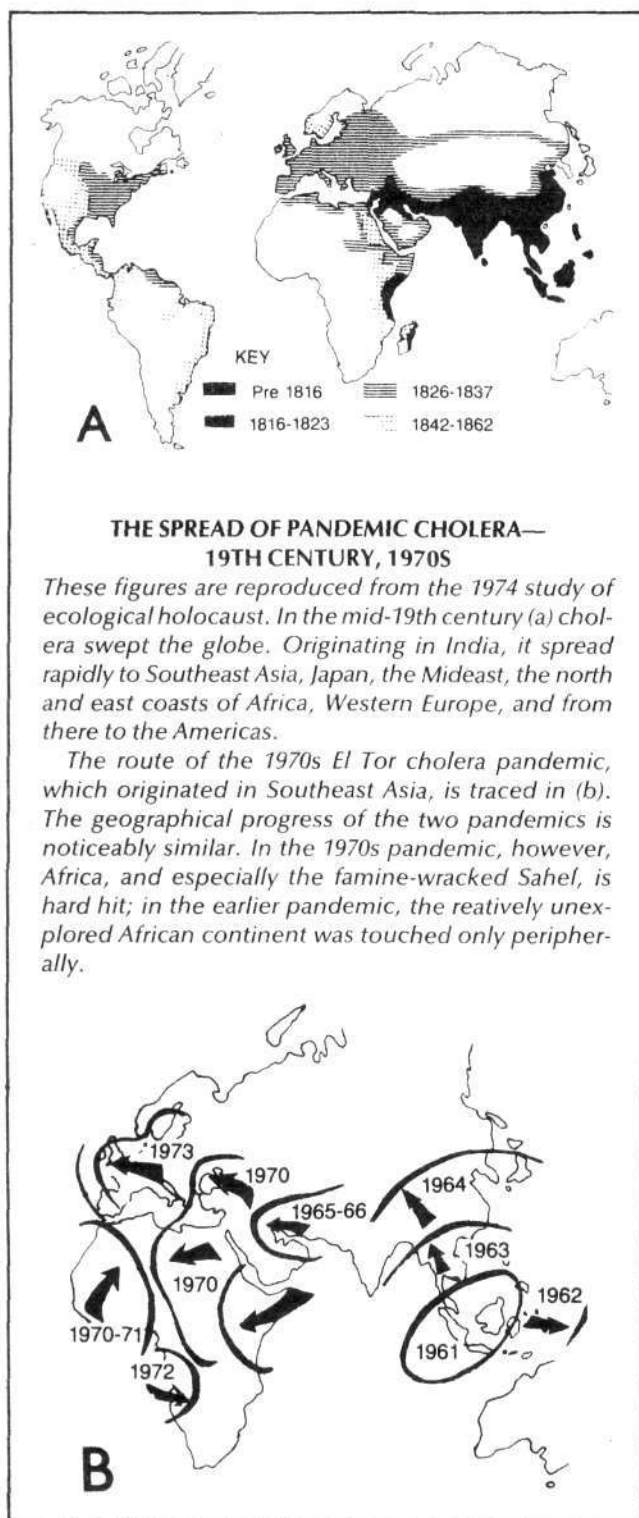
Today's unfolding biological-ecological breakdown was predicted 11 years ago in precise detail by a task force of the National Caucus of Labor Committees established by Lyndon H. LaRouche, Jr. LaRouche initiated the biospheric modeling project in 1974 to study the consequences if the zero-growth policies, then being implemented by the International Monetary Fund and Robert McNamara's World Bank, were not altered. Under my direction, the task force worked from September to December 1974, following the research guidelines of LaRouche. Preliminary results of the study were presented at the founding meeting of the Fusion Energy Foundation in November 1974, and at a December conference of the National Caucus of Labor Committees.

We forecast at that time that a global ecological holocaust would be the inevitable consequence of the policies then being implemented by the IMF and World Bank to slash the food and energy consumption of the world's population. The IMF and World Bank specified the "triaging" of certain nations and entire regions, which were given the designation of the Fourth World. Written off as unworthy of any investment for economic development—"bad credit risks"—these Fourth World nations were established instead as looting zones. At LaRouche's suggestion, the task force investigated what the consequences would be if the IMF and World Bank applied to the world as a whole Adolf Hitler's economic policy of "primitive accumulation" against labor and capital infrastructure.

Specifically, we concluded in that 1974 study that the holocaust would develop in successive waves of famine and disease, ratcheting upwards in a succession of exponential step functions, to a final breakdown phase and a full ecological holocaust in the period 1987-1988. This process would undergo several phase changes, which can be approximated in simplified form by the classic thermodynamic progression from ice to water to steam. The principal global phase changes, prior to the 1987-1988 period, were forecast to occur in 1980, 1982, and 1984, as blight and collapse of basic agricultural production capacity were expected to hit Ibero-America and famine conditions were to strike the underdeveloped nations of Asia, Africa, and Ibero-America.

We forecast that the outbreak of a cholera pandemic in Africa in the 1980s would precede the final breakdown phase. We predicted that in the 1980s, there would be a renewed, virulent outbreak of a cholera pandemic in the region of the famine-wracked Sahel of Africa. Among the distinctive features of our study was the forecast that this cholera pandemic, unlike the one of the 19th century, would be initially centered in Africa. We feared, as well, that at a certain stage the cholera pandemic would be complicated by renewed outbreaks of bubonic plague ("Black Death") and new, mutated, even more deadly forms of disease, which would totally overwhelm the immunological defenses of populations.

In the final phase of ecological holocaust, we predicted that various strains of pandemic diseases would simultaneously attack the world's flora, fauna, and human populations—spreading rapidly throughout Africa, Asia, and Ibero-America, as well as invading the advanced-sector areas of North America, Europe, and Japan. We warned that the very areas that the World Bank and IMF wrote off, classifying



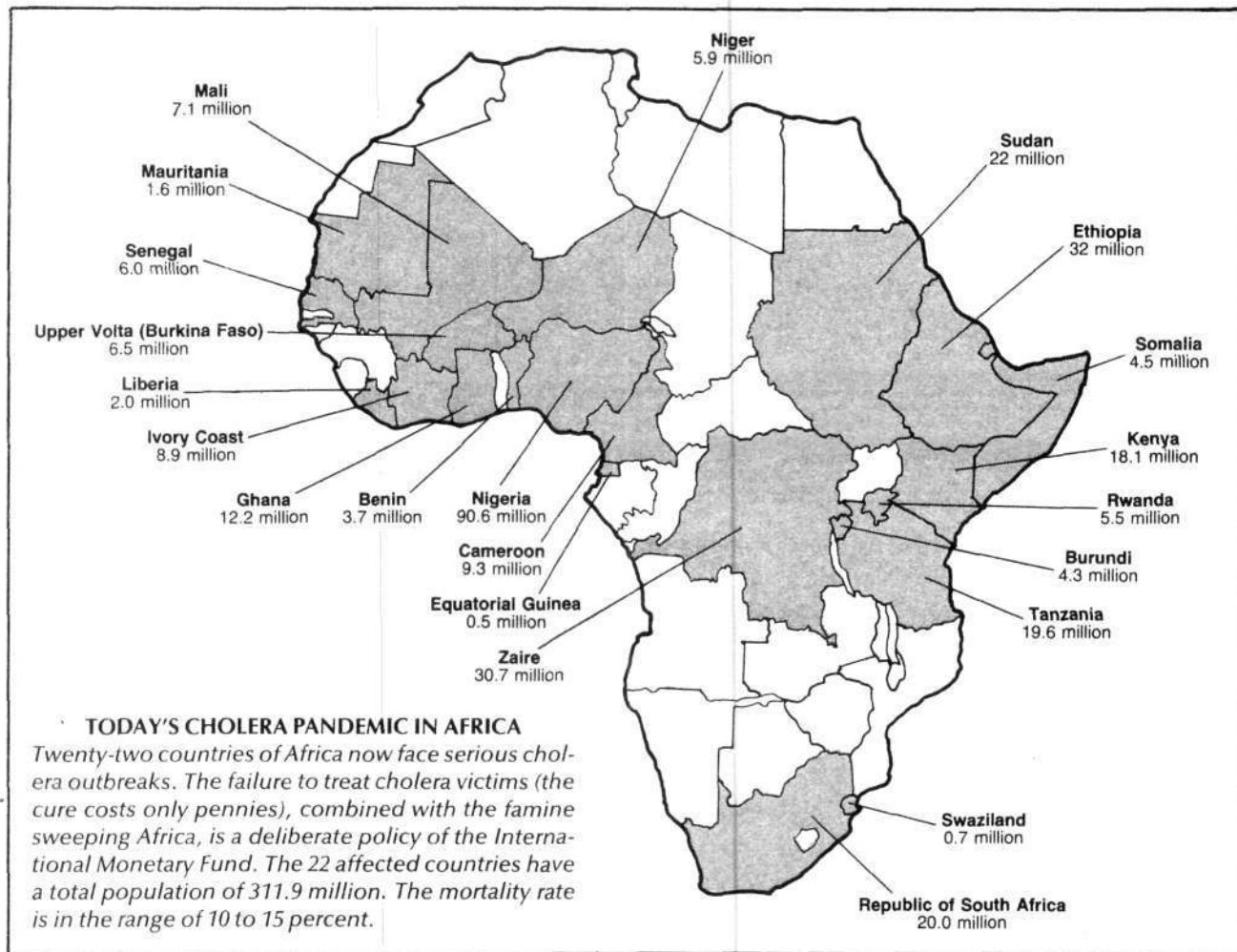
THE SPREAD OF PANDEMIC CHOLERA— 19TH CENTURY, 1970S

These figures are reproduced from the 1974 study of ecological holocaust. In the mid-19th century (a) cholera swept the globe. Originating in India, it spread rapidly to Southeast Asia, Japan, the Mideast, the north and east coasts of Africa, Western Europe, and from there to the Americas.

The route of the 1970s El Tor cholera pandemic, which originated in Southeast Asia, is traced in (b). The geographical progress of the two pandemics is noticeably similar. In the 1970s pandemic, however, Africa, and especially the famine-wracked Sahel, is hard hit; in the earlier pandemic, the relatively unexplored African continent was touched only peripherally.

ing them as "the Fourth World," were the areas where plague and other diseases are endemic—the African Sahel, the Rio de la Plata region of Latin America, northern Brazil/Venezuela, the Middle East, Southeast Asia, and the Indian subcontinent.

The task force presented data estimating that the final phase of ecological holocaust would take a toll far, far great-



er than did the Black Death centuries ago. Specifically, we forecast deaths through the 1987-1988 phase change to be approximately 1 billion persons, including 56,423,000 deaths in West Africa, 10,672,000 deaths in North Africa and the Mideast, 73,428,000 deaths in East Africa, 749,277,000 deaths in Asia, and 81,019,000 deaths in Latin America for a total globally of 970,819,000.

The approximately 140,000,000 deaths we forecast by 1987-1988 in Africa alone is fewer than the number of Africans now threatened with death by the outbreak of pandemics in the precise zone of Africa that we had pinpointed 11 years ago.

Furthermore, we warned that the so-called cost-efficient World Bank programs of Robert McNamara in Ibero-America would generate conditions of laterization and erosion of topsoil. This would result in ecological collapse in the areas of fragile jungle ecology, which would be compounded by the high rainfall. As topsoil and nutrients were washed to the sea, sheets of mineral salt would remain, which, without fertilizer input, would turn once lush jungle into desert. The beginning destruction of a vast jungle area such as the Amazon would have global consequences on world weather patterns.

We said in 1974 that the policies of the IMF and World Bank, then on the drawing boards for global implementa-

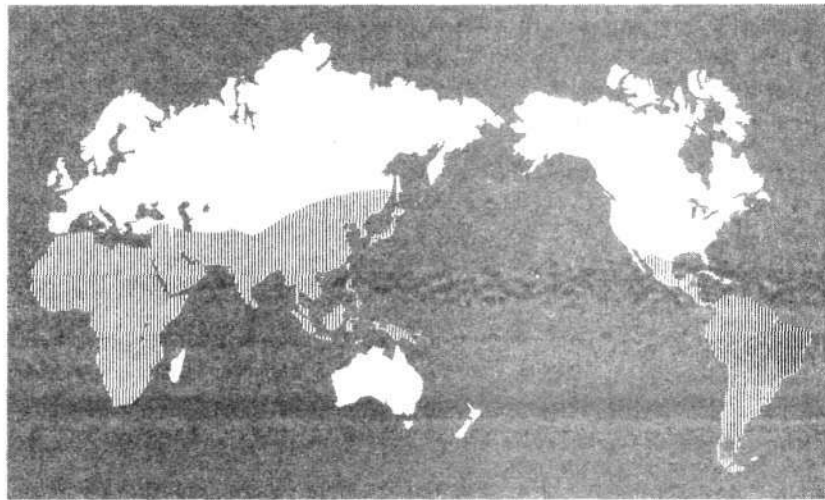
tion, represented merely a "scaling up" of the economic program of Adolf Hitler's economics minister, Hjalmar Schacht. Consequently, those policies would generate a "scaled-up" toll of mass murder and genocide. What is occurring today is what the LaRouche task force warned would be the consequences if Hitler's economic policies were repeated on a worldwide scale.

The Historic Precedents

Over the span of recorded human history, pandemics have inexorably resulted whenever an oligarchy has violated the basis of natural law, that man obey God's injunction to "be fruitful, and multiply, and replenish the earth, and subdue it," and instead has imposed brutal population reduction and austerity regimes. In fact, from the first recorded pandemics in the 14th century B.C., through the outbreak of the IMF's cholera, malaria, and other pandemics today, science can document two basic epidemiological laws of world history:

First, pandemics do not strike productive, expanding populations, but rather follow inevitably as the consequence of decades of oligarchical debt-looting regimes.

Second, although pandemics may first break out among a "weak link" localized population, under conditions of overall austerity regimes, the world's population as a whole

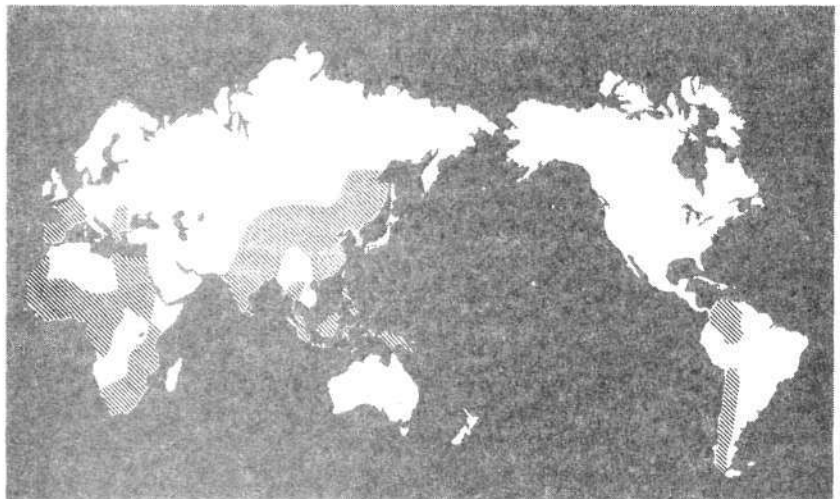


**LACK OF ANIMAL PROTEIN
IN DIET**

A global ecological holocaust is the inevitable consequence of IMF and World Bank policies implemented in the 1970s to slash the food and energy consumption of the world population, triaging entire regions.

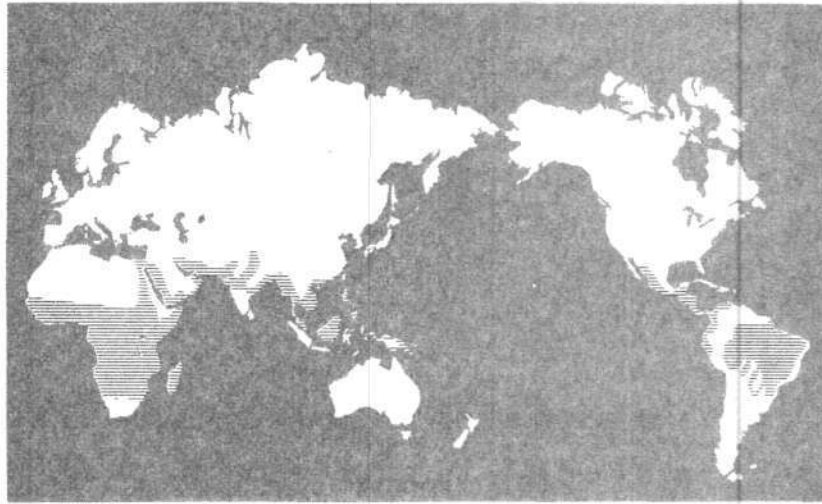
PRIMARY LIVER CANCER

Contrary to environmentalist propaganda that cancer is a disease of well-fed Americans, the data show that deprived populations, whose immune systems are weakened by famine, are extremely vulnerable to certain kinds of cancer.



**KNOWN PLAGUE AREAS AND
PROBABLE FOCI**

Plague is endemic in the areas of the world that the IMF and World Bank have written off, creating ideal conditions for the rapid spread of pandemics as the living standard and ecology plummet downward.



TODAY'S MALARIA PANDEMIC
Experts conservatively estimate that there are 200 million malaria victims worldwide, 160 million of them in Africa alone.

is the target.

There is no lack of historical examples. As the Bible documents, the very basis of Judeo-Christian civilization was defined as an organized movement against famine, drought, and pestilence. After each episode of brutalized slave labor and famine, pestilence ensued. The notorious policies of the Egyptian and Babylonian oligarchies caused severe breakdowns in food supply and led to conditions of uncontrolled famine, drought, and disease.

- After the reign of the brutal Justinian in the 6th century A.D., plague originated in Egypt in A.D. 542 and spread via Byzantium to Turkey and Europe. The "Justinian Plague" is estimated to have caused 100 million deaths.

- In the 14th century, after the looting regimes of the Bardi, Peruzzi, and Acciaiuoli, a pandemic of "the Black Death" broke out, spread across Asia Minor and Africa, and then killed one-third to one-half of the European population! From a medical-scientific standpoint, the 1348 pandemic was not fully ended for at least three centuries—breaking out as epidemic "flare-ups."

- In the 19th century, as a result of the British colonial austerity policies in India in the early 1800s, cholera pandemics swept the globe. Originating in India, the pandemic spread rapidly to Southeast Asia, Japan, the Middle East, the north and east coasts of Africa, and Western Europe, and from there to the Americas. The cholera pandemics at the end of the 19th century occurred simultaneously with the renewed eruption of a massive pandemic of plague, which started in Yunnan in 1892 and reached Bombay in 1896. In India alone it killed 6 million people.

- During the 20th century, protein intake of populations was drastically reduced around the period of the pre-World War I global crisis and the subsequent war, and then again during the Great Depression of the 1930s. Under the brutal policies of British colonialism, India suffered five major famines in the first 20 years of the 20th century alone. The collapse of living standards around World War I was compounded by the outbreak of plant diseases. In 1917, potato blight destroyed 40 percent of the Eastern European and Central European potato crop. The collapse of protein intake in the advanced countries began simultaneously, as

well as the increase of disease potential throughout the world. Waves of epidemics swept Czarist Russia. In 1917, there were epidemics of syphilis and measles.

In 1918, this process peaked, with the outbreak of a virulently mutated strain of influenza—unlike any influenza today—with an enormously high mortality rate. It killed 40 to 50 million people worldwide in six months, an order of magnitude more than the number that had died fighting in the war. Half a million of these deaths were in the United States. During the 1930s Depression, a similar process occurred, again precipitated by policies that drastically reduced the general nutritional levels of populations.

The Black Death

The infamous "Black Death" of the mid-14th century represents the classic case to illustrate the consequences of population-reduction and looting policies. As the available data show for the population of Florence in the century after the death of Dante, the Black Death came *after* the imposition of brutal population-reduction programs. The Florentine population reached a peak in the year 1300, of 105,000. By 1338, it had declined to 90,000, and by 1340 to 75,000. In 1347, before the Black Death, the population of Florence was only 80,000. In other words, the population had already been decimated as a result of the policies carried out by the oligarchy. Furthermore, the long-term effect of this devastation was enormous. *It took 400 years for the population of Florence to recover its population levels of the year 1300.*

For Europe as a whole, varying estimates indicate that between 25 and 50 million died in the initial attack of 1348, not to mention the resurgences of 1361, 1371, and 1382. The plague appeared again and again throughout the 15th century in localized form. Then, from 1663 to 1668, there was a final, devastating, European pandemic flare-up. In 1663, for example, the plague killed 10,000 in Amsterdam out of a population of less than 200,000. In the next year it killed another 24,000 in Amsterdam, spread to Brussels and Flanders, and on to London. Two-thirds of the inhabitants of London fled the city in panic, thereby spreading the disease throughout England. From Flanders, the plague passed to



THE SPREAD OF THE BLACK DEATH IN EUROPE

The Black Death is a classic case of the consequences of population-reduction and looting policies. Between 25 and 50 million people died in Europe in the initial attack of 1348.

--- Approximate area of advance of the plague shown at 6-month intervals

Source: "Autour de la Peste Noire," by Elizabeth Carpentier in *Annales: Economies, Sociétés, Civilisations* (1962), pp. 1062-92.

Westphalia, down the Rhine, into Normandy and Switzerland, reaching Austria in 1668. Throughout the remainder of the 17th century, localized breakouts of the disease still occurred.

What Is an Ecological Holocaust?

In the final phases of ecological holocaust, as described in the 1974 study, disease organisms would have an increasing chance to successfully mutate into more virulent strains, as the resistance of the human population is lowered. Disease mutants would be less likely to die out, because the human population's immunological defense system would break down under conditions of drastically diminished protein intake and collapse of basic irrigation, sanitation, and other health services. Under such conditions, the increase in the total disease population leads to the possibility of an increase in the rate of evolution of any given disease, and then the cycle continues.

The outbreak of epidemics and pandemics, we said, was not limited to the individuals or subpopulations catching or carrying the disease, but, especially under conditions of massive reductions in the living standards of populations, was a threat to the human species as a whole. Furthermore, the disease outbreaks were only one prominent feature of what could become the full-scale collapse of man's biosphere itself, subsuming breakdowns in flora, fauna, natural irrigation, and weather cycles. Our historical studies

showed that under conditions of global economic brutality, full-scale economic/biological breakdown crises occur as one coherent process, and that under pandemic conditions, annual death rates shoot up into the 20-25 percent range. Thus the outbreak of an epidemic in one portion of the human species was in fact a threat to every member of that species. Given the interrelated nature of the world economy in the late 20th century, we anticipated that this feature would be even more pronounced. At Lyndon La-Rouche's suggestion, therefore, we adopted as our basic modeling concept an exponential step-function model for ecological holocaust.

The Current Global Mapping of Pandemics

Comparing the current global disease situation to the model we developed 11 years ago, there is no doubt that we were entirely accurate in forecasting a global biological-ecological "point of no return" in the period leading into 1987-1988. In addition to the human diseases erupting either in pandemic conditions or as epidemics exhibiting unusual qualitative features that suggest that they may either become pandemic or suddenly develop new strains, which may rapidly develop into pandemics, there is evidence of a phase change in the population's receptivity to disease.

The uncontrolled outbreak of AIDS, Acquired Immune Deficiency Syndrome, from a restricted distribution in certain "high risk" populations (homosexuals, drug users, he-

mophiliacs, and Haitians) to the world's population as a whole represents a qualitative indication of the breakdown in the general level of disease resistance of the human population under conditions of collapsing nutrition and sanitation.

To quote Dr. John Seale, a British specialist:

The potential for the spread of AIDS in developing countries is almost unlimited. The overcrowded and unsanitary conditions in which the bulk of the people live, combined with a high frequency of infections, injuries, and sores which break the skin, make blood contact among family members practically inevitable, with the transmission of the virus likely.

In Congo, Rwanda, Uganda, and Zaire there is a high proportion of AIDS antibodies among tested populations. Peter Piot of the Institute of Tropical Medicine in Antwerp states: "On current data we estimate the incidence of AIDS in Kinshasa is about 17 per 100,000. This is a minimal estimate and is comparable to or higher than the rate in San Francisco or New York." The present evidence is that healthy people can fight off exposure to small amounts of the AIDS virus (HTLV-III), while screening studies in the United States indicate that 500,000 to 1 million Americans have been exposed to the virus. However, large exposures, such as contaminated blood transfusions, can infect otherwise healthy people, who are also weakened by the condition requiring transfusion.

Those people whose immune systems are depressed by malnutrition and contamination from poor sanitation are highly susceptible to even small amounts of virus. Reports of nonsexual transmission between family members are just beginning to appear, mostly in Africa, where immunological collapse in the population is most marked. As nutrition, medical care, and sanitation continue to decline in other areas of the world, this can be expected to become more common.

Thus, AIDS is a barometer of the general health of a society, and a sudden nonlinear increase in the disease prevalence, especially among new population groups, indicates a nonlinear breakdown in general health conditions. Medical experts in the United States and elsewhere are already posing the following frightening hypothesis, to use the words of one scientist from Texas: "We may be seeing the beginning of the Black Death of the 20th century." AIDS undergoes rapid mutations into new strains, he said. He reported that this is similar to what happens with African sleeping sickness, which undergoes antigenic changes once per week! Diseases that are so mutational are very difficult to vaccinate against. These diseases are biologically novel and represent a complete challenge to basic biologic science.

Declare a War on Disease

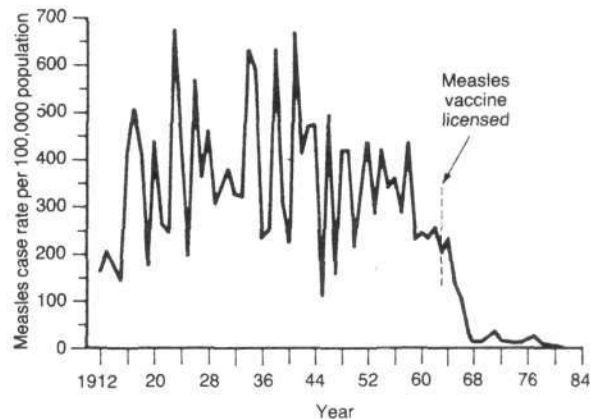
Given the accelerating nature of the current health crisis globally, nothing less than the declaration of a full-scale war on disease, utilizing the most modern military and scientific technologies, is necessary to stop the holocaust. The front line of this global war on disease is the campaign to save Africa.



This question of returning virulence is of the greatest interest in the etiology of infectious diseases. An epidemic in which the enfeeblement of the virus has been attained can flare up again by the restrengthening of the virus under certain circumstances. . . . The plague is a virulent disease peculiar to certain countries. In all these countries its virus must exist, ready to resume its active form whenever the conditions of climate, poverty, or famine give it a fresh opportunity.

—Louis Pasteur, *De l'attenuation des virus et de leur retour a la virulence*, 1881

The existing international health institutions—like the so-called relief agencies, the World Health Organization and the International Red Cross—have proven themselves impotent in the face of the magnitude of the problem. Worse, the so-called feeding stations set up in famine areas in fact function as disease transmission centers—or, to use the more accurate term, extermination camps. Therefore, we propose that the war on disease be conducted through a military chain of command with a general staff composed



CONTROL OF A COMMUNICABLE DISEASE BY IMMUNIZATION IN THE UNITED STATES

These data show starkly how science—and a pro-growth policy can rapidly curb the spread of communicable disease.

Source: *Control of Communicable Diseases in Man*, Abram S. Benenson, ed. (Washington, D.C.: American Public Health Association, 1985).



of representatives of the United States, the developing sector, Western Europe, and Japan, with full respect for the national sovereignty of nations in which the battle lines occur.

Were the commander-in-chief of the United States, for example, to declare a war on disease, the military could launch an immediate airlift of medical personnel, medical supplies, food, and water. Large aircraft such as C-5As and C-141s could be flown into Addis Ababa, Khartoum, and Nairobi to be transloaded to short-landing-strip aircraft, which could be flown to smaller airports. There, in turn, they would be transloaded onto helicopters. Various underutilized specialized units, such as the Army Corps of Engineers, could provide a major role in the war on disease.

The emergency military "invasion" phase of the war on disease must address a finite number of logistical and policy questions, and all planning and logistical functions must function under a strict military command.

The first objective of the war on disease must be to instantly lower the morbidity rates on the front lines—namely, in Africa. Simultaneously, the spread of infection from the disease epicenters must be prevented at the same time as a basis is laid for prevention. Since the accelerating morbidity rates are the direct and indirect consequence of what are euphemistically termed IMF conditionalities, we propose that the first act of the war on disease be a *full-scale moratorium on all IMF conditionalities*. Furthermore, all *debt payments to international financial institutions must*

be frozen, pending reorganized arrangements to be worked out in the context of international negotiations, to allow the concentration of maximum resources upon the task of winning the war on disease.

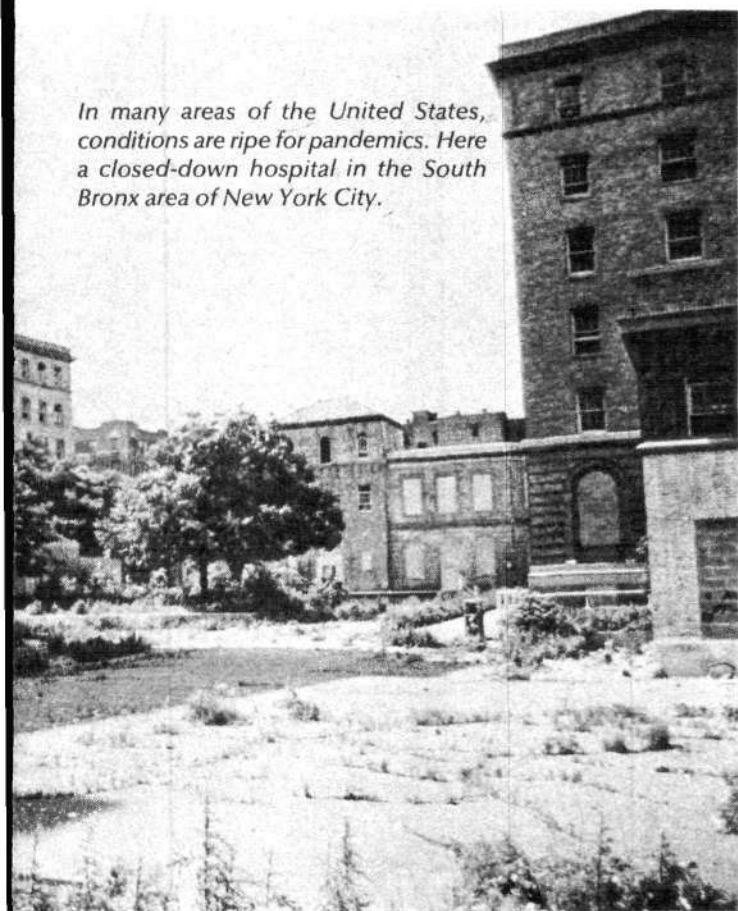
Specifically, the prime objective of protecting the right to life of all human beings can be met through a military mobilization program providing for the following:

Personnel. To supplement military medical units there must be a massive mobilization of qualified doctors, nurses, and paramedics on a world scale. In addition, to recruitment of large numbers of African personnel currently in the United States and Western Europe, nations such as Egypt and India could function as personnel mobilization epicenters.

Food. First, we must bring to an abrupt end the overall protein-energy-vitamin deficiencies of the world's population by providing emergency minimum diets of 1,500-2,000 calories with 50-100 grams of protein daily and a profile of essential vitamins. This would merely alleviate the famine conditions that now exist. In many areas of Africa, starvation diets of 500-1,000 calories now prevail. In Phase 2 of the project, virtually immediately after the raising of the diet to the emergency levels specified, a diet in the range of 2,300-2,500 calories with 100 or more grams of protein and a complete spectrum of vitamins is required. This will allow the necessary immunological resistance to be built up.

Clean and uncontaminated water. Specialized military

In many areas of the United States, conditions are ripe for pandemics. Here a closed-down hospital in the South Bronx area of New York City.



Carlos De Hoyos

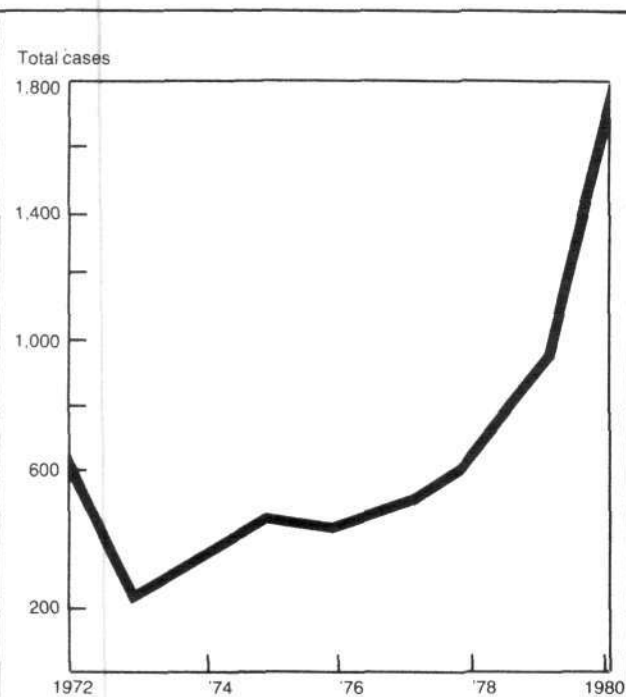
units capable of setting up desalination stations on the coastal areas already exist under military command. To supplement these stations, adequate water distribution systems must be rapidly organized.

Immunization. Multivalent vaccinations are necessary, carried out on a systematic, global scale with emergency mass immunizations in the so-called relief centers in Africa. In addition to the importation of vaccines, vaccine-production facilities must be constructed on the front lines. The construction of indigenous medical facilities is an overall priority of the project.

Medicines. A full arsenal of the antibiotic spectrum, especially massive amounts of tetracycline, must be available on the front lines. A thoroughly uncontaminated blood supply—with full screening tests for AIDS and any other potential disease agents—must be available at all times. Furthermore, huge amounts of basic malarial and cholera treatments must be made available. In addition to rehydration medicines, the material for infusions must be made available. Overall, the operational procedure must be to administer medical treatment from the standpoint of “presumptive treatment” for the worst case situation.

Sanitation. Basic waste separation and disposal methods must be implemented. Basic sanitation must include preventive measures such as control of rodents and arthropods, spraying and pesticides, chlorination of water supply, pasteurization of milk, and so on.

Other areas for emergency military-style action are *quar-*



**CASES OF MALARIA IMPORTED TO THE U.S.,
1972-1980**

The rise of malaria coincides with increasing conditions of poverty and lowered living standards worldwide.

antine measures, animal health management, and crop and flora health management.

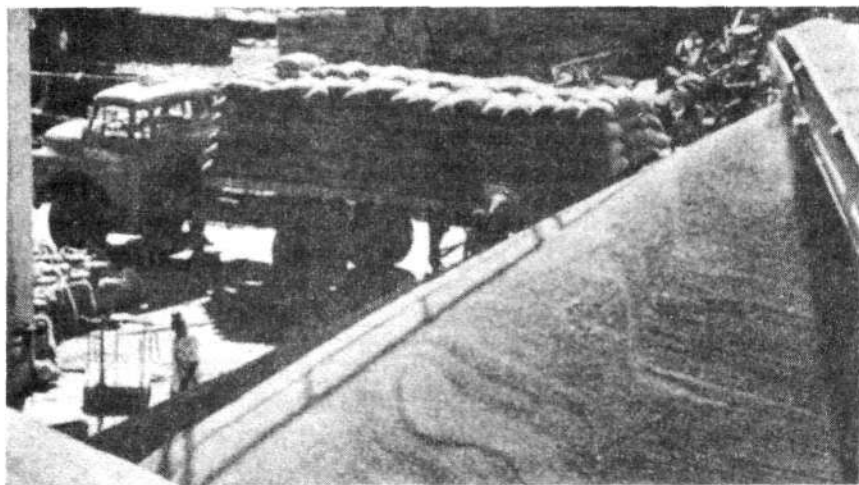
The particular programs required to address each of these areas are generally standard procedures, which can be upgraded through use of the most modern technological means. For example, NASA's Landsat Program is capable of precise land mappings, while NASA's space experiments have already demonstrated the capacity for upgrading medicine production. Mobile operational medical treatment and surgical units should be airlifted and deployed into critical battle zones.

In addition to the first phase airlift with C-5As and C-141s, the shipment of emergency medical and food supplies requires war-footing-type upgrades of ports, rail and road networks, canals, and waterways. Military methods of logistical deployment, coordinated government-to-government between Western Europe, the United States, and other food-exporting nations on the one hand, and the receiving nations on the other, are required. The prototype for the operation is the World War II Normandy landing.

In short, with a full-scale emergency mobilization effort we can successfully stop the unfolding biological-ecological holocaust. Mankind has no choice but to fight and win this war on disease.

Science Can Save Africa

Even while the first phase of the emergency program is being implemented, steps must be taken to increase agri-



United Nations

A full-scale war on disease must use the most modern military and scientific technologies to stop the holocaust. The front-line of this global war on disease is the campaign to save Africa. Top left: Sorghum from Argentina on its way to Africa. Above: Ethiopia's 1968 desert locust control program to protect its crops. Left: U.S. Sorghum being unloaded in Upper Volta.

FAO

cultural production within Africa, using the capital-intensive American model. Under present conditions, however, the African continent does not have the necessary water systems required to improve agricultural production, nor does it have the transportation networks required to distribute it across the continent. The following longer-range infrastructure projects must simultaneously be undertaken:

Basic agricultural development. Over time, food assistance must be replaced with capital assistance, so that each nation's own agriculture can produce enough to provide for its population. Water pumps and irrigation equipment must be brought on line as quickly as possible. The construction of a simple energy supply system must begin in rural areas in order to reduce the use of wood for fuel. This is of utmost importance to preserve forests and fight the process of desertification. Bottled gas and simple gas stoves are readily employed substitutes for wood-burning, until large-scale water power and nuclear power stations can be operational.

An effective system of defense against vermin, and against plant and animal diseases, like rinderpest, must be built as

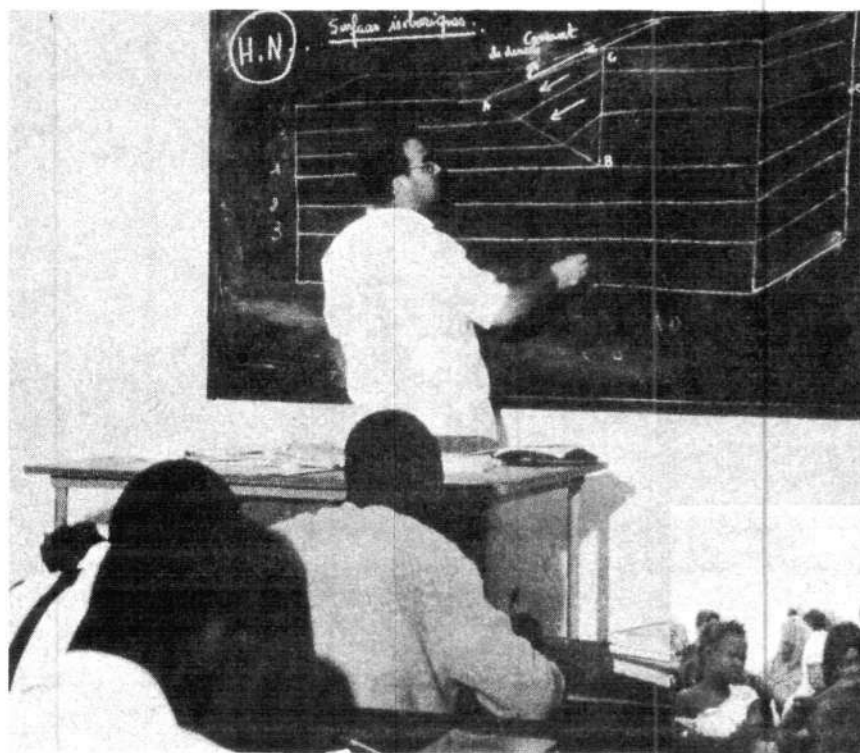
an essential part of the assistance program. This includes the placement of equipment, vaccines, and insecticides and agricultural training by a team of experts. A well-run system of cattle-raising must also include sufficient barbed-wire to prevent roaming herds from destroying vegetation.

Great Projects. Two major infrastructural projects will rapidly have enormous effects on ending the drought-famine-pestilence cycle on the continent of Africa:

(1) a rail-system cutting across the southern Sahara from Djibouti in the east to Dakar, Senegal, in the west;

(2) a water redistribution plan, bringing surplus water north from Zaire in central Africa into Lake Chad for distribution to the entire Sahel region.

The east-west trunk rail-line will intersect already existing north-south lines through Nigeria, Egypt, and Sudan. The east-west line across the southern Sahara-Sahel region will serve as a logical base for deploying to reverse the present southward spread of the Sahara Desert. A north-south link from Algiers in the north to Lagos in Nigeria will begin the crucial trading links among the Arab nations of the north and the black West African nations. The same will be accomplished by a north-south route on the eastern side of



Left: A theoretical course on installing and maintaining a food canning factory in Dakar. Below: A medical clinic at a refugee camp in Mauritania.

United Nations

the continent from Cairo south to Kampala in Uganda, past Lake Victoria to Lusaka, Zambia.

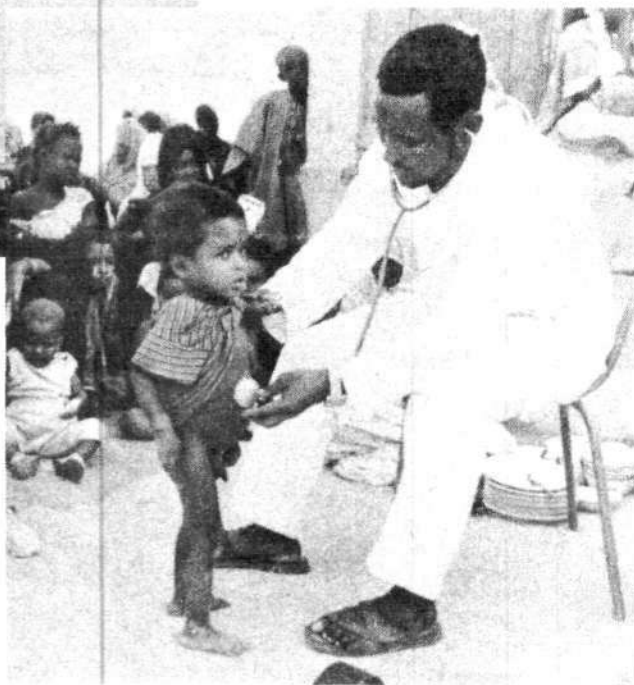
In crisis-zone areas, appropriate development projects must be implemented military-style. For example, the Jonglei Canal Project—a 175-mile canal bypassing part of the Nile that winds through the Sudd, where huge quantities of water evaporate—was specifically planned to help make Sudan the breadbasket of Africa. The result of the IMF's successful campaign to block the project is the current mass murder of millions of Sudan's children through *planned* famine and disease.

The capability exists to reverse this holocaust. The combined effect of railway development and water-management programs will provide the indispensable basis for the introduction of modern agriculture into Africa. This vastly *underpopulated* continent has the potential to become a breadbasket, feeding not only hundreds of millions more of its own people, but exporting from a food surplus to the entire world.

Over time, an advanced energy grid must be developed for Africa, one which combines the use of water and coal reserves, and the installation of nuclear energy. The dust-gathering plans for "nuplex" developments, agroindustrial complexes centered around nuclear power plants, must be pulled off the shelf and implemented. Finally, a general improvement of communications will be an important contribution to increasing productivity.

Creating Health for Mankind

There is no excuse for any individual policy maker or scientist alive today to deny the thorough interrelationship of economic development and health. Approximately 100 years ago, the great Louis Pasteur, in a series of beautiful and simple experiments, demolished for all time the idea



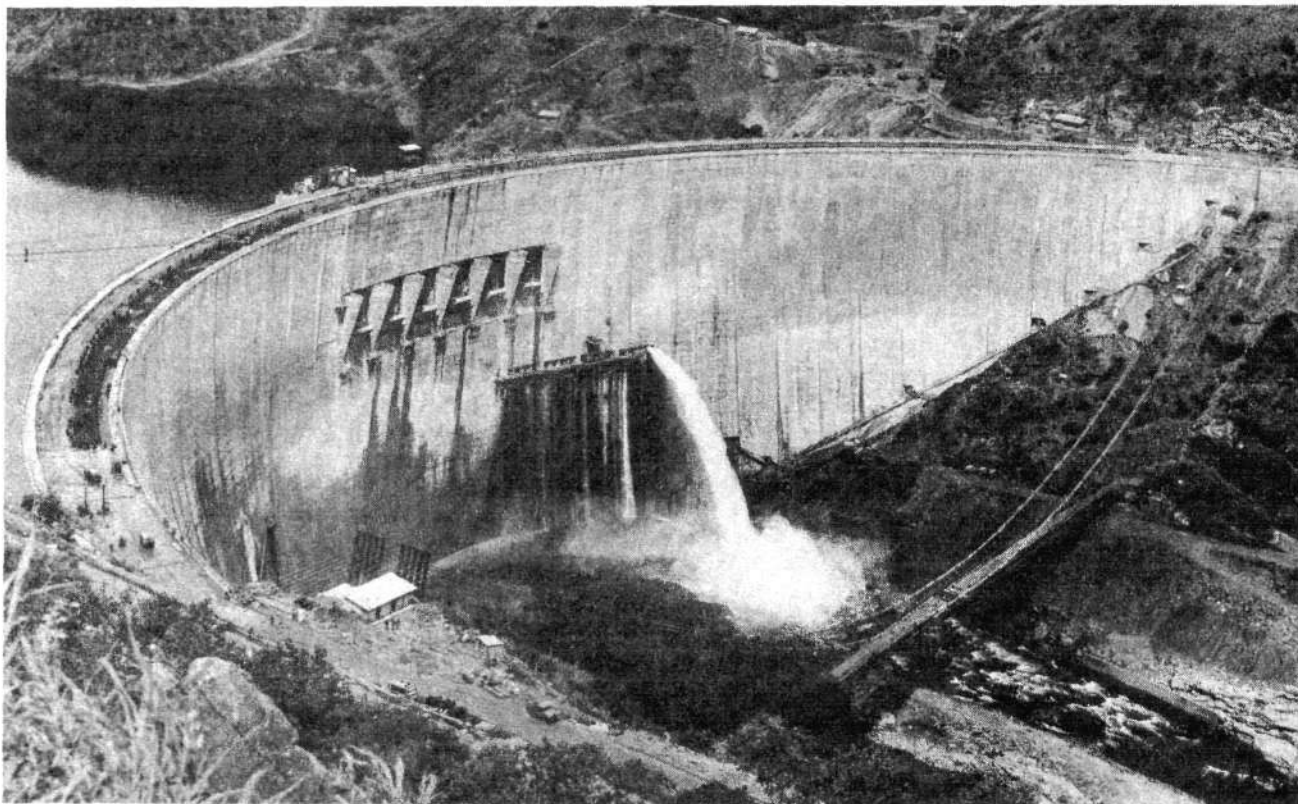
UNICEF

that disease was caused through "spontaneous generation."¹

Pasteur developed the modern germ theory of disease through a series of specific studies in combating cholera and silkworm disease (1865), anthrax (1877), chicken cholera (1879), rabies (1880), and cattle pleuropneumonia.

The pandemic nature of the disease threat confronted Pasteur from his first work on silkworm disease, which was then ravaging French industry. It had shown its first symptoms in France in 1849 and then had traveled to Italy, Spain, Austria, and eventually China (1864) before reemerging in a devastating French outbreak in 1865. The British Imperial cholera pandemic, which claimed 200 victims a day in Paris in October 1865, had spread from Egypt to Marseilles to Paris.

In his *Memoire on the Germ Theory* (1878) Pasteur presented the basic conception that disease results from specific microorganisms that can be isolated and controlled by man. Man has the capacity to make his own species "health-



United Nations

Above: The Kariba hydroelectric project on the Zambesi River is one of several 1960s big projects to industrialize Africa. This progrowth spirit by the 1970s was overrun by the Malthusian policy of population reduction and "small is beautiful" technology.

Right: A Canadian C-130 Hercules cargo aircraft unloading food in central Niger.



FAO

ier" from generation to generation—a conception that Pasteur himself received from his self-acknowledged appreciation of the life's work of Benjamin Franklin. Pasteur demonstrated that through science and economic progress man had the ability to raise what he termed "the resistance level to disease." In addition to natural immunity (sanitation, building up the immune system through better nutrition and so forth), man can acquire immunity by vaccination against specific diseases. As he stated:

Is it impermissible to believe that a day will come when easily applied *preventive measures* will arrest those scourges that suddenly desolate and terrify populations—such as the fearful disease [yellow fever] which has recently invaded Senegal and the valley of the Mississippi, or that other [bubonic plague], yet more terrible perhaps, that has ravaged the banks of the Volga?

For the sake of our posterity and the very biosphere itself, we dare not let those in the International Monetary Fund, the World Bank, and the U.S. State Department, who would dictate a negative response to Pasteur's question, prevail—

lest even they themselves along with all mankind, eventually suffer the horrible demise of those cavalier revelers in Edgar A. Poe's "The Masque of the Red Death." Let modern science, instead, fulfill its historic mission by creating a healthier human species here on Earth, beginning with the task of saving Africa.

Warren J. Hamerman, a founding member of the Fusion Energy Foundation, has a background in basic immunological research.

Notes

1. See "The Overlooked Importance of Pasteur," by this author in the *Fusion Energy Foundation Newsletter*, May 1977, p. 4. This was also published by the Johns Hopkins Medical School and the Pasteur Institute of Lille, France.



U.S. Air force

Getting the job done: This giant C-5A Air Force Galaxy, the world's largest transport aircraft, is carrying tanks here, but it could carry food and medicine.

Proposed Guidelines for Transporting 25 Million Tons of Food Supplies into Africa

by Col. Molloy C. Vaughn, Jr.

The author, a retired colonel in the U.S. Army, presented this emergency program for Africa at international conferences sponsored by the Schiller Institute in Richmond, Va. and Dusseldorf, West Germany this year.



I. Personnel to carry out task.

- A. Use of a "Berlin airlift"-type operation (Navy, Army, Air Force, Merchant Marine active units).

- B. Use of Peace Corps organization (no uniforms).
- C. Joint task-force of nations (under direction of the United States).
- D. Use of retired military to staff task-force.

II. Formation of site survey teams for each country to provide required data for in-depth planning.

- A. Gather all available data on each country that will receive aid.
 - 1. Latest maps of all affected areas. Sources: U.S. Army Map Depot (obtain permission of host country for their release), NASA map files, England, France.
 - 2. Existing communications data.
 - 3. Existing power sources available.

4. Existing ports and their capacities.
5. Existing airports—their type and capacities: Capability for fast aircraft turnaround. Ground handling equipment, fuel, aviation oil, minor maintenance, navigation aids.
6. Existing medical facilities and their capacities.
7. Available storage facilities.
8. Available resources in host countries for constructing roads, bridges, storage facilities, housing for support personnel.
9. Available drinking water and fuel supplies (aircraft and auto).
10. Available personnel to perform required labor-support tasks, i.e., construction of roads, bridges, building, seaports, airports, communications, power plants, and medical support.
11. Available (trained) host country administrators.
12. Available security personnel.
13. Estimates as to number of persons to be provided for in each country, i.e., to feed, clothe, house, and provide medical support to.
14. Obtain all available climatic studies (rainfall, temperature, dry and wet seasons, sand storms, and locust cycles).

III. Upon receipt of all data in II above, determine the following items:

- A. Priorities of support to be provided, i.e., supplies to be sent by airlift; by waterlift; by road transportation; by rail transportation.
- B. Amount of supplies to be provided. Schedule of arrival in host country, transit time to storage areas or to forward distribution points.
- C. Based on paragraph B above, determine support personnel requirement by type of function to be performed. Schedule for hiring, training (orientation), and arrival in host country.
- D. Medical requirement for support personnel and for personnel in host country based on agreed level of medical support to be provided by relief program.
- E. Housing and feeding requirements for support personnel.
- F. Determine requirements for local hire of host country personnel.
- G. Determine amount of money required to support and implement relief program in each country.
- H. Determine source of U.S. personnel, hire, and process for movement to host country; see paragraph C above.

IV. Review all above data and prepare Master Plan for each host country that has been selected to receive the proposed relief program. Secure host country acceptance of the proposed Master Plan.

- A. Publish approved Master Plan for each host country and its implementation schedule.
- B. Move funds forward into host country's banks.
- C. Host country to have its support administration teams organized and on site.
- D. Have all customs regulations (cost and fees) agreed to

by all parties. This will also cover movement of relief supplies and support personnel across borders of all host nations.

- E. Start all local construction projects (i.e., roads, bridges, storage buildings, seaport and airport, communication and power requirements).
- F. Establish completion dates for all required support projects in host countries.
- G. Based on paragraph F above, determine shipping dates (based on means available—air, water, road transportation) for food and medical relief.
- H. Schedule arrival of relief supplies into host countries so that the established system is not overloaded, but can move the supplies to the forward distribution points, and so that the required storage facilities are available, and so that the personnel are in place to receive the relief supplies.
- I. A joint U.S.-host country team will handle all funds required to implement the relief program.
- J. Daily communications will be maintained between all forward distribution points and the central planning office (capital) to ensure there are *no surprises*.

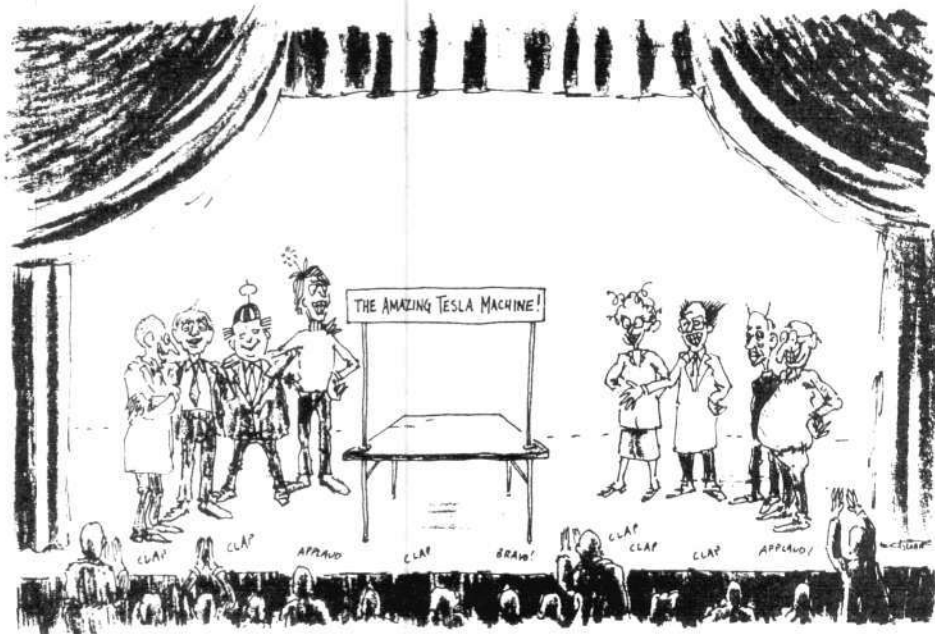
V. To be able to "crash" this program, the following steps are proposed:

- A. Select planning personnel with great amount of overseas experience working with personnel of other countries in large projects. Many of the desired personnel are known to me.
- B. Propose that serious consideration be given to the hiring of retired military personnel to fill the requirements for support personnel for this relief project. This source of personnel will provide a vast pool of experience in every aspect of this project.
- C. Select a civilian contractor to provide complete logistical support for all U.S. support personnel. This contractor is available now for this project. In the Middle East and Africa for the past 20 years, the London-based Abella Construction and Catering Service, Ltd., has and is continuing to provide complete logistical support for all projects in the United Arab Emirates and Saudi Arabia and in many other areas of the world. They fed over 90,000 persons during the civil war in Nigeria.

VI. With the implementation of the above proposed guidelines, which would result in a successful receipt of 25 million tons of relief supplies in Africa, many other vital projects could be started that are critical for the development and future industrialization of Africa.

These would include: a continental railroad system, a network of power systems that would make available a power grid for the entire continent, roads and communications networks, fuel pipelines to all nations, and new seaports and airports. These projects could start in conjunction with the recommended food relief project as stated above. When this critical program is implemented, the long-awaited industrial revolution of Africa will at last be realized.

How the science of Tesla has been mystified to manufacture right-wing Greenies who prefer magic to reality.



Illustrations by Christopher Sloan

So, You Believe in Tachyon Energy?

by Jonathan Tennenbaum

It is truly remarkable: Over the past two years, the secret knowledge about "Tachyon Field Energy" has been spreading out to growing circles of the population. Supposedly, totally new machines, called "converters," enable us to "tap" unlimited amounts of energy from the universe. The proponents of this theory draw the conclusion that nuclear power, and with it, all the other "orthodox" energy technologies, will become totally superfluous. It is said that in some places of the world, such "Tachyon converters" are already in operation.

Not only that, the Soviet Union, reportedly, has already piled up an arsenal of these awesome Tesla-weapons, based upon unorthodox principles, that allow them to influence the weather in the West, to trigger earthquakes, or to cripple all NATO forces at a moment's notice! Companies and research laboratories all over the world should work feverishly to develop this technology—all of them under the strictest secrecy, of course.

Although such "detailed knowledge" is claimed of these sensationalist applications, the specific physical laws of "Tachyon Field Energy" are clouded in general ignorance and confusion. But this does not prevent an increasing number of laymen and aficionados from having absolute certainty that this is a new energy source. The "insiders" are not irritated by the apparently insurmountable difficulty in attempting to get hold of a functioning Tachyon device. Just the opposite, these difficulties merely generate more clouds of rumor, which "prove" all the more to the initiate, that a top scientific secret is involved. The interest in this adventurous nonsense is increasing. The persuasive power of the Tachyon rumors increases at exactly the same rate at which the discussion initiated by the Tachyon rumors spreads. We are confronted with the key characteristics of a classical fraud.

If you look closer at these Tachyons with your investigator's reason, they will quickly evaporate out of the realm of physical reality and reappear as a purely psychological phenomenon. Ask yourself, astonished, why so many people—among them very prominent personalities—could have been tricked by this fraud, and you are reminded of the old saying of the famous American circus director P.T. Barnum, "There's a sucker born every minute."

The issue of Tachyons, however, cannot be so easily put aside. The ideological manipulation includes an effort to drag people into a "right-wing" version of environmentalist or Green ideology. There is the danger that this manipulation is an element of strategic deception to cover up the real intent and capabilities of the Soviet Union. It should be noted that the Tachyon discussion went into high gear just at the time when the United States, in the context of the Strategic Defense Initiative, entered into an accelerated development phase for laser and particle-beam weapons. Was the purpose of the Tachyon hoax to deflect money and energy from serious frontier research in directed energy, into nonsense? Moreover, the networks that are spreading the Tachyon fraud in the United States heavily overlap the KGB-infiltrated networks of the Esalen Institute and the cult circles of the L-5 Society.

Some readers will not accept this statement. I can clearly imagine the indignant heklings. "Why should we believe you, Mr. Tennenbaum? We have extremely confidential communications from highly reliable sources, which say that Tachyon energy and Tesla weapons have to be taken very seriously." Thank you very much for your reminder. It leads us directly to the question, which we want to deal with in the first part of this article. The majority of those interested in Tachyons are, according to their own self-evaluation, not able to form an *independent* judgment on

this question. They therefore are looking for the opinion of experts. But who are these "experts"? How do you know, that their "reliable source" will answer the question posed reliably and correctly?

The True Secret of Tachyon Generation

The breeding ground, spreading the Tachyon fraud (quicker than any virus from the arsenal of biological weapons), is the inability of large parts of the population to make independent judgments, even when—as we shall show—the *form*, in which the fraud is spread, should suffice for people to recognize that it is a fraud. The intellectual and moral immune system of our population is extremely weakened by reductionism in the natural sciences and by widespread cultural pessimism. In fact, one need not be an "expert" at all, to uncover the Tachyon fraud; all one needs is a rigorous faculty and some basic knowledge about the psychological and cultural weaknesses that favor the spreading of fraudulent operations, cults, and other swindles.

In each deception, the essential and most dangerous element is not that the factual content of the proposition made is untrue, but the fact that in the victim's mind a wrong method of thinking is stimulated and exploited. Starting with this insight, it is easy to uncover the fraud.

The key to uncovering psychological warfare, spreading of cults, and psychological mass manipulation is *epistemology*—raising the question of the criteria of judgment, or the mental processes, by which people are led to true or false knowledge.

Take the case of the magician. He is an expert in *psychological warfare*. It is not essential for a successful magic act what the audience actually sees, but how they *interpret* what they are seeing. This is clear to anybody, who has himself performed a conjuring trick or to whom the "trick" of such a performance was revealed beforehand. You then are astonished about the apparent blindness of the audi-

ence to what is really occurring onstage: 95 percent of the deception is *in the mind of the spectator*. The magician succeeds by means of gestures and skillful speech in directing the attention of the audience so they do not see what is going on "right in front of their noses." The audience "sees" a person disappear all of a sudden from the stage with flashes, fire, and smoke.

The kernel of the deception lies in the question of causality. While the magician is dealing with a process, which he simply steers by mechanical and optical means, the audience "sees" the intervention of "extraterrestrial forces." The success of the magician rests mainly on the unconscious wish of the spectators to be deceived, so they do not have to recognize the lawful process onstage.

The spectators want to relax. For a short period of time, they want to be freed from the "oppressing" lawfulness of real life. They therefore make an unconscious "deal" with the magician. They surrender their critical faculty and allow themselves to be manipulated; they give the magician a certain "credibility." In return, the magician must deliver a moment of psychological "liberation" from the demands of a causal universe, natural law.

In time of crisis, this desire for liberation becomes so strong that large parts of the population will grab every *psychological equivalent* of magic, like astrology, parapsychology, religious cults, psychotropic drugs, and so on. Dependency and passivity are created and utilized to weaken or undercut the ability for independent judgment. The Tachyon fraud proves that this phenomenon does not stop outside so-called leading circles.

A concrete example of mass brainwashing, which directly has laid the ground for the Tachyon fraud, is the "limits to growth" hoax.

The late founder and president of the Club of Rome, Aurelio Peccei, has described the notorious report on the "Limits to Growth," which is still today respected by the majority of German professors as a "scientific" masterpiece," as a "psychological command." The details of this operation have been covered elsewhere; here we are concerned only with the following points.

- First, the world population was terrorized with "oil shocks" and the prognosis of imminent catastrophe: resource scarcity, energy crises, carbon dioxide pollution, poisoned food, nuclear winter, and so on, starting in 1973, in order to create a widespread apocalyptic mood.

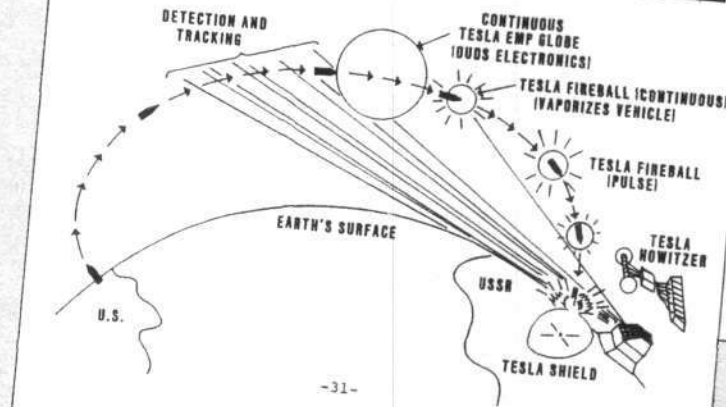
- Then realistic solutions to the resource problem were blocked. There was particular sabotage against already universally available nuclear energy by the antinuclear movement, and a general campaign of harassment against modern technology was started. The possibility of solving the crisis with modern science and technology was blocked.

- Finally, the Club of Rome and its allies in the supranational institutions declared that the crisis anticipated by them could be solved "only globally" and that the individual nation states must delegate their sovereign power to supranational institutions of "crisis management."

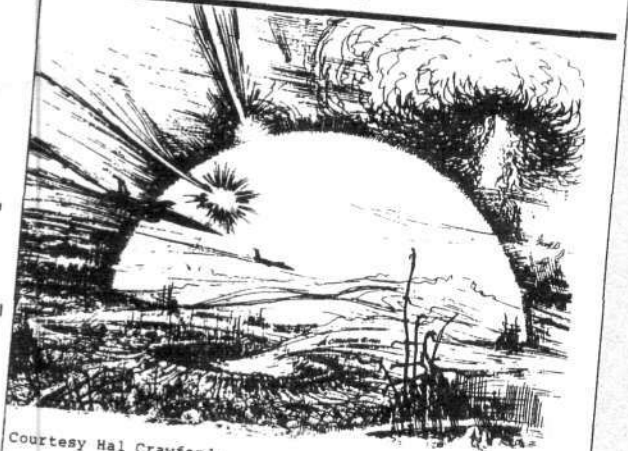
Particularly the younger generation was provided an escape from the stress of "complicated" reality and thrown into the arms of simplistic explanation of these "masters" of zero-growth philosophy.



Item 10. **TESLA ABM DEFENSES**



Item 6. **TESLA SHIELD**



Courtesy Hal Crawford.

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This "Tesla shield" (above) and "Tesla ABM Defense" are both featured in *Star Wars Now! The Bohm-Aronov Effect, Scalar Interferometry, and Soviet Weaponization*, edited by T.E. Bearden and published in 1984 by Tesla Book Co., Millbrae, Calif.

Generally, the insecurity in the population grew, and through this, its manipulability.

Tachyons—A Backstage View

Now we enter backstage and review point for point the Tachyon fraud. Our primary source is Dr. Hans A. Nieper, president of the "German Association for Gravity Field Energy" and member of the founding board of the "American Association of Gravity Field Energy" in Huntsville, Alabama.

Nieper prefaces his book, *Revolution in Technology, Medicine, Society—Conversion of Gravity Field Energy*, with an argument taken directly from the Club of Rome. He predicts an imminent collapse of nature:

Mankind moves toward a catastrophic situation with breathtaking speed. Population explosion, destruction of nature, destruction of tropical jungles, increase of carbon dioxide content of the atmosphere, contamination of the water.

The rational solution is blocked: predictably, Nieper opposes nuclear energy. He continues:

The true background is the uneven distribution of richness on earth. . . . [This] in turn has its essential cause in the fact that our modern technology is not able any more to maintain mankind adequately. . . . A first attempt to escape this difficulty has actually broadened this dilemma. Nuclear power is technically, economically, sociologically, and politically unfit for this task.

Nieper is shameless enough to trumpet out the lying demagoguery of the Greenies.

Nuclear power is essential to secure the world energy supply of a growing mankind at an appropriate living standard for all. The scale on which nuclear technology is used today, despite the sabotage of the zero-growthers, proves the opposite of Nieper's stipulation. In France, 54 percent of electricity is generated in nuclear power stations, in Belgium 46 percent, in Sweden 36 percent, and so on. Nuclear technology is technically feasible, and especially with fast-growing energy consumption, it is the most efficient and safest energy source. Only the political sabotage of the antinuclear movement, initiated by the Club of Rome, has prevented its expansion. Nieper transforms this result of political propaganda into a seemingly self-evident axiom: "Nuclear power is politically unfit," Nieper says.

But the credulous Tachyon supporter is facing further threats. Therefore, Tachyons to the rescue. Nieper writes:

While there is a worldwide energy crisis coming up, with catastrophic direct and indirect consequences and the responsible politicians don't know how to solve it, a broader public for the first time realizes that the whole planet swims in an energy field of immensely great density, the so-called Tachyon field. Obviously, it is possible to plug into this energy field with only relatively small effort. . . .

Very impressive! Nieper continues:

This energy field essentially has nothing to do with light or the energy of the Sun, but is to be described as Graviton, Tachyon, or Neutrino field. . . .

In Nieper's theory, all so-called natural accelerations can be reduced to one and the same basic principle. According

to him, they come about because of directed Tachyon deceleration; this is true for gravity acceleration, electrostatic, magnetic, and electromagnetic radiation.

It must be noted that Tachyons don't belong to the normal objects of physics. When some theoretical physicists are working on speculations about "Tachyons" or "Gravitons" in their universities, they don't do so because these apparent particles have ever been detected anywhere. The "Tachyon" was born in the course of purely formal algebraic games, when some theoreticians asked themselves what properties a particle theoretically must have when it travels faster than the speed of light.

Nieper is not impressed by the fact that there has never been an experimental proof for the existence of Tachyons. Just the opposite; he simply states a "Nieper's principle," which says, that all existing actions in the universe are based on Tachyons!

In other words, the cleaner one's wash, the more little green men must have been stored in one's detergent. At least, that is what the TV commercial would have us believe.

However, while supposedly Tachyon energy converters are functioning all over the world to tap energy from the energy field, there appear again and again insurmountable difficulties when one tries to locate a suitable demonstration machine at a given place at a given time. For one reason or another, the machine cannot be viewed in action.

Is There a Conspiracy Against Tachyons?

And then there are long stories about bizarre persecution directed against Tachyon supporters. Take, for example, the case of the famous psychoanalyst Dr. Wilhelm Reich, as reported by Nieper.

Reich discovered a motor force in Orgone energy,



and in 1948, the first prototype of the Orgone Energy Motor was running. . . . This prototype supplied permanent energy to a 25-volt motor and represented an energy converter for the primary, cosmic "energy of the thousand names," which today may be best known under the name of gravitation or Tachyon field. . . . Based on his spectacular Oranur experiment. . . . Reich was officially asked in March 1954, to give up any further research and study on the field of Orgone energy. . . . Three years later, Dr. Reich died in an American prison. His books and writings were confiscated and burned.

In fact, Reich was indicted—for fraud.

Another example, is the case of Dr. Henry Moray of Salt Lake City, Utah.

A year before, a furious "customer" had destroyed the prototype of the [Moray] machine with a heavy hammer, when Moray refused to give out all information about set-up, principle, and materials used. For this reason Moray always carried a pistol in the laboratory. . . . He equipped his car with bullet-proof windows. Nevertheless, more attempts against him were tried, even in the open street. . . . Private researchers currently try to uncover the secret of composition of the semi-conductor material used. . . .

And then there is the unhappy case of the American citizen Lester Hendershot:

Only in 1960, a newly established research team of about 20 responsible personalities filed a motion to the "U.S. Navy Office of Naval Research" for \$150,000 to investigate the Hendershot machine, which was called "magnetronic generator." The motion was documented and accompanied by 22 certified testimonies of prominent personalities who had seen and watched the machine operating. . . . In April 1961 Hendershot publicly declared his readiness to explain all details and the operational principles of the machine before prominent men of science. . . . The project and all the new plans associated with it ended with the suicide of Lester Hendershot on April 26, 1961.

Exemplary of how the hoax works is a caption on page 86 in Nieper's book. He uses a typical magic trick to create an illusion in the mind of the spectator.

Curve of the increasing potential of Takamura's Gravity Energy Generator, which has an initial value of 2 volts, while after 3 months it reaches 40 volts. This result shows continuous influx of gravity field energy from the gravity field. With this machine we can obtain unlimited gravity energy.

Here, the attempt is made to fool the layman, who does not understand the difference between electric voltage and energy. With any normal transformer one can arbitrarily increase or decrease the voltage of alternating current, without producing energy. A transformer is like the gear

transmission of a car, for maximizing the use of its engine's power. Like the transmission, the transformer does not produce energy.

The Secret of Nicola Tesla

Nicola Tesla (1856-1943) is considered the great guru of the Tachyon movement. Born in Yugoslavia, Tesla was a gifted engineer and inventor, who laid the foundation of alternating current technique by building the first alternating current power plant at Niagara Falls. He is also the inventor of the Tesla transformer, which can generate very high voltages and frequencies; with this he made an essential contribution to the development of efficient radio stations. These other inventions of Tesla are integral parts of modern electrical engineering.

The Tachyon fraud is largely based on a *mystification* of Tesla's method. Tesla, who had received a solid education at the Polytechnic School in Graz, Austria, applied two basic principles of physics and technology that were already formulated by Kepler and Leibniz:

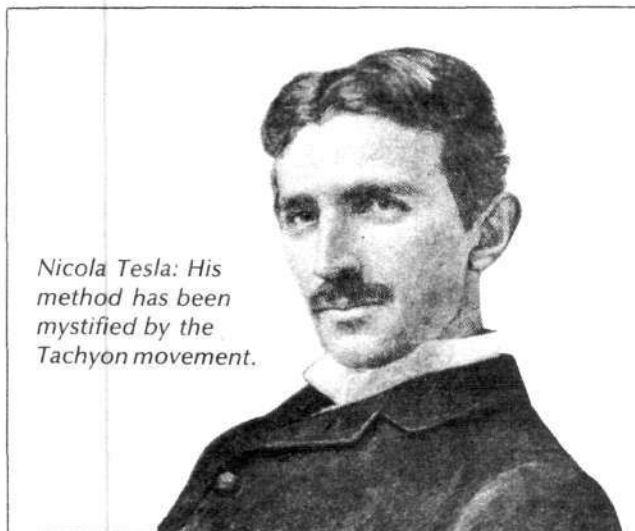
First, the principle of *resonance*, according to which all processes in the universe are ordered by harmonic relationships. Tesla was clear about the fact that the effect of electromagnetic waves as, for example, radio waves, on physical systems depends significantly on the frequency of the wave. At certain frequencies, especially strong interactions occur by resonance.

Second, the principle of increasing energy density as it was employed by Leibniz on the problem of developing a Papin steam engine. Leibniz knew that the efficiency of a steam engine is improved by increasing its working temperature. Tesla employed this principle in electrical engineering by attempting to reach ever-higher voltages and frequencies. In this, he realized, constantly new physical effects (singularities) occur. Tesla was the first who, to the great interest and also joy of his colleagues, generated voltages of several million volts.

Although we cannot discuss Tesla's work in more detail here, this should be enough to expose his so-called admirers of the Tachyon brigade, who have mystified this simple principle of increasing energy density—which Tesla employed and which has been known to modern science since the work of Leibniz (since Archimedes, really)—by transforming it into an extraterrestrial mystery and mixing into it an absurd notion of *perpetuum mobile*.

It is no argument for Tachyons that some things can be accomplished with a million volts that are impossible with only 10 volts; for example, one can generate spectacular sparks. But the Tesla transformer, which increases 10 volts to 1 million volts, does not create energy in the common physical technical sense of the word. The fact that certain phenomena occur only at higher energy densities points to a flaw in the normally accepted notion of energy; the work potential of a given physical action cannot be sufficiently characterized by its so-called energy content or caloric value alone.

The Tachyon defrauders say that their machines are "open systems," meaning that they are in interaction with an outer physical system, the Tachyon field. Then, however, these experts must also describe the effect of their machines on this outer physical system, not only the supposed effect of



Nicola Tesla: His method has been mystified by the Tachyon movement.

Engraving by T. Johnson from a photograph by Sarony

the Tachyon field. But that they don't do. The fact that between the Earth and its atmosphere there exists a voltage of about 100 volts per meter, does not mean that you can tap out of this "field" any volume of energy. As soon as a conductor is introduced, the voltage difference is leveled out through a very weak current down to Earth.

Tachyon energy is a fraud. However, there is a *perpetuum mobile*, a system that generates constantly more energy. This *perpetuum mobile* is of a totally different nature than the Tachyon magicians would have us believe: It is human society!

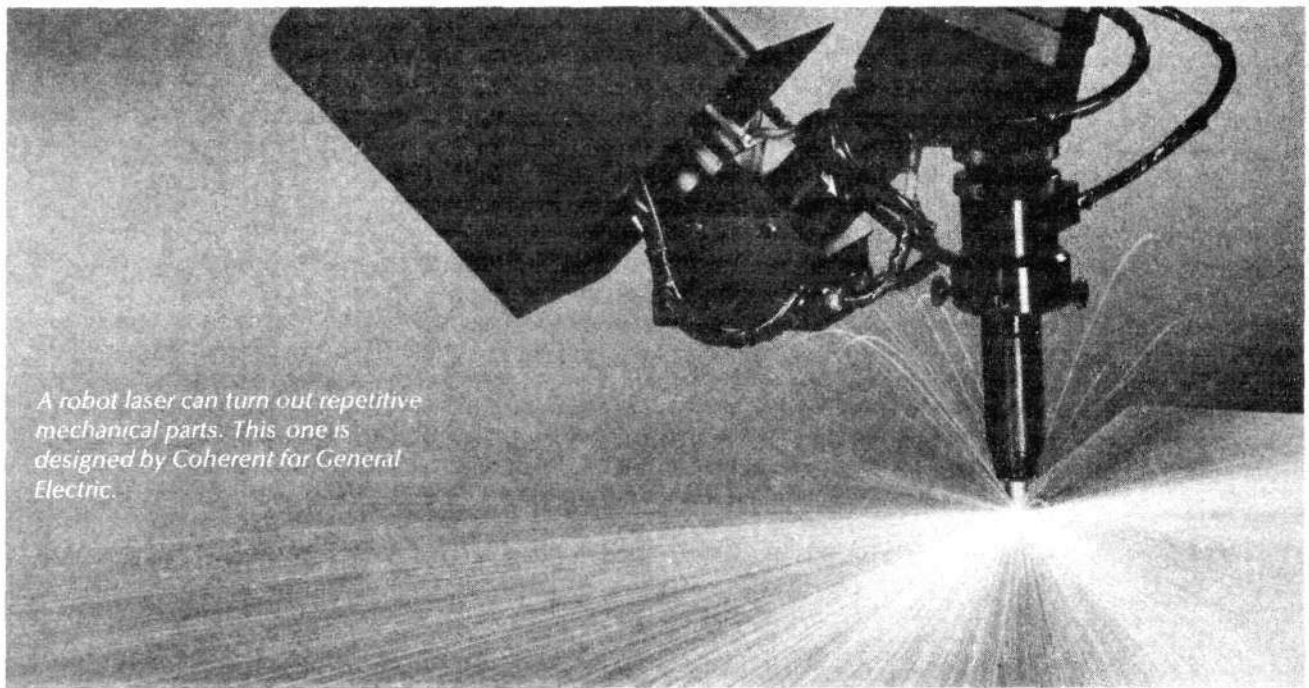
Through the development of science and technology, this *perpetuum mobile* runs ever more quickly and more efficiently—at least, if it is steered correctly. Why mystify this process? There is nothing mystical in it at all; it is the day-to-day reality of a progressing economy, in which creative thinking—the development of new hypotheses mediated through new technologies—constantly increases the power of man over natural forces. Decisive for this process are exactly such breakthroughs as Tesla made—not as the Tesla cultists portray him, as an intuitive, lonely genius, but as the inheritor of the science tradition of Kepler, Leibniz, and the founders of the French Ecole Polytechnique. This tradition is totally unknown to Nieper and his followers; they don't know it and don't want to know about it.

The *perpetuum mobile* of human economy cannot be maintained on the basis of a fixed set of technologies. Any technology is condemned to aging and scrapping by the relative limitedness of the resource base determined by it. The key is that technological progress continues from the basis reached so far and always creates the potential to take the next step.

Today, we see at the horizon the possibilities of fusion power. Before it is technically realized, we must create the *fast-expanding economic base needed for that*. The cheapest, cleanest, and best way to do that is the worldwide use of nuclear fission, which is already under our command. Today our old slogan is more true than ever: More Nukes, Less Kooks!

Jonathan Tennenbaum is the editor-in-chief of the German-language Fusion magazine.

Laser Technologies—



A robot laser can turn out repetitive mechanical parts. This one is designed by Coherent for General Electric.

Courtesy of Coherent General, Inc.

Ready to Take the Economy Into the Plasma Age

The laser technology spinoffs from the beam defense program are available today to make the next industrial revolution. All it takes is a political decision to reduce interest rates and issue low-interest credits to American industry.

by Carol White

The spinoff benefits from the Strategic Defense Initiative program are ready to provide a "shot in the arm" to the ailing U.S. economy, generating the increased productivity and increased tax revenue that would more than pay for the entire beam defense program. These laser technologies, if applied to the civilian economy, would be the peacetime equivalent of the World War II economic mobilization. A crash program to develop the Strategic Defense Initiative and its spinoff technologies would cause a fourfold increase of economic productivity, an increase of 4 million jobs per year, elimination of the U.S. trade deficit within a two-year period, and a rise in real per capita income by 5 percent per year.¹

What's holding back the potential of laser and related technologies from fueling an industrial takeoff? The credit

and investment policies of Paul Volcker, chairman of the Federal Reserve.

The Assimilation of New Technology

The health of any economy is immediately dependent upon the health of its capital goods sector—and especially those capital goods used to produce more capital goods and infrastructure. But in the longer run, its viability is a function of the rate at which higher and higher rates of productivity are infused into the economy, by a rapid rate of introduction and assimilation of new technologies. Each new technology is in a sense a singularity. Whether or not it "flies," depends upon the ability of the system as a whole to assimilate it.

The present financial manipulations of the economy by

The present financial manipulations of the economy by Paul Volcker, and the Eastern Establishment banking strata that he represents, are deliberately strangling the productive economy in order to favor the speculative "black" economy typified by the illegal drug trade, the gambling casinos, and the real estate swindles through which they launder cash. This, of course, is coupled with the depression of world trade through the same policies by the World Bank and the International Monetary Fund. The effect of these policies on machine-tool production can be seen in Table 1.

To judge the impact of high interest rates, look at the cost of leasing laser equipment today. The standard leasing arrangement is for a three to five year period, at an average cost of 2 percent over the prime rate—a leasing cost today of about 12.5 percent. For the entire period between 1940 and 1960, interest rates did not rise above 4 percent. If one compares the cost to industry of a laser leased at today's prices with that at a reduced 4 percent rate, one sees that the "tax" that industry is now paying to financial speculators is preventing any rapid modernization from taking place. Financed over five years, a \$200,000 machine now costs \$376,714, compared to \$243,331 at the lower interest rate. The additional \$133,381 is a 55 percent add-on to the cost of the machine. Similarly, a \$500,000 purchase today costs an extra quarter of a million dollars or more.

There are other factors that also determine the rate at which new technologies are assimilated into an economy. Chief among them is perhaps the morale of the population. During World War II, the urgency of the task of meeting the goals of war production introduced a "crash program" mentality that mobilized the creative energies of the whole population. Countless inventions at the shop-floor level must take place to upgrade the efficiency of any new invention and adapt its design to the specific tasks at hand.

There is also a necessary density that must be reached before a new technology really takes hold. There was a phase change at the end of the 19th century from a steam-powered economy to one dominated by electricity, but this only occurred over time. It was first necessary to introduce a sufficient number of motors into the economy to cheapen the cost of production and allow their assimilation on a volume basis. Today the nation is at the point where laser technology is poised for takeoff, with the potentialities much as predicted in the study carried out two years ago by the Fusion Energy Foundation and the *Executive Intelligence Review*—provided the appropriate changes are effected in credit and related policies. The laser industry is still small, but in the last two years, by any measure, it has registered real growth. People in the field estimate that about 20 to 30 percent of lasers used in machine tooling are used in the aerospace and defense industries, while the rest are spread throughout the economy.

Between 1983 and 1984, total laser output doubled—although it should be borne in mind that most of the growth was in diode lasers, which are the least expensive, costing between \$10 and \$100 each. Nonetheless, all areas of laser production were up. One of the fastest growing areas for lasers is in the field of communications. AT&T has replaced copper wires by 700 miles of fiber optics on the East Coast of the United States, which carry a laser beam that transmits

Table 1
NUMBER OF U.S. MACHINE TOOLS
PRODUCED

1976	1980	1981	1982	1983	1984
169,690	203,193	188,769	118,172	150,837	164,590

Sources: UN, National Association of Machine Tool Builders

Table 2
NUMBER OF LASERS SOLD WORLDWIDE*

Type of laser	1983	1984
HeNe	113,285	212,395
Ion	10,387	10,765
HeCd	1,077	1,430
Dye	655	739
Carbon dioxide	1,664	2,224
Solid state (YAG and ruby lasers)	4,203	4,451
Diode	496,400	979,300
Excimer	355	397
TOTAL	628,026	1,211,791

*60% of laser sales worldwide are by U.S. companies.

Table 3
NUMBER OF LASERS SOLD TO
METAL-WORKING INDUSTRY

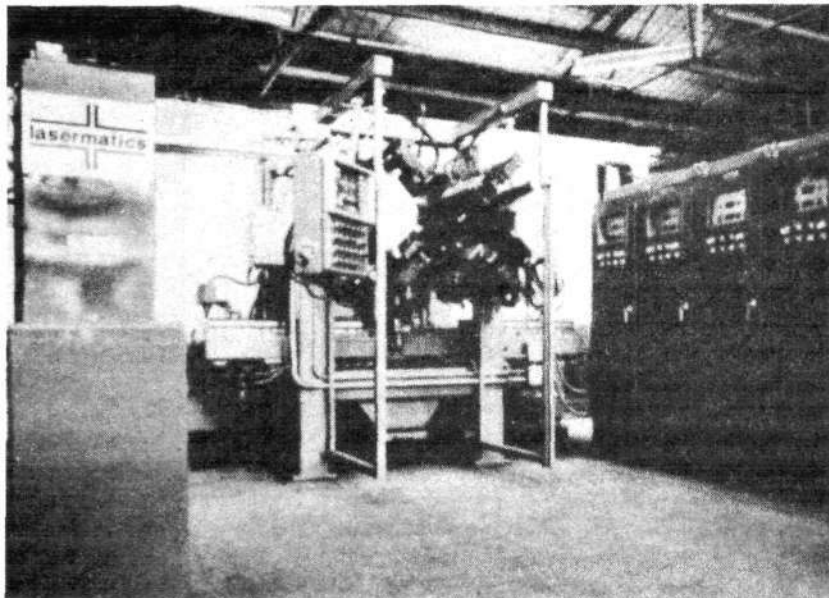
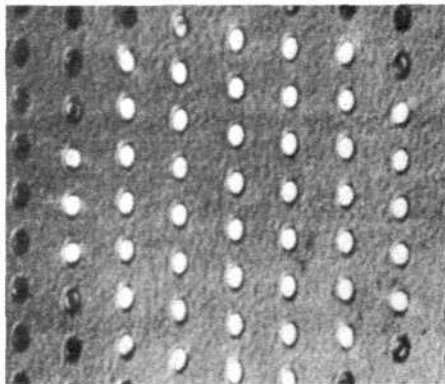
Type of Laser	1982	1983	1984
Carbon dioxide	550	725	942
Solid state (YAG)	600	630	733
Excimer	3	6	
Total	1,150	1,358	1,681

Table 4
LASER SYSTEM USE BY TYPE OF INDUSTRY
(WORLDWIDE)
(in millions of dollars)

Type of industry	1983	1984
Printing/xerography	805	1,095
Optical communications	797	1,067
Color separations	505	570
Tactical military	307	316
Therapeutic medical	199	261
Metrology	203	248
Materials processing	186	233
Audiodisk	105	160
R&D	94	109
Agriculture and construction	76	86
TOTAL	3,442	4,376

Source: *Lasers and Applications*

This automatic multistation drilling machine can simultaneously drill eight .040 inch holes in an automotive camshaft. It eliminates the cost of tool replacement. The savings in drill bits alone economically justify the purchase of the system. Inset are perforated Mylar holes drilled by a carbon-dioxide laser. The holes are smooth and round, with precise hole density.



Courtesy of Coherent General, Inc.

sound at a greatly reduced cost and enhanced speed. This system will be extended to the West Coast.

Although metal-working consumes only a small amount of world laser output (it ranks only seventh among laser users in industry), the rate of growth in this sector was 18 percent in 1983 over 1982, and it increased 24 percent in 1984 over 1983. Total sales for worldwide laser systems (that is, machines incorporating lasers) were \$3.442 billion in 1983 and \$4.376 billion in 1984. The United States would then have produced \$22.50 billion in laser systems in 1984. Since total machine-tool sales were \$2,650 million in 1984, a fair estimate would be that laser machine tools accounted for 4 percent of these sales. The automation of laser production itself, which depends upon the total parameters of laser use, will of course benefit every particular application. One way of cheapening the cost of using a laser machining device is the proliferation of laser job shops around the country, particularly in the northeastern United States. This makes lasers available for the small batch, 10,000 parts-to-be-welded per month, type of job.

The Laser Tool

Although lasers in themselves would not now be the tool of choice for many cutting jobs, they are already demonstrating their value not only for their ability to concentrate energy at high densities, but for their ability to be applied flexibly to varied jobs, from cutting to welding and plating. Best of all, this same flexibility can be put to use in designing and redesigning machine tools with minimum effort. For example, where a punch press is designed to punch holes in preassigned places, based upon the dies that are inserted in the press, the die itself must be changed at a cost of several weeks' time and several tens of thousands of dollars, in order to modify the distance between the holes. With a laser, one need only insert a new program into the machine console.

And, of course, the laser is capable of extraordinary precision. Laser machines now in use can drill holes that are 0.003 inch in diameter. A drill bit would break were it applied to such small holes. One application that is under proprietary wraps at the moment is the making of semiconductor chips for computers; which benefits from the capability of a laser to etch lines at hair thickness. At the moment, lasers are operating in the range of a couple of micrometers. What is needed is an etching line less than 1 micron (micrometer) in thickness, which requires going beyond the ultraviolet range. Excimer lasers are now producing cuts 0.5 micron in width. This is being pursued in the United States and Japan.

One immediate advantage of the application of lasers to machining is the ability to cut without having to adapt a die to the shape being cut. This is especially useful in the case of etching rectangular shapes into steel balls, as in the placement of stems on ball bearings. For example, contrast the use of laser-cutting devices with conventional machines for making the blades that are attached to the end of jackhammers. With the latter, five machines work for 40 hours a week to make a batch of blades, compared to one laser machine working only one eight-hour shift. This laser machine also demonstrates a flexibility that will become typical in the factory of the future. The same tool not only cuts teeth into sliced pieces of metal, but then fuses the serrated metal strip into a straight piece of metal to create the blade. Similar time savings have been reported by General Electric, up to as much as 98 percent.

Lasers can also be used to make nugget welds, which, unlike electric-arc welds, do not require copper flux. With frequent welding, a \$150,000 laser will pay for itself in one year simply by eliminating the copper.

Laser cutting of aluminum and copper has been especially problematic, since these metals tend to absorb the applied heat. But during the past year, with enhanced laser focusing, a YAG laser (a neodymium-doped yttrium-aluminum-garnet laser) has been developed that can cut these metals. It is superior as a cutting instrument to its more

high-powered cousin, the carbon dioxide laser, because of its higher frequency. Coherent-General of Palo Alto, Calif., has found a method of concentrating the energy of the YAG laser at its center, thereby considerably magnifying the energy density that its beam can develop, while maintaining a fine incision. In the coming period we can anticipate large-scale adaptation of methods now being developed to achieve precision targeting of beam weapons, and to achieve further energy densification of lasers at the point of production.

In the area of robotics, while the Japanese are in the lead, Westinghouse has devised a laser-robot hookup that works along a monorail 40 feet long. Another Westinghouse experimental system uses a 25-kilowatt laser to feed six work stations. As a metal-working tool, the laser beam is piped throughout the shop from one central laser source.

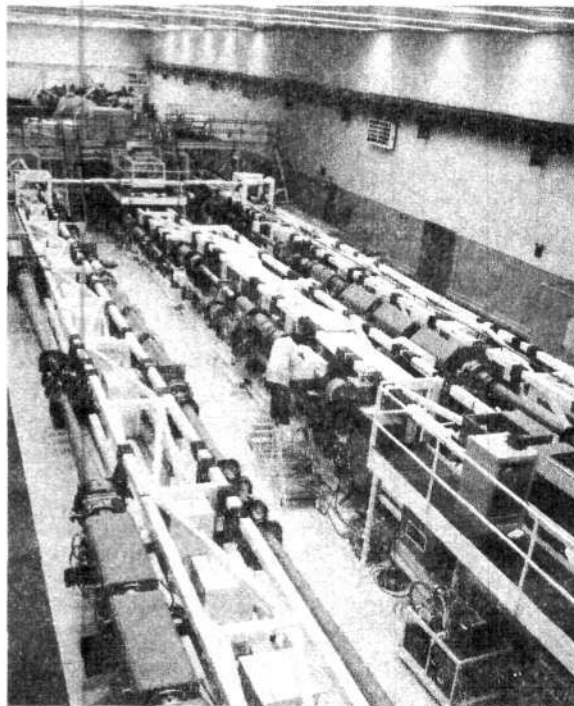
New Materials: The Case of Zirconium

One of the most significant elements of the new industrial revolution will be the introduction of new materials into production. Now, a key bottleneck preventing leaps in productivity comes from the limits imposed upon the efficiency of machines by the inability of the materials of which they are composed to tolerate high temperatures or extreme variation in temperature. Other problems are durability and resistance to corrosion. It is the latter, for example, that prevents the use of hydrogen as a replacement for petrochemicals.

Materials are also the limiting factor in a large array of higher-temperature processes using lasers, plasmas, and advanced nuclear technologies, which should otherwise be commercially available, but are not economically attractive under current depression conditions. The SDI program and its space infrastructure will push currently available alloys and ceramics to their limit, while also requiring the development of new materials. The SP-100 nuclear reactor in space program, for example, demands reactors that are both compact and efficient. This means that they must be able to operate at a higher temperature. This program is already transforming the state of the art in materials.

Over the past two years, this nuclear reactor development program has again become a focus for NASA, the Department of Defense, and the Department of Energy—not, as in the past, for propulsion, but for space-power production for laser, particle beam, radar, and other military systems. This SP-100 program, jointly sponsored by the above three agencies, and a parallel effort that will develop power sources larger than the 100-kilowatt SP-100 program, are resurrecting the materials work stopped in the early 1970s. One material coming to the fore is partially stabilized zirconium, a ceramic originally developed in 1977 by an Australian firm, Nilcra Ceramics, and patented in the United States in 1981. The three U.S. government agencies are presently considering use of some form of zirconium to strengthen refractory metals slated for use in the SDI space nuclear reactors against thermal shock.

Pure zirconium is a ceramic with a high melting point. Although it is immune to chemical attack, in its pure form it is very brittle. At 1,090° Celsius it undergoes a change in its crystal structure, which usually results in cracking and then the decomposition of the material. Recently it has



James E. Stoots/LLNL

Lawrence Livermore's two-beam Novette laser used in laboratory experiments that promise the development of an X-ray laser capable of three-dimensional imaging of living processes at the atomic level.

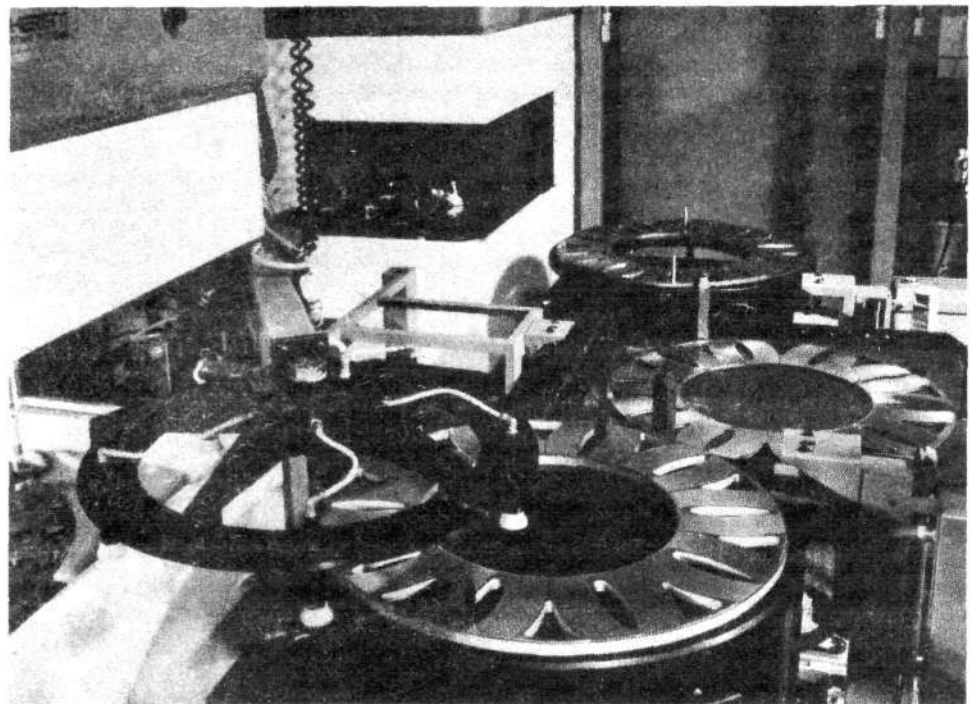
Lasers for Defense

Lasers are a key element in any effective antibalistic-missile system because of the speed with which they can deliver energy on target, their ability to concentrate that energy to deliver a knock-out punch, and the more subtle effects that are possible by "tuning" the delivery of a graduated series of shock waves to a target in order to render it dysfunctional by induced phase changes. One of the key elements of laser targeting is, of course, the alignment and focusing of the beam. These systems demand the most advanced computer controls and diagnostic capabilities. Not only must the beam be able to pinpoint its target, but it must be able to discriminate between live missiles and drones. All these elements of the system, applied to industrial production, provide greatly enhanced capabilities.

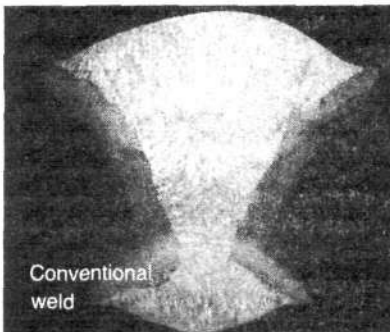
As the Japanese experience now shows, we are on the verge of a revolution in robotics that can introduce the automated factory. The wedding of advances engineered through the Strategic Defense Initiative (SDI) program to these systems will continually upgrade their potentialities. At the same time, there is the possibility of introducing a whole array of new metals and ceramics into production. To engineer most efficiently the kind of industrial revolution this implies, will demand real time diagnostics of the sort being developed through the SDI.

This laser welding system is designed to weld heat exchanger plates used in large turbine engines. Its two carbon-dioxide lasers and computer numerical controllers direct the entire welding operation as well as the load/unload robot and automated tooling set.

The cross sections of welds (below) on 1/2 inch steel indicate why laser welding produces dramatic improvements in productivity. The conventional weld required several passes, while the laser weld was accomplished on one pass. The 15-kilowatt laser travels at 47 inches per minute. The diffuse heating in conventional arc welding distorts the stock and may require hours of treatment to restore it to planeness.



Courtesy of Coherent General, Inc.



Conventional weld

Naval Research Laboratory



Laser weld

been found that alloying zirconium with magnesium, calcium, or yttrium produces a material that can withstand 300,000 pounds per square inch of pressure. Materials such as zirconium can only be introduced into production as methods of handling them become available. Lasers are an essential element in this configuration, because they are able to cut through such materials. For example, the ribs of aircraft are made with the super-hard metal titanium, which is easily cut with a laser, but otherwise requires the exertion of tremendous force.

The SP-100 program has plans to use one of two heat-resistant metal alloys for the fabrication of heat pipes. One of these, tantalum, will be doped with zirconium. This metal has a melting point at 3,269° Celsius. The application of the design features developed by the SP-100 program to the growth of a second generation of commercial nuclear reactors, particularly in the design of high temperature gas reactors to give greater efficiencies of power generation, is essential if the nation is not to be held back by a severe power shortage. And, of course, the greater thermal efficiencies would significantly cheapen the cost of power generation.

Energy efficiency would also be achieved by the use of hydrogen gas as a fuel. The cost of cracking water to produce hydrogen is directly dependent upon the heat at which the process takes place. This in turn depends upon a heat source as well as upon the availability of heat- and corrosion-resistant materials. It is foolishly wasteful to burn petrochemicals, which are potentially limited and are only now in apparent oversupply because of the present severe contraction of production. Partially stabilized zirconium (PSZ) has recently shown in successful laboratory tests that it can withstand the necessary high temperatures. What is lacking is the heat source itself. The present sabotage of the commercial nuclear power program not only has stopped the building of nuclear reactors in general, but also has prevented the development of the high-temperature gas reactor, which could provide a cheap source of high-temperature process heat.

One immediate spinoff from this work is the development of internal combustion and Stirling cycle external combustion engines that could at least double the efficiency of current engines, because they operate at higher temperatures. The U.S. Army Tank and Automotive Command is funding research and development at Cummins Engine Co., in Columbus, Ind., for the development of an adiabatic diesel engine. The goal of this research is the production of 70 percent thermal efficiency as opposed to the 30 percent efficiency of current diesels.

This advance is made possible by the development of ceramics that have properties like those of steel, except that they can withstand the higher operating temperatures required to attain the desired thermal efficiencies. The optimal ceramic for use in engines and the one that the Army-Cummins program is built around turns out to be partially stabilized zirconium.

In laboratory tests so far, the Cummins engine has achieved a thermal efficiency of 48 percent. Cummins drove

a truck with one of these engines 10,000 miles, with reportedly excellent results. The engine does not require a radiator to dissipate heat. Cummins has dispensed altogether with 360 parts in addition to the radiator, by making cylinder linings, piston caps, valve guides, valve seats, and so on, out of partially stabilized zirconium, so that the engine can operate with cylinder head temperatures of 760-870° Celsius. This produces a savings of 420 pounds in the weight of the engine, compared to a water-cooled diesel of the same power.

The Army is interested in the engine because radiators are the most vulnerable spot in a tank. In order for the radiator to dissipate heat from the engine, it cannot be heavily armored. The result is that a single projectile into the lightly armored radiator stops a tank dead. Reportedly, the temperatures in the combustion chamber of the test engine are so high that one could use rags for fuel, not to mention kerosene. Cummins is now trying to use the partially stabilized zirconium to eliminate the need for oil, to further reduce heat loss, and to raise the thermal efficiency even more. They plan to use solid lubricants for point contact and leave the lubrication of the pistons and other moving parts to the circulating fuel itself. The Japanese are already making replacement engine parts out of partially stabilized zirconium, but do not appear to be working on a new engine design.

Making New Alloys with Plasmas

High-quality metal alloys are made today in electric arc furnaces that operate at about 1,650° Celsius. Research in fusion energy and plasma physics over the past two decades has opened up the use of plasmas at an order-of-magnitude higher temperature, where more materials can be alloyed to steel. The most advanced plasma steelmaking process in the world is nearing commercial demonstration in New Jersey by a private company. Only the underinvestment in the steel industry over the last decade, and now the current outright demolition of capacity by the major steel producers, has prevented this revolutionary new technology from placing the United States in world leadership in this crucial materials field.

The plasma furnace uses a high-temperature inert gas that has been ionized, consisting of positively and negatively charged particles. At 20,000°, no material could contain this hot gas; therefore, as in fusion experiments, magnets surround the furnace to hold the plasma in the shape of a cone. Pellets of the materials to be refined are dropped into the furnace from the top, and in the 0.45 second it takes the pellet to fall to the bottom of the furnace, the material has been refined. At these increased temperatures, alloys with barium and tungsten can be created.

These super-hard materials can be used for tool steel, which cannot be cut even with a diamond. Rather than changing the tool in an automatic lathe, for example, after each eight-hour shift, this new alloy extends the life of the tool from seven to ten times. The barium and tungsten alloys can withstand temperatures up to 2,210° Celsius, compared to the 1,650° of today's tool steels, and are oxygen-resistant.

A significant stimulus to the design of new materials can

be expected to come from the need to improve laser optics in beam weapons. In mid-February, the Los Alamos National Laboratory began a joint \$3 million program with other laboratories and industry to develop improved optical coatings for use in defense weapons systems. In order to at least double the currently available power of lasers for military applications without damaging their optics, basic research in materials, laser-material interaction, and chemistry will have to be performed.

As in many other fields of SDI-funded research, there will be numerous applications in industry from the technology developed through this program. An understanding of how lasers interact with the coating materials on their optical components in different kinds of environments will allow the development of new coatings tailored for specific uses. These new materials will extend the range of lasers used in industry. Lasers depend upon mirrors that amplify the reflected laser beam in their internal design. Large mirrors located in space will also be used to target laser beams propagated through space.

The SDI office has asked Los Alamos National Laboratory to develop materials that will enable mirrors to withstand a factor of 2 or more power than laser optics can withstand today. In order to do that, scientists will first have to develop an understanding of how coatings less than a millionth of an inch thick react when exposed to corrosive chemicals and intense radiation, because defense lasers and external mirrors could find themselves in hostile environments. Scientists estimate that the thin-film coatings, which are usually metallic oxides and fluorides evaporated onto a base material, can be made from 10 to 100 times more damage resistant.

Of course, the converse is also true. Increase in knowledge of how lasers interact with materials will improve the ability to kill missiles efficiently, which after all is the point of the SDI program. In some industrial processes such as laser welding, laser-induced "damage" is also the aim of the process. In many cases today, getting the weld desired



Courtesy of Cummins Engine Co., Inc.

The adiabatic diesel engine in this Cummins truck operated at temperatures of 760° to 870° for 10,000 miles with excellent results. The design makes use of partially stabilized zirconium and eliminates the need for a radiator as well as 360 other parts.

is a hit-or-miss estimate, in terms of the length of the pulse or power level of the laser itself. If materials specialists understood more precisely how the laser "damages" the materials being welded, the laser pulse could be shaped for precision applications.

For example, when the laser is applied to a material, it creates a plasma vapor at the surface. At high power densities, a plasma wave propagates back up the laser beam. Up to a certain level, this plasma wave radiates heat back to the target material, enhancing the welding. Too high a power density can form that plasma into a shock wave, which can block the laser and reduce the efficiency of the energy coupling between the laser and material. It is also the case that the functioning of lasers themselves for industrial purposes could be improved by an in-depth understanding of laser-materials, such as the carbon dioxide laser, which produces its coherent light through a chemical reaction. The reaction can damage the optical components of the laser, causing clouding and other problems.

Laser Chemistry

There could also be significant improvements made in the use of lasers in chemistry—such as isotope separation, the creation of more powerful agents to clean up radioactive waste, and other processing techniques. In these situations, the chemical interaction of the laser and material to be processed can produce a drift of chemical reactants out of the chamber where the laser chemistry is taking place, back to the laser, causing damage. The use of lasers in chemistry and the use of chemical lasers would both benefit from a scientific understanding of how the laser couples its energy to create various chemical reactions. Although industry may not use lasers at the power level that the SDI program is examining, if the one-shot threshold for optical damage is improved for military applications, it will also improve the reliability of multishot industrial processes at the lower power levels.

Since the development of laser technology in the 1950s, attempts have been made to use lasers in chemical applications; however, so far, lasers are actually applied on a broader scale only in a few areas of chemistry. The main argument against laser use here is that investment in laser-produced photons is not economical; traditional methods, although much less efficient, are considered to be superior. This may have been true until some years ago, but now efficient lasers of all different wavelengths and intensities are available, so that a reconsideration of potential applications of lasers in the chemical and pharmaceutical industry is overdue.

One of the most obvious applications of laser-generated photons is the production of Vitamin D, which the human body itself synthesizes in the skin by means of the ultraviolet spectrum of sunlight. The method to apply laser light in this process was developed in 1982 at the National Research Council in Ottawa, Canada, but has not been used. "It is commercially not feasible," commented Dr. Peter Hackett, the chief researcher at the Council, in an interview.

Actually, laser application in Vitamin D production could serve as a paradigm for other areas. It works as follows: A

laser beam of a specific frequency will selectively excite only one of the reacting molecules, and a second laser at a different frequency inhibits the creation of an intermediate product, which would impurify the substrate. Laser application leads here to a yield of up to 80 percent of the end product, instead of a yield of only 35 percent with the traditional arc lamp as a light source. A similar process could be applied to produce the hormone prostaglandin, which is important in many metabolic processes in the human body.

A broad area of potential laser application is also the production of antibiotics, most of which are still produced now by rather expensive, inefficient means.

In fact, the only broader scale use of lasers is in the field of isotope separation, especially used for the separation of uranium atoms. One of the processes in use exploits the fact that U-235 absorbs energy of laser light at a different wavelength than does U-238, so that an ion extractor based on electromagnetic fields can separate the two ions. Two other processes with significantly higher efficiency than the old, energy-intensive method are known; however, all industrial-scale application capabilities are now under strict classification for military reasons.

The purification of chemical products with lasers proves to be a very efficient method, utilizing the different absorption pattern of the contaminating substances in materials, which should have a high grade of purity.

Basic research must be directed specifically to study the effects of tuned lasers upon molecules and molecule combinations, to be able to apply photons in a way that controlled changes in these molecules occur. So far these processes are poorly understood, as tuned energy applied to specific chemical bonds, for instance, is redistributed too quickly over the whole molecule, before it can effect the wanted result. Some knowledge of these effects, a kind of fluorescence generated by specific resonance frequencies in atoms, is so far used only to study the reaction of certain chemical processes at the laboratory level.

Other Spinoffs

Although superconductors have existed for the past two decades, the expanded demand for their development in connection with the use of large accelerators to project electron beams should have a revolutionizing impact on production, similar to the earlier development of semiconductors. A superconductor, when cooled to near absolute zero, is capable of transmitting large electric currents without any significant level of resistance. The mechanical analogy would be to a frictionless machine, because without resistance there is no heat loss in the operation of the circuit. The only loss in transmitting the electricity then would come from the energy cost for maintaining the superconductor at cryogenic (near zero) temperatures. At 99 percent efficiencies, this can be made practicable.

The SDI program depends upon vastly expanded computer capabilities, in order to process the vast amount of information necessary in real time. One line of development is in optical computers, and along with this is further development of what are called systolic systems; that is, computers that can carry out many parallel functions at one

time. A further line of development would be use of organic chips; however, these have such fine-scale gauges that messages would have to be conveyed at X-ray frequencies. The development of organic material capable of sustaining X-ray irradiation without damage is now being worked on with genetic engineering techniques.

For more than two decades, the power of computers has been increased every year by about a factor of 2. This steady advance in computing power has been almost entirely the result of improvements in computer hardware, by reducing the scale of circuitry. Obviously, any such computer developments immediately have an impact on the potentialities for the fully automatic factory.

A new development has recently occurred within the domain of linear programming, which may vastly improve the speed of computation. The author of this new system, Narendra Karmarkar, a mathematician now working at Bell Labs, claims that while the number of computations needed to solve linear programming problems with the simplex method can grow exponentially with the number of variables involved, his new method requires calculations that grow only in direct proportion to the number of variables involved.

It was, of course, the Apollo project that gave the greatest stimulus to the computer revolution, with the development of semiconductors cheap enough to become commercially feasible. It has been conservatively estimated that for every

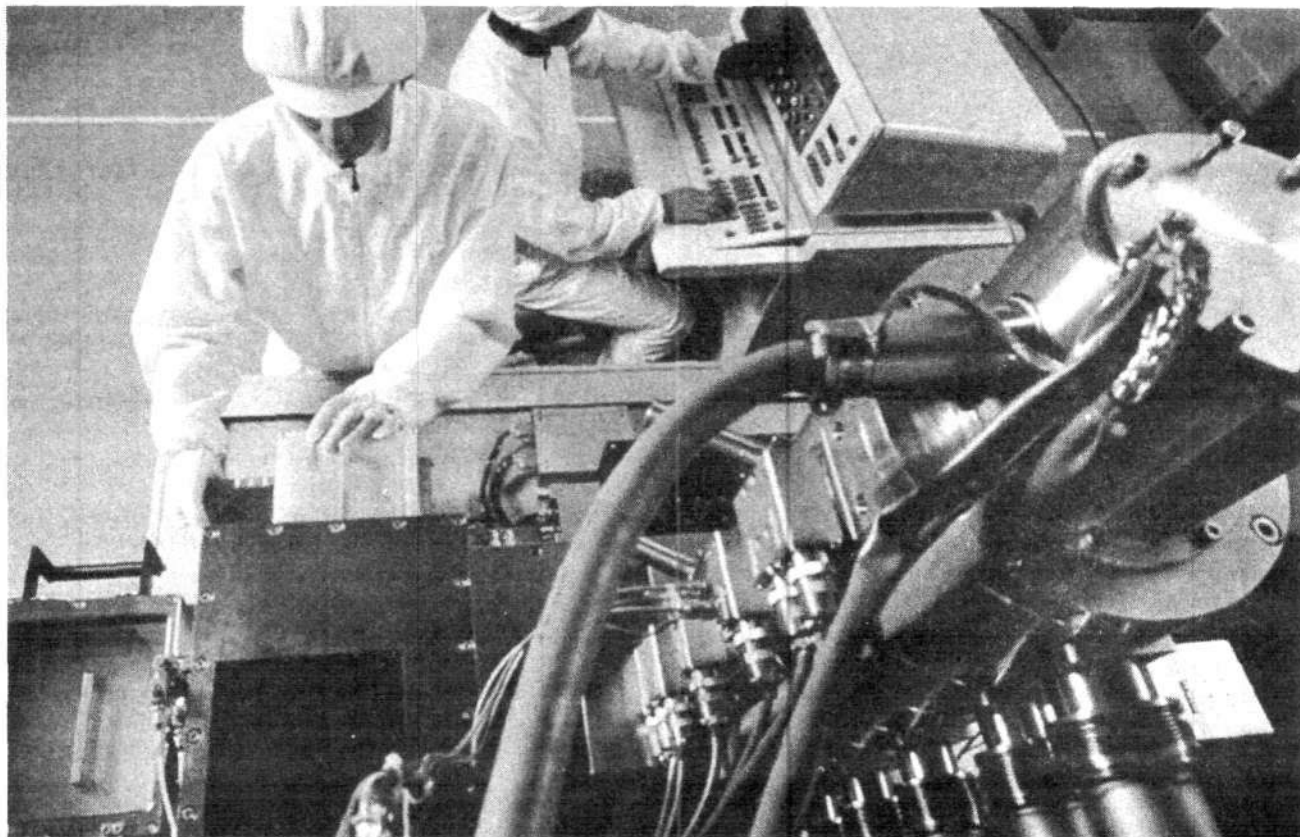
dollar spent by NASA, \$10 was returned to the economy. The SDI has a far wider technology mandate. Over the past year, NASA has once again geared up its apparatus for reaching industry to transfer space-program developed technologies. The SDI office, on the NASA model, has started to hold workshops with potential industrial contractors who will be researching and building the future defensive systems. In addition to briefing the contractors themselves, the SDI office could begin to establish pathways for non-defense corporations to become involved in the transfer of new technology as it develops.

All of this can and will occur only in an economic climate in which new capital investment is being made at an accelerated rate, as opposed to the present system, in which existing capital infrastructure, like that of the steel industry, is being destroyed without replacement.

Carol White is the editor-in-chief of Fusion. This report is based on material researched by Marsha Freeman, Richard Freeman, Charles Stevens, Robert Gallagher, and Wolfgang Lillge.

Notes

1. This report, "The Potential Economic Impact of Relativistic Beam Technology," was issued by the *Executive Intelligence Review* in June 1983 and is available from the Fusion Energy Foundation at \$250.



Courtesy of Hitachi

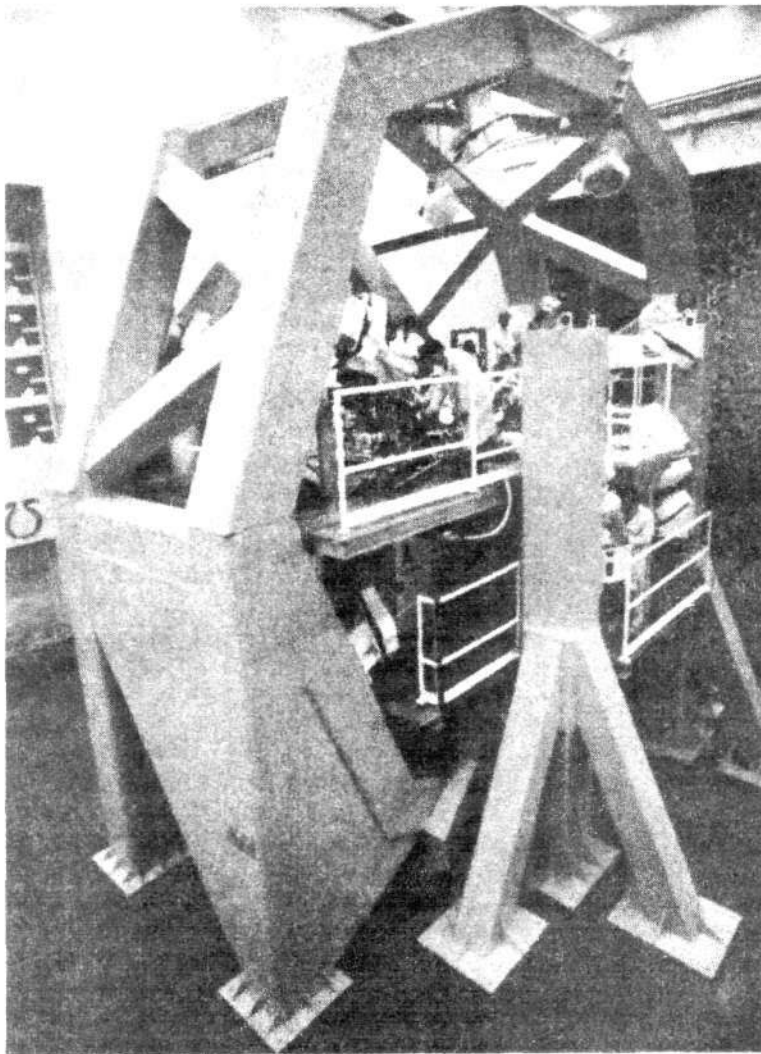
Hitachi engineers with an electron beam lithography device that uses the sharply focused beam to write complex patterns on silicon wafers.

Rochester University's Laser Energetics Laboratory is the home of the record-breaking Omega laser fusion device and a thriving center for laser technology research.

Rochester's High-Power Laser Fusion Lab

*Research on the
Frontiers of
Science*

by Charles B. Stevens



LLE
The Omega laser experimental chamber is in the center of this massive structure.

In suburban Rochester, a few miles south of Lake Ontario in upstate New York, scientists at the University of Rochester's Laboratory for Laser Energetics direct a concentration of energy 20 times more powerful than the total generating capacity of all the electrical power plants in the United States. This tremendous energy is in the form of the Omega laser's 24 beams, which can be focused onto a target less than 0.001 inch wide. The beams are about 12 inches long, and traveling at the speed of light, it takes these powerful beams less than 1 billionth of a second, a nanosecond, to deposit their energy. Just a few days after the Omega laser came on line this spring, it set the record for generating laser fusion energy, with more than 1.6 trillion fusion neutrons measured.

The University of Rochester Laboratory for Laser Energetics, or LLE, was established in 1970 as a joint effort of the University, New York State, and private industry. Its unique capabilities and competence were recognized when the federal government designated LLE as the only National Laser Users Facility among the national laboratories that are part of the Department of Energy's controlled fusion research program. In fact, LLE is the most powerful and versatile research facility readily available to scientists throughout the world, including researchers from academic and medical institutions, industry, and government.

Although the harnessing of laser fusion energy is the major mission of the Laboratory for Laser Energetics, scientists at the lab are involved in other laser research that promises to revolutionize every field of science and industry. This broader role of the LLE was featured at a conference titled "Lasers and Particle Beams for Fusion and Strategic Defense," held at the Lab April 17-19 to coincide with the dedication of the full-power, blue Omega laser.

The 24-beam Omega puts out more than 12 trillion watts of laser light. Recently it was converted to the short-wavelength, ultraviolet 0.351 micron—a laser wavelength that is called "blue." The advanced laser and optical technology developed at the University of Rochester has allowed the Omega to have one of the highest repetition rates in the world for high-power lasers. Omega can be fired every 30 minutes, while other facilities, like the 130-trillion-watt, 10-beam Nova at Lawrence Livermore National Laboratory in California, generally are capable only of just a couple of laser shots per day.

This makes the Omega very productive for research. Over the past three years, more than 21 user experimental programs have been carried out on the Omega.

At the Frontier of Laser Science

From its inception, the Rochester lab has been dedicated to exploring the full range of scientific and industrial applications of powerful lasers. Specifically, in its charter, the LLE is dedicated "to investigate the interaction of intense radiation with matter."

A look at some of the ongoing research projects conveys a sense of the breadth of the Rochester lab's work with high-power lasers:

- Generation of bursts of radiation lasting less than a trillionth of a second—a picosecond—and ranging from the long-wavelength microwave region (inches) to the short-

wavelength X-ray region (angstroms or atomic radii) of the electromagnetic spectrum. Combining and synchronizing with picosecond laser pulses provides a unique means for the examination and recording of rapid microscopic processes. This diagnostic is utilized in observing solid-state physics processes—the science of computer microchips, imaging of biological specimens and metabolisms, and chemical-reaction dynamics.

- Generation of picosecond electron beams and electric pulse detection. This provides a new way of imaging fast processes and resolving microscopic resonances in the structure of various materials.

- Development and application of ultra-high speed (trillion times a second, a trillion hertz) sampling systems.

- Creation of new types of optical materials and coatings for high-power, short-wavelength laser light and radiation.

- Short-pulse, subnanosecond, high-resolution X-ray diffraction and crystallography.

- X-ray laser development and application.

- Demonstration of high-resolution X-ray lithography to print microchips.

- Development of high-repetition-rate, high-efficiency, high-power glass lasers.

- Applications of solid-state switching technology to picosecond, time-resolved spectroscopy for both biology and chemistry.

Over the years, the Rochester lab has also accomplished a number of "firsts," pioneering research in laser fusion itself. The lab conducted early experiments demonstrating the presence of nonlinear "parametric" processes in the interaction of laser light and matter. It made the first direct measurement of compressed fuel density in laser-driven targets and the first comprehensive measurements of harmonic and subharmonic emission from spherical laser fusion targets. It also did pioneering work on high-gain, nonlinear, low-index-of-refraction phosphate glass for high-power lasers, and it developed efficient nonlinear methods for upshifting laser light frequencies—making shorter wavelengths out of longer ones.

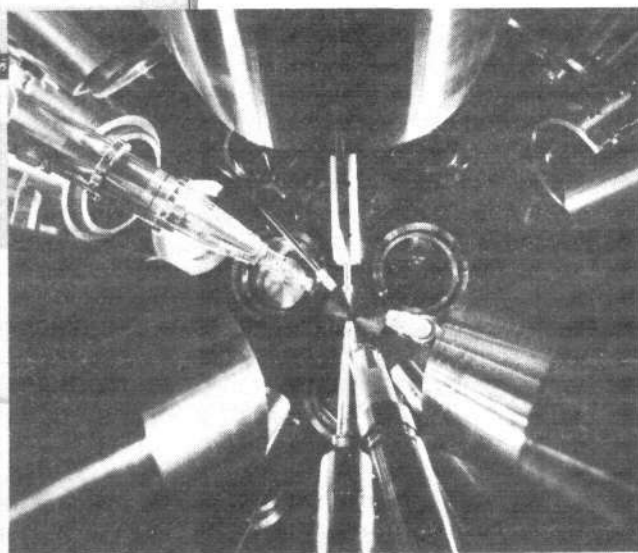
This last "first," efficiently making shorter wavelengths out of longer ones, gives some indication of how laser technology could increase U.S. industrial productivity. The innovation has already saved the Department of Energy more money than the entire cost of the LLE facility!

Upshifting Long Wavelengths

By the late 1970s, it became clear that if there were to be any significant progress in laser fusion, existing high-power lasers would have to be efficiently converted to higher frequencies—shorter wavelengths. This is because longer-wavelength laser light is not efficiently absorbed in matter, and the energy that is absorbed produces large fluxes of high-energy electrons, sometimes called hot electrons. Hot electrons, in particular, make the design of laser fusion targets very difficult—if not impossible. The hot electrons penetrate to the interior of the fusion fuel pellet, while it is being compressed, and heat the fuel before maximum compression is reached. To achieve high-gain laser fusion, it is important to compress fusion fuel to extreme densities with a "cold isentropic" implosion. The preheating of the



The Omega laser system: 20 times the entire electrical generating capacity of the United States. Inset is an inside view of the target chamber showing the target support stalk, focusing lenses, and diagnostic systems.



LLE

fuel by these hot electrons prevents this. It has been shown that higher-frequency, short-wavelength laser light does *not* generate hot electrons, and simultaneously achieves high absorption efficiencies—effective coupling to the target.

The most powerful lasers in operation are made of glass embedded with rare earth elements that produce laser light in the near infrared region—with wavelengths of 1 micron (micrometer). The wavelength thought best for laser fusion is in the range of 0.25 to 0.33 micron. Thus, some means had to be found to efficiently convert the 1-micron wavelength into such shorter wavelengths. There were methods then in use for doing this, but they were less than 50 percent efficient.

In 1980, Dr. Stephen Craxton of LLE proposed a new, nonlinear method for efficiently upshifting the frequency of laser light. Craxton's primary area of research has not been that of optics or lasers as such, but the design of laser fusion targets. Target design involves the way in which shock waves generated at the surface of a pellet of fusion fuel compress and heat it to fusion conditions. This is essentially a hydrodynamic problem and does not directly involve questions of laser-matter coupling and optics.

An LLE experimental team demonstrated Craxton's method of laser light conversion in 1980, and it had better than an 80 percent efficiency—almost twice that of previous methods. This meant that laser facilities could double their laser fusion capabilities. The new method alone saved the

Department of Energy tens of millions of dollars on the mainline U.S. Nova laser system at Lawrence Livermore.

How It Works

The Craxton method of laser upshifting simply involves the proper positioning of two crystal slabs through which the laser light is passed. The particular crystalline material involved is potassium dihydrogen phosphate (KDP). When a laser beam passes through a crystal, the beam travels with a speed that depends on its color (wavelength), its polarization (the geometrical alignment of the electric and magnetic fields, which constitute the laser light wave), the angle at which the beam intercepts the optical axis of the crystal, and the crystal's temperature. Normally, different colors travel at different speeds in a material; this is what causes the refraction of white light into the colors of the rainbow in a prism.

But polarized light, when directed at particular angles to the optical axis of a crystal, will have the same velocity at different colors. When this happens to two coherent beams at differing wavelengths, they combine to form a beam with a single, shorter wavelength; and this nonlinear upshifting can occur for beams of differing wavelengths as well as of the same wavelength. Therefore, aligning the KDP crystals at the proper angle to the incident laser beam leads to its upshift. When the incident laser light is at the same wavelength, the upshifting process converts only about two-thirds of the beam to the shorter wavelength. But by doing

it twice, a total of 80 percent of the original beam can be converted.

At LLE, the process involves passing the laser light through two KDP crystals that are rotated 90 degrees with respect to each other. These two crystals must be tightly aligned with the incident laser beam, and their temperature must be maintained within a fraction of a degree. When a laser beam passes through the first crystal, about 67 percent of it is converted from 1.0 micron infrared to 0.5 micron green light. The remaining 33 percent of the infrared light passes through the first crystal unchanged. The green light is called the first harmonic of the infrared, and has exactly double the frequency.

When both the remaining infrared and converted green light pass simultaneously through the second crystal, they combine to form 0.351-micron blue light at about an 80 percent total efficiency.

Blue Light and Short-Wavelength Coupling

The enhanced absorption and reduced hot-electron generation with blue ultraviolet light not only aid the production of high-density implosions for fusion energy production; they also provide the key to the generation of a wide range of X-ray radiation frequencies and energy pulse shapes. In itself, reaching the ultraviolet portion of the spectrum is extremely important—it represents the transition to efficient atomic action.

Imagine that the atom is like an assembly of concentric gears, with the innermost gears having the greatest energy flux densities of application. In this case, though, the "wavelengths" of the gears decrease as one proceeds to the energy-rich interior. The outer gear is the easiest to access because it has the longest wavelength and slowest speed of rotation. Attempting to act on it, though, with too long a wavelength of radiation could lead to the gear breaking before it is usefully engaged. The ultraviolet region represents the point where the radiation wavelength is matched to that of the outer electron orbits of the atom—the "gears."

In addition to engaging outer electron orbits with the precisely correct wavelength, which permits highly efficient management of chemical reactions, more significantly, the ultraviolet makes visible how these "gears" work, especially in molecules and crystals. Thus, real molecular engineering becomes possible.

In the Craxton upshifting system, this process is reversed by utilizing the higher harmonics of a crystal lattice. When the incident angle is correct, the lattice as a whole is able to absorb the radiation and reemit it at a higher frequency. The key to this process is polarization. The KDP crystals have two axes of polarization. That is, when an object is viewed at the correct angle through the crystal it will appear as two separate images. This double refraction provides the means to generate the upshift.

As Christian Huygens first pointed out in the 1700s, double refraction seen in calcite crystals demonstrates that light is not a simple transverse wave. Take, for example, a jump-ropes that carries a vertically directed wave. A picket fence with vertical slots will permit the vertical rope wave to pass unaffected. But if the jump-rope has a horizontal motion, the wave will not pass through the picket fence. If there are



Dr. Stephen Craxton holds a sample of KDP crystal, the type used in the frequency-tripling process he invented to convert infrared laser light to ultraviolet light.

two successive fences, one with vertical and the other with horizontal slots, this would appear to prevent the transmission of any transverse wave, no matter whether its polarization is vertical or horizontal. But calcite transmits and can produce two images, each of whose polarizations is at right angles. This shows that electromagnetic waves are not simple transverse sine waves, but rather have a form like that of a cylindrical helix. It is this same property of light that produces self-focusing in lasers, and this is what Craxton made use of to achieve a frequency upshift.

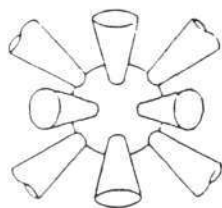
Direct Drive Fusion

The Rochester LLE is the leading U.S. lab exploring the development of direct-drive inertial confinement fusion. In this approach, laser beams are directed onto a spherical target containing fusion fuel. The deposition of the laser energy on the surface of the target causes an outward explosion of plasma. This outward explosion, in turn, produces an inward force—action and reaction as in a rocket—which shock compresses the fusion fuel to high densities.

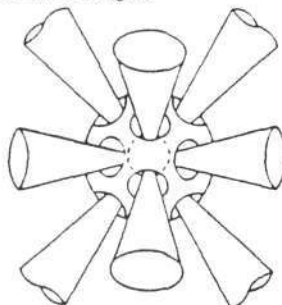
The key to attaining the high fuel densities needed for high gain fusion is that of achieving the highest compression pressures. One way of enhancing the power density, and therefore the pressure, of the laser beams driving the implosion is to arrange for the target to be in the shape of a hollow sphere, a spherical shell. This means that the spherical shell can be accelerated over the distance of the inner radius before any resistance to the compression is encountered.

One problem with this is that all portions of the spherical shell must arrive simultaneously at the center. If this is not the case, the focusing of spherical geometry will be lost and the fuel will not be compressed. Given that any practical irradiation scheme must involve small asymmetries in the

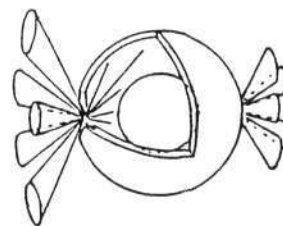
(a) Direct-drive target



(b) Cannonball targets



12 holes



2 holes

Figure 1

LASER FUSION TARGET CONFIGURATIONS

In the direct-drive target shown in (a), the cones represent incident laser beams that are symmetrically directed onto the surface of the sphere of fusion fuel. As the beam energy is deposited, the surface of the fuel target is boiled off, creating an oppositely directed force toward the center of the fuel target, and compressing the fuel to high densities. The fuel will now burn up before it blows up; that is, the small ignited core will generate sufficient fusion energy to heat and burn the remaining fusion fuel.

In the cannonball targets shown in (b), the incident laser beam cones are trapped within the cannonball. In this indirect-drive method, the incident beam energy is transformed into another form of energy, usually X-rays, that then compresses and heats the fusion fuel target.

application of the driver energy to the surface of the pellet, the imploding spherical shell will experience small perturbations along its surface. These small-scale waves can grow at the expense of the implosion energy. More significantly, they can lead to larger wave motions along the pellet surface that preclude simultaneous arrival at the implosion center.

Understanding and controlling this process—often termed the Rayleigh-Taylor instability—is key to minimizing the driver power needed to attain high gain fusion.

Within the national weapons laboratories a second approach to laser fusion is being explored based on indirect drive. In this case, the laser light is first converted to soft X-rays within a chamber called a *hohlraum*. An example is shown in Figure 1, the Osaka cannonball design developed at Japan's Institute for Laser Engineering at Osaka University.

The cannonball is the hohlraum. The laser light is introduced at an oblique angle through the small holes in the cannonball and is then absorbed by the interior wall of the cannonball. The wall then emits X-ray radiation and hot plasma. The plasma rapidly covers the entrance holes so that all of the radiation is trapped within the cannonball. The plasma also scatters the X-ray and remaining laser radiation so that it becomes quite symmetrically dispersed within the hohlraum; that is, it becomes what is called blackbody radiation.

The fusion fuel is contained within a spherical target at the center of the cannonball and the highly symmetric blackbody radiation drives the implosion of this pellet.

Because of this high level of symmetry, the hohlraum design can drive very hollow fuel targets, thus achieving the highest geometric multiplication of the driver power. In fact, the ratio of the target's overall radius to the thickness of the shell can be as high as 40 to 50. (This ratio is

often called the *aspect ratio*.) The direct-drive system does not appear capable of attaining such high levels of irradiation symmetry; therefore, it must operate at lower aspect ratios that necessarily involve higher driver powers in order to attain high-gain fusion. In general, it is currently believed that direct drive can only stably implode targets with aspect ratios of less than about 10, even with a large number of incident, uniform laser beams.

Hohlraum targets, however, also have numerous drawbacks. In the first place, while necessary driver power is reduced, the total beam energy needed is increased, because a significant fraction of the beam driver input is absorbed by the hohlraum itself. Potentially far more serious, the long plasma scale lengths and limited angles of irradiation inherently involved in hohlraums may lead to laser absorption problems.

For example, most of the incident laser beam will have to transit a plasma generated from the interior surface of the hohlraum by the first part of the beam. The length of this path must be much longer than with a direct-drive target, because the indirect drive beam must generally come at an oblique angle to the irradiated surface. In direct drive, the perpendicular (normal) angle of attack is used. This longer plasma scale length means that the incident laser beam has far more chance to interact with the blowoff plasma before it reaches the irradiation surface, and plasma-laser interactions produce highly nonlinear effects, such as hot electrons.

Possibly more significant is the fact that in the simple hohlraum that the Japanese are pursuing, the angle of irradiation is not parallel to the direction of the plasma blowoff density gradient. In general, the plasma blowoff density will decrease, and this variation occurs along the normal to the irradiation surface. In the cannonball, the path of the laser is necessarily at an angle to the irradiation surface.

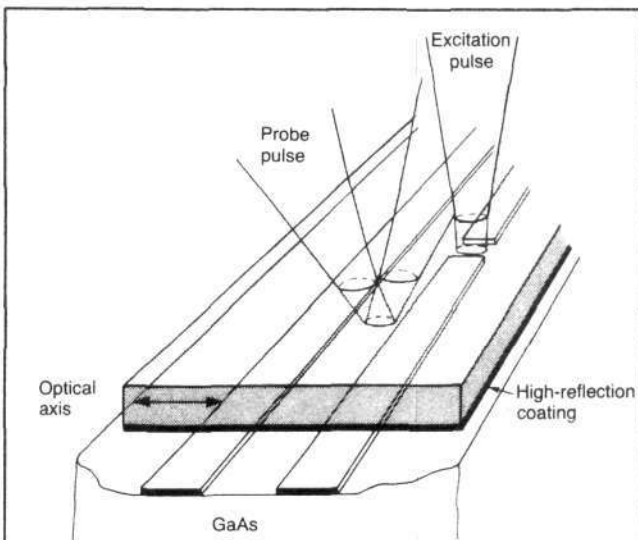


Figure 2
REFLECTION-MODE SAMPLER
TO MEASURE HIGH-SPEED PULSES

This LLE device has a spatial resolution of 10 to 15 micrometers and a temporal resolution of .75 picosecond and is used as instrumentation with very high speed semiconductor devices. An electrical signal, the excitation pulse, is generated by laser-induced photoconductivity in the gap. As the signal propagates down the transmission line, the electric field it generates penetrates into the thin slab of LiTaO₃ and changes the slab's optical properties according to the strength of the electrical current. This electrically induced change is detected by a laser probe pulse that is reflected by the high-reflection coating on the slab.

While there are some references to this question in the scientific literature, there is no thorough review of the issue. Yet this type of important question must be addressed if the advantages of direct and indirect drive are to be competently compared. This is a hole that Rochester is attempting to fill. The Rochester lab will be carrying out major research on direct-drive, high-aspect ratio targets to experimentally determine the maximum aspect ratio that can be stably imploded. In addition, the lab's continuing research with short-wavelength laser-plasma interaction may provide insights to problems faced by indirect-drive hohlraum targets.

Spinoff Technology

Only a small portion of the electromagnetic spectrum is being harnessed in industry and scientific research today. High-power lasers like Omega provide both the means and immediate motivation to rapidly extend this. Just a brief look at some of the spinoff technologies the Rochester lab is researching makes this point.

The picosecond switch. High-power glass lasers, despite gargantuan outputs measured in trillions of watts, are actually quite fragile devices. They are designed, constructed, and operated with extreme accuracy. The buildings in which they are placed are made superclean and reinforced against

even the smallest vibrations. Within the bay of the Omega, for example, the atmosphere is maintained 100 times cleaner than the cleanest operating room found in the best hospital.

Producing and measuring processes that last less than a billionth of a second necessitate operating some elements of the system on much smaller time scales—trillionths of a second or picoseconds. In developing a subpicosecond switch to control one of Omega's elements, Rochester scientists contributed a major advance to computer microchips.

Very-high-speed semiconductor devices, like the heterojunction bipolar transistor, have attained response time at less than a picosecond, but no current method exists for measuring such fast circuits, and measurement is essential both to circuit design and testing. The instrument needed to make such measurements must be able to detect currents on a picosecond resolution within a space less than a trillionth of a square meter—micron-scale spatial resolution. Rochester scientists developed such an instrument as result of their work on laser fast switching.

The system, shown in Figure 2, is called the reflection-mode sampler. In this particular case, a thin slab of LiTaO₃ is located near the surface of a coplanar electrical transmission line built on Cr:GaAs substrate. The transmission line is broken by a 50-micron gap, which is also the dimension of its width. This forms two electrodes. The bottom face of the LiTaO₃ is covered with a high-reflection coating. Both ends of the electrode are connected to a few tens of volts potential. When a laser pulse is directed at the 50-micron gap, it interrupts through laser-induced photoconductivity the flow of electricity from one electrode to the other. Utilizing a subpicosecond laser pulse, a subpicosecond electrical signal can be generated in this manner. As the electrical signal propagates down the strip line, it transforms the optical properties of the LiTaO₃. This optical transformation can be detected by a second laser beam, which is reflected off the coating on the bottom of the LiTaO₃.

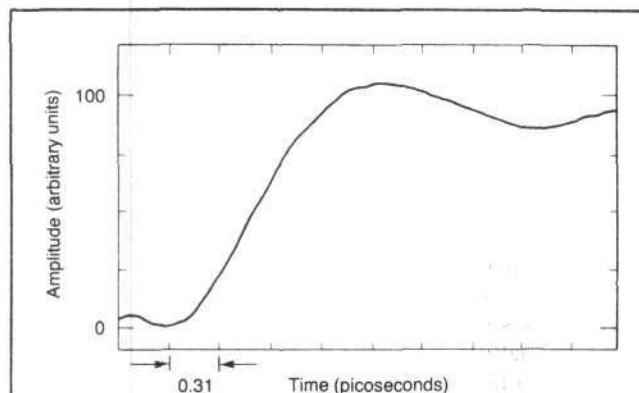
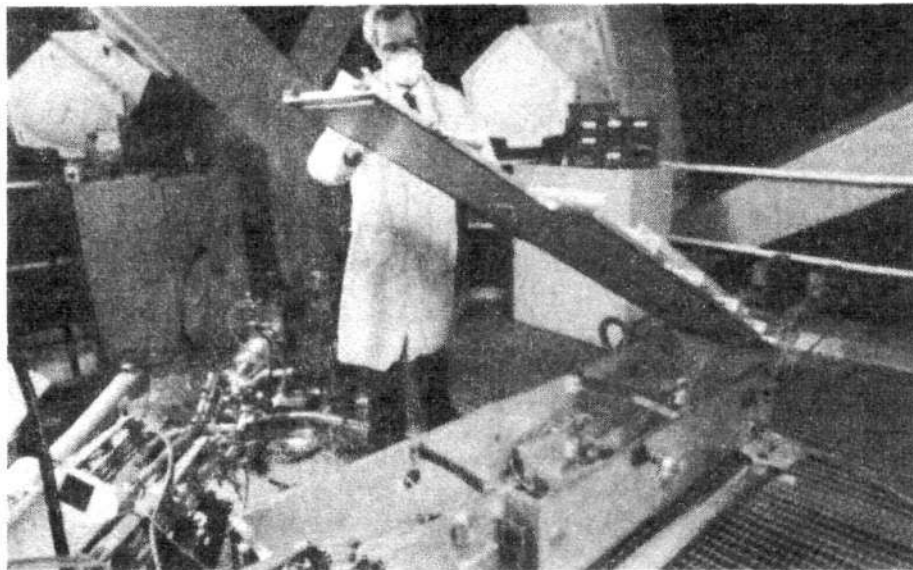


Figure 3
EXPERIMENTAL RESULTS OF
REFLECTION-MODE SAMPLER

The reflection-mode sampler has a time resolution of 0.75 picosecond. The amplitude (in arbitrary units) is given on the vertical axis, with the response time on the horizontal axis.



LLE

An LLE scientist closes the cover of one of the many diagnostic instruments attached to the Omega target chamber to monitor fusion reactions within.

The experimental results using a 0.1-picosecond laser pulse is shown in Figure 3, where the electrical signal rises in less than 0.75 picosecond. Rochester is now preparing to test very-high-speed microchips.

Picosecond electron microscopes. Today's microscopes with the greatest spatial resolution are electron microscopes, which recent advances have lowered to below atomic dimensions of 1 angstrom. Short laser pulses can generate electron beam pulses of short duration, which permits the electron beam pulse not only to image atomic-scale processes, but to image them on extremely short time scales. This enables the examination of phase changes in structures like monomolecular layers—thin films—which are the most essential element for constructing microchip circuits.

Lasers and heart disease treatment. Biological and medical research are proving to be the most fertile fields for high-power laser diagnostics. One of the newest examples is angioplasty—the removal of plaque in the arteries of the heart using short-wavelength laser beams.

The condition known as hardening of the arteries or atherosclerosis consists of the blockage of the heart arteries by plaque (Figure 4). When 80 to 90 percent of the cross-sectional area of a coronary artery is occluded—blocked—the flow of blood is seriously impaired and the risk of cardiac arrest and the general susceptibility to disease and infection is increased considerably.

The present treatment for this condition is major surgery to restore the blood flow in occluded arteries, and arterial bypass surgery, one of the surgical treatments used, is the most commonly performed type of operation in the United States today. In this case the chest is opened and the surgeon opens up the heart itself to graft bypasses to reroute the blood flow around blockages. Even for a healthy person, such a procedure is life threatening and necessarily involves a long convalescence.

Rochester laser scientists are among the leaders in development of new techniques that would remove the plaque without surgery. The new concept involves the injection of a minute fiber of optical material. This provides a channel

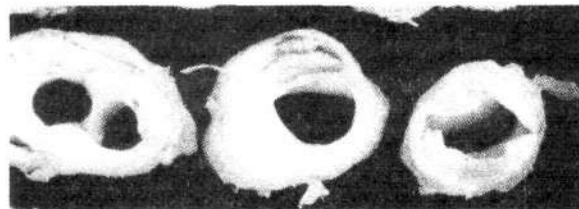


Figure 4

HUMAN ARTERIES WITH BLOCKED BLOOD FLOW

Photograph of cross sections of human arteries showing various degrees of occlusion—blockage of blood flow—because of atherosclerosis. When 80 to 90 percent of a cross-sectional area of a coronary artery is occluded, the flow of blood is impaired and there is a increased risk of cardiac arrest. LLE is researching laser surgery as an alternative to the currently used high-risk surgical procedures to remove the occlusion.

to permit an intense burst of laser light to be directed onto the plaque blockage and blow it away—dissolving the plaque material into the blood without damaging the artery.

The optical fiber is combined with an endoscope for monitoring the process and delivered to the artery site through a four-port catheter, introduced into the body through a small incision and threaded along the arterial passageways. The other two ports are used for local blood-flow blockage and for suction and flushing. The diameter of the entire catheter device is less than 2 millimeters.

The chief problem is to develop irradiation methods that remove the plaque without damaging or scarring the tissue of the artery itself. Rochester scientists are investigating a wide range of laser wavelengths and power levels to find the optimal configuration for doing this, and expect to perfect clinical applications within 1985.

Charles B. Stevens is director of fusion engineering for the Fusion Energy Foundation.

Research Report

INTERVIEW WITH MISSION SPECIALIST BYRON LICHTENBERG

Spacelab As a Testbed for Space Science

Dr. Byron Lichtenberg was mission specialist on the Space Shuttle's Spacelab mission in November-December 1983. A biomedical engineer, Lichtenberg was formerly with the Massachusetts Institute of Technology. He is interviewed here by the Fusion Energy Foundation's Wolfgang Lillge, M.D., in March 1985.

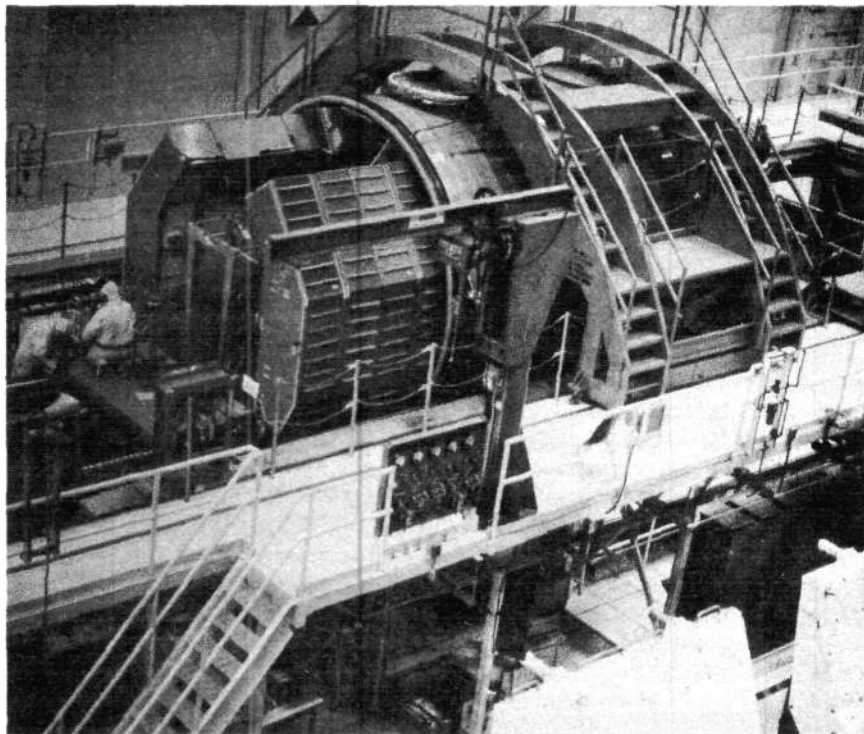
Question: How would you summarize the most important results of the first Spacelab mission in November-December 1983?

The first is that we were able to demonstrate the usefulness and the flexibility of Spacelab and the way that the scientist on the ground can communicate and interact with the scientists on board. In all previous space missions, this has been pretty much open-loop—the people on board would do the experiments and then at some later time, maybe even after the mission, send the data to the ground or talk with the scientist involved.

In our Spacelab mission, we were able for the first time to close the loop, so that we could talk and interact immediately with the scientists. They would be able to see some of the science data and also be able to change the way the science experiments were going in real time, right during the conduct of the experiments.

Specifically, we were involved in five different science disciplines, and the areas which probably had the most interesting results were material science and life sciences. The other areas—astronomy, solar physics, and Earth observations—were very successful, but those types of experiments have been done before in other flights.

This flight used Spacelab as a testbed to show improvements in the types of science data that we would return from those areas. In the field of space plasma physics, we had some equipment problems and we were not able to conduct all of the experiments we wanted



NASA

Technicians placing the experiment rack of the Spacelab inside its protective shell in preparation for the maiden flight of the NASA-European Space Agency project.

to. So these will be flying in a future mission, called EOM (Environmental Observation Mission).

Going back to materials: For the first time we were able to establish long columns of fluid supported by two plates. This was a set of experiments done on the fluid physics module that was produced and built by the Fiat company and integrated into the German Material Sciences Double Rack. These types of experiments have not been done before, and we were able to make large columns of fluid. By studying the shape and motions of each column of fluid, we could learn more about the interactions of solids and liquids, which has direct applications to growing crystals, and in the future, possibly for better electronic semiconductor materials.

In another field of material science,

crystal growth, we had some very interesting and amazing results in growing protein, that is, organic crystals. We did this very slowly over a period of days, and we were able to make two different organic crystals, one of which had a volume 1,000 times larger than any similar crystal grown on Earth—that means an increase by a factor of 10 on each side of the crystal's size.

The other crystal was smaller; it was only 27 times as large, but that still means a threefold increase on each side. These results were important, because we will be able to do X-ray crystallography on these much larger crystals and understand the structure of the protein crystals. By doing that we learn more about the binding forces in the proteins, and this will hopefully lead to a better understanding of the way a variety of proteins work. This

certainly has a lot of applications on the ground for future medical technology—for drug development and understanding of why and how certain drugs work.

Question: Can you discuss some of experiments in the life sciences?

In life sciences, we were primarily interested in the vestibular system, the organ of balance in the inner ear. This is implicated in the problems of space motion sickness. We learned quite a bit in the field of vestibular physiology. Very interesting results came from Prof. von Baumgarten's laboratory at the University of Mainz, looking at the caloric response. We injected either hot or cold air into one ear and the opposite temperature's air into the other ear.

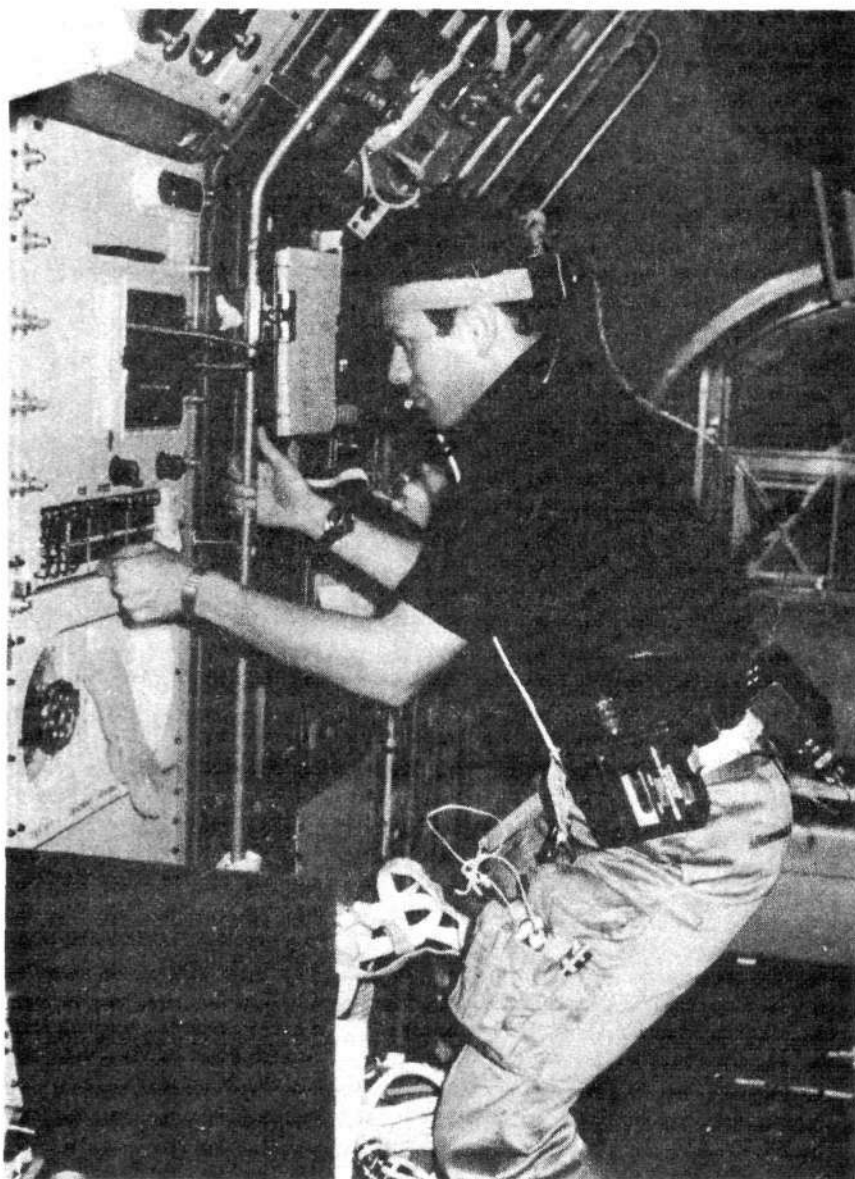
On the ground, that stimulates a conductive flow, which we thought was due to a difference in density; that is, you would heat the fluid on one side and it would become lighter and tend to rise, and on the other side it would be colder and tend to fall. This would induce a sense of motion in the subject.

The hypothesis was this would be the only mechanism involved, since in space there is no net force and temperature differences shouldn't really matter. Therefore, there should be no sense of rotation in this particular type of event.

Early in the mission we did not get any difference, there was no sensation; but later in the mission there was a sense of motion and a sense of rotation. This was not predicted at all. . . .

The basic thought on the ground before this, was that it was primarily a gravity kind of response. Let's say the left ear would be heated; then on the outside edge of the semicircular canal the fluid would become warmer; and in the presence of gravity it would be lighter and pushed upwards, and this would tend to stimulate the semicircular canal.

On the other side of the head, where the cold air was going in, just the opposite would occur. The fluids nearest the outside of the head would be colder and heavier and would be pulled down, and this would confirm and amplify and go along with the same direction as the signals from the left ear. Therefore, you get a strong sense of



Dr. Byron Lichtenberg at the materials science double rack facility during the *Spacelab* mission. NASA

rotation.

In space we did see this sense of rotation, these eye movements during the later portion of the mission, and that means that there must be some other effect than just purely a density difference. It may be some direct temperature effect on either the semicircular canals or on the nerves that go from the semicircular canals to the brain, or some other effect.

The causes are not clear yet, so we are not sure what is going on. There have been experiments on the ground that have shown a very small temperature asymmetry or temperature effect

somewhere in that system, but it seems to be stronger in space; in other words, the speed of the eye movements was greater in space than one would predict just on the basis of ground-based experiments. I think that there has to be a lot more work done on this.

Growing Human Lymphocytes

Another very interesting experiment involved the growth of human lymphocytes, the white blood cells. This was done outside of the human body in an experimental test tube, *in vitro*. The activity of the lymphocytes was judged by first stimulating them, so that they were starting to produce

antibodies and proliferate. Then we labeled them with a radioactive tracer, and hours later we were able to fix them in a fixative liquid.

From the first results, it looks like the ability of the lymphocytes and antibodies to respond to some sort of challenge or foreign substance was remarkably impaired. That does not quite go along with some of the experiments that we did on whole human blood, where after the flight we saw almost no change in immunoglobulin activity. There is a lot of work to be done to reconcile these different results.

Question: You will also be involved in the German Spacelab D-1 mission which is coming up in October 1985. What will you be doing on that mission?

My role in the upcoming German D-1 mission is as a science liaison with the American life science experiments. The D-1 mission is primarily involved with life science and material sciences.

The life sciences will be done primarily on the vestibular sled, which is a linear accelerator that is capable of moving a human being back and forth in the Spacelab, along 3.5 meter length. By putting very controlled linear accelerations into the test subject, we can start to study the parts of the inner ear which are called the otoliths. These organs are sensitive to linear motion, and we can look at changes in the threshold (changes in the ability of these organs to detect very small motions) and changes in the perception of motion, that occur at a very high level in the brain. We can also record eye movements, which are driven and controlled to some extent by the otolith organs and the inner ear system in general.

Question: Where has this sled been developed?

In Europe through the European Space Agency (ESA)—it was primarily put together at the European Space Technology Center up in Holland. It was ESA's decision that it is also being made available to some American investigators.

My role in the D-1 mission will be as a coordinator working in the science operations center near Munich, West Germany, in Oberpfaffenhofen. I will

"I think we are just beginning to scratch the surface of the types of experiments and activities we can do in space."

be in telephone contact with the scientists in Houston, both with Prof. von Baumgarten and Prof. Young, and will be there at least as Prof. Young's representative to the science operations working groups and the payload control center, people who will take a look at how the experiments are going and make decisions on resources or what experiments have to be rescheduled.

Question: What is the current state of American-European cooperation in space research, and what would you propose to expand this cooperation?

I believe that there is a good level of cooperation between scientists in Europe, the United States, Canada and Japan. Of course, people want to explore their own ideas, but the course of progress and results are published openly. Most space experiments, and especially some of those on the new space station, will be, of necessity, cooperative in nature. The space station will be like a research facility similar to a large particle accelerator (CERN, for example). It will be relatively expensive to use and must be tightly scheduled. This will encourage cooperation and produce the best results from scientists throughout the world.

Question: Have you in mind other avenues of experiments in space that would tell us something basically new about the laws of the universe under conditions of zero gravity?

That is a very difficult and broad-based question to answer. In a general sense, I think we are just beginning to scratch the surface of the types of experiments and activities we can do in space. Although Spacelab is a very good place to do scientific research, the Space Shuttle is still limited in the amount of time and the amount of materials and people it can carry up.

It will mainly be in the areas of life science and material sciences that we

will see some very great strides made in the future. Other than talking about some of the interesting things in pharmaceuticals and crystal growths going on, we just have to wait and see.

Question: Many people want to know the immediate benefits of operations like Spacelab. Is the aim of such missions directed toward concrete, practical results?

So far it has been mainly basic research in the areas of life and material sciences. But we start to see more practical results in the field of pharmaceuticals, and we will see some hopefully immediate—in terms of several years—application and maybe the ability to separate larger quantities of pharmaceuticals and drugs in space and bring them back to Earth and use them for curing some diseases here.

Question: When you look back to the Apollo mission to the Moon, which once motivated a whole generation to turn their eyes to space, a new kind of cultural optimism was created. Today, such a push for a scientific and cultural revitalization seems more urgent than ever. Do you think that the current space programs can create this kind of mobilizing effect again?

I am certainly an optimist, and I think it can, but it may take something a little more dramatic than Spacelab. It probably takes a space station, an international joint cooperative venture with many European countries, Japan, Canada, and other countries involved. When people can see this actually orbiting over their heads—because it will in fact be a very large structure probably visible at twilight and certainly before sunrise—to know that people up there are continuously doing science research, observation, and astronomy activities, this will keep space research in people's minds.

Then we need a new spacecraft to go from there, using the space station as a jumping-off point for a possible mission to Mars and/or lunar bases. These kinds of things will really spark the imagination of people and help to bring us all closer together, because of the very cooperative nature of the whole space station program. I see that coming down the road in five to seven years.

Conference Report



INDIAN PLANNING MINISTER:

Asia Should Cooperate to Build the Kra Canal

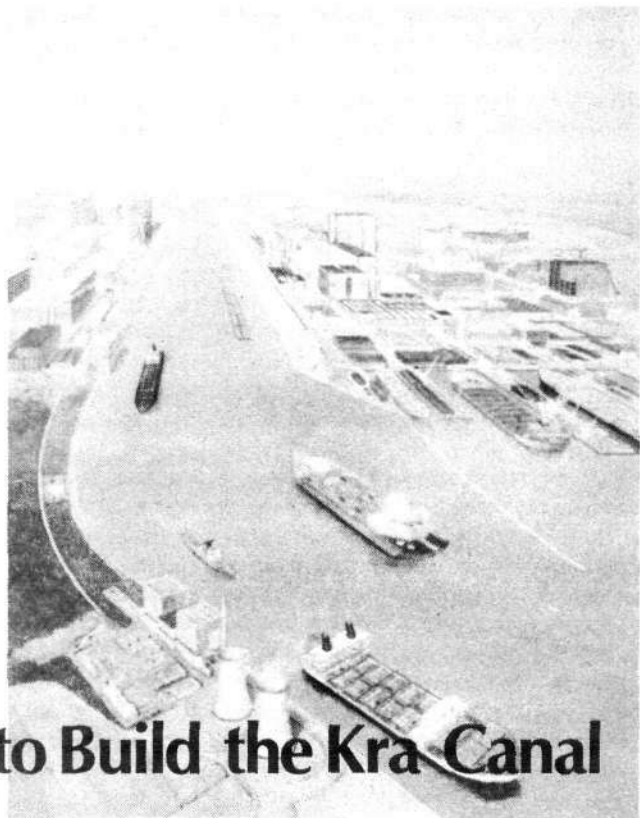


Illustration by Christopher Sloan

Above left, K.R. Narayanan, Indian Minister of State for Planning (center), with Susan Maitra of the Executive Intelligence Review and former ambassador to Surinam, M. Gupta. Right: Artist's illustration of the Kra Canal project.

The Kra Canal and a similar Great Project to turn India's Ganga River Basin into agricultural superproducer were both endorsed by Indian Minister of State for Planning, K.R. Narayanan, in his keynote address to the *Fusion Asia* conference on India's economy, held at the India International Center in New Delhi April 9. Sixty government, industry, and science representatives attended the two-day conference, titled "India, An Agro-Industrial Superpower by the 21st Century: A Strategy for Economic Breakout."

"Though extravagant, because we in India do not normally talk of superpower status for us," Narayanan said, "the title for this conference is an encouraging theme, an optimistic theme, and maybe a realizable thing." Narayanan contrasted the theme of the meeting to the theories and predictions of economic hopelessness and political disintegration for India heard frequently in the West and even in India.

Commenting on the "Look East" trade policy for India proposed by *Fusion Asia*, Narayanan stated: "We are

now entering a new era in which the old concept that Jawaharlal Nehru had entertained of Asian cooperation is again emerging as a practical possibility. In this respect, the idea of a Kra Canal is a very crucial one. This is an idea I used to hear about 15 years ago when I was ambassador to Thailand. In order to link up India, China, Japan, and the Southeast Asian countries together, this canal can play a far-reaching role, and I hope this will take shape—and it can take shape only with Asian cooperation."

The development of the Ganga River Basin, was an early commitment of the Congress Party, Narayanan said, and received special attention from Jawaharlal Nehru. He then read the text of the resolution passed by the Congress Executive Committee in 1937: "Comprehensive river surveys are necessary for the formulation of a policy to prevent disastrous floods, to utilize the waters for the purposes of irrigation, to consider the problem of soil erosion, to eradicate malaria, and for the development of hydroelectric and other schemes. For this purpose, the

whole river valley will have to be surveyed and investigated, and large scale planning resorted to."

"This is exactly what the *Fusion Asia* Conference is calling for," Narayanan said. "Now Jawaharlal Nehru's grandson has established the Central Ganga Authority to take up the problem of the river's pollution, and that is directly related to the valley's overall development. "The Ganga is the country's lifeline," Narayanan asserted. "And the potentials of the valley are immense. The whole of India can be fed by the Gangetic Plain."

'The Height of Technology'

On the question of the use of high technologies, particularly lasers and nuclear power, to increase the pro-

ductivity of the economy, Narayanan said: "To improve the standard of living of the people even marginally, we have to reach the height of technology. This is in a sense the logic and irony of life. We have to pursue the Moon as well as pick up the sixpence from the mud. This is typical of life, typical of progress.

"To give even a little to the people, we can not do it with small science, with small technology, but only by mastering high technology and the most advanced technology," Narayanan continued. "If I may draw a parallel to religious or cultural life, we need a few saints and a few poets, great poets, in society from whom we can derive ideas and inspiration which keep the whole people going for centuries. This is not only typical of India, but of the whole world."

Narayanan concluded his remarks with a mandate for concrete ideas and proposals. "I hope in your deliberation you will throw up concrete ideas to realize these dreams, which may not be dreams, in regard to the development of the Ganges, the application of technology to daily life and production, and to linking Asia more effectively in a cooperative sense," he said. "I am looking forward to the final product of this conference."

Other speakers at the conference

included C. Hingarh, chief executive of Modipon Ltd. and chairman of the conference organizing committee, who welcomed the conference participants. Hingarh reviewed the thoughts and aims for the conference, and emphasized that these deliberations were meant not to debate whether or not we should develop the Ganga Basin, expand economic ties with the rest of Asia, or have advanced technologies, but to discuss "how to get the job done."

Editor-in-chief of *Fusion Asia*, Ramtanu Maitra, opened the panel on the specifics of the Ganges River Valley development, discussing the potential as well as problems such as that of flood control and replenishing ground water for the Valley. *Fusion Asia* proposed a full survey of the river, carried out by a panel of top experts, both public and private, pulled together by the government. The Ganges River valley, with a population of 300 million, is one of the poorest in the country, but potentially one of the richest because of its fertile soil.

Then, Dr. H.L. Uppal of Punjab Agricultural University, who has made extensive studies of the rivers flowing into the Ganges from the Himalayas, spoke on the specifics of river engineering. He is a former director and chief engineer at the Punjab land re-

clamation and irrigation department, and a former agricultural adviser to the Punjab government.

India's High Technology Role

The second day of the conference was opened by Fusion Energy Foundation research director Uwe Parpart-Henke, who outlined the historical relation between energy flux density and productivity. Henke described recent developments in the field of high energy physics in biotechnology, lasers, and plasmas, making the point that India must produce more manufactured goods of quality and begin to satisfy the immense shortage of capital goods in Southeast Asia.

Ramtanu Maitra commented that although India had been at the forefront of science and technology from its very inception, it has not been able to catch up with the most recent advanced technologies and break out of a situation of long-term stagnation.

Next, laser physicist D.K. Ghosh, a professor at the Indian Institute of Technology in Bombay, discussed the tremendous changes in industry to be expected as lasers are introduced. With a limited budget, Dr. Ghosh has constructed several lasers himself and with his students.

The last speaker on this panel was Dr. Tata Rao, chairman of a state electricity boards. Dr. Rao, a "grand old man" of the Indian energy development programs, made the point that the "fusion group has proven convincingly, using the LaRouche-Riemann model, that the only way to enhance productivity is by introducing high technology into industry." He also strongly attacked the Club of Rome, noting that these are policy interventions by the Club of Rome, not mere theories. Human resources are the most important aspect of an economy, not raw materials or related questions, he said.

The final panel on a "Look East" trade policy for India was chaired by former deputy governor of the Reserve Bank of India, Dr. R. K. Hazari. The first speaker was Professor P. N. Agarwal, a U.N. consultant who teaches at the Institute for Developing Economies in Tokyo. Agarwal focused on the Japanese perception of the requirements of the 21st century, contrasting this to

Continued on page 62



Fusion Asia editor-in-chief Ramtanu Maitra (second from left) chairs a New Delhi press conference to discuss the proposed Great Projects. With him are (from left) R.P. Swami, C. Hingarh, Uwe Parpart-Henke, and P. Adireksan.

Viruses: Some Day You May Want to Catch One

by Gary Raham

You may go to the doctor with a fever—and perhaps some aches and pains for good measure—and he might say, “Looks like you’ve caught a virus.” Chances are he’s very safe in saying that, because there are thousands of viruses that attack human beings, and many of them produce similar symptoms.

There are many flu viruses, for example. Most viruses, fortunately, only make us sick for a few days, but a few can be very deadly, depending on our age, general health, and other factors.

But viruses are not always “bad

guys,” and some can even be helpful. Scientists who work in the field of genetics, the science of heredity in living things, are finding ways to use viruses for the benefit of man.

What Is a Virus?

Viruses are unusual creatures. Some scientists debate about whether they are even “alive.” They can be dried and crystallized, much like salt, and then lie dormant indefinitely. Viruses, however, cannot reproduce except within the living cells of some organism.

There are many other organisms that survive as parasites on other

creatures. To better survive in their hosts, these parasites have lost body parts or simplified them. This is true, for example, of the intestinal worms that can enter the human body through dirty food or bare feet. Viruses may just be an extreme example of this sort of adaptation.

Viruses are composed of the same classes of chemicals as other life: nucleic acids, proteins, and sometimes simple compounds made from sugar molecules. Viruses are so small, however, that they usually contain only one or just a few molecules of each type (see Figure 1).

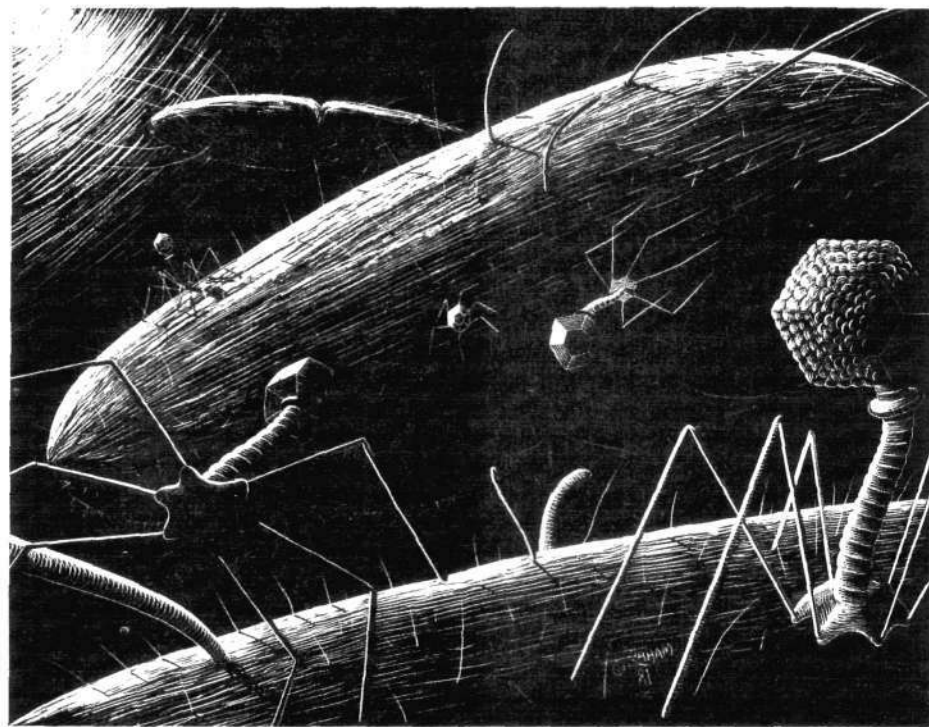


Figure 1

WHAT A VIRUS LOOKS LIKE

If you were the size of the spiderlike viruses shown here, it might look like this as you drifted down and landed on some bacterial cells. The bacteria themselves are only about 2 microns long (it would take 500 of them placed end to end to equal 1 millimeter), but the viruses are much smaller (0.36 micron, including the long tail fibers). After a virus attaches to a cell, it injects its DNA (or RNA) into its host.

All viruses have one of two nucleic acids, DNA or RNA, because, like all other life on Earth, they are dependent on these molecules for reproduction and for the control of necessary chemical activities. DNA stands for deoxyribonucleic acid. Deoxyribose is a sugar that is connected to phosphate (a combination of phosphorus and oxygen) in two long, intertwined chains. Sugar and phosphate alternate positions in each chain—sugar, phosphate, sugar, phosphate, and so on.

Connected to the sugars are four kinds of organic bases. They are *organic* because they contain the element carbon and they are *bases* because of their chemical activity (they react with acids to form salts). These bases—adenine, guanine, cytosine, and thymine—link the sugars in the two intertwined chains, much like the steps of a spiral staircase. RNA is similar to DNA, except that ribose replaces deoxyribose as the sugar, and uracil replaces thymine as one of the bases. All the information needed to create a virus particle is coded by the sequence of bases along the sugar-phosphate chain.

Because the DNA or RNA of a virus is easily broken down by chemicals and other external substances, it is protected inside the hollow center of a coiled strand of protein. This part of the virus is often referred to as the *head*. Another protein forms the *tail* of the virus and allows it to latch on to some unsuspecting cell (see Figure 2). A virus can do no damage unless it successfully connects itself to a cell and transfers its nucleic acid inside the cell.

The Virus Enters the Cell

Once it has hooked on to a cell, a virus injects its nucleic acid through the cell membrane, probably with the help of a chemical that dissolves or modifies the membrane (Figure 3). Inside the host cell, the viral nucleic acid does one of two things. It may connect itself to the DNA in the nucleus of the host's cell, or it may latch on to the cell's chemical-making machinery.

In the first case, the viral nucleic acid is reproduced along with the

host cell every time the cell divides. No real damage is done, and the host organism does not become sick.

The other thing the viral nucleic acid may do, however, is stay out in the main part of the cell, the *cytoplasm*, and take over the host cell's machinery for making cell chemicals. The viral nucleic acid latches on to structures called *ribosomes*, which are necessary for the production of a cell's proteins. Then it uses the host cell's energy sources and enzymes to "read" the viral nucleic acid code and to produce virus protein. These proteins assemble themselves into heads and tails and form new virus particles from copies of the viral nucleic acid. The new virus particles eventually fill the host cell. When the host cell bursts, there are hundreds

of new virus particles that can attack neighboring cells.

The host feels "sick" when enough cells are destroyed to affect the functioning of the organ or part of the body that has been attacked or to cause the host's defenses to counterattack the virus. Viruses can be carried for years in their inactive form, attached to the host's DNA, until stress or some other factor causes them to go into their active form.

A Virus 'Shuttle Bus'

Viruses become useful to scientists when they make mistakes. They occasionally do this when they detach themselves from a host's DNA. Once in 100,000 times or so, a fragment of the host's DNA, containing one or more genes (protein codes),

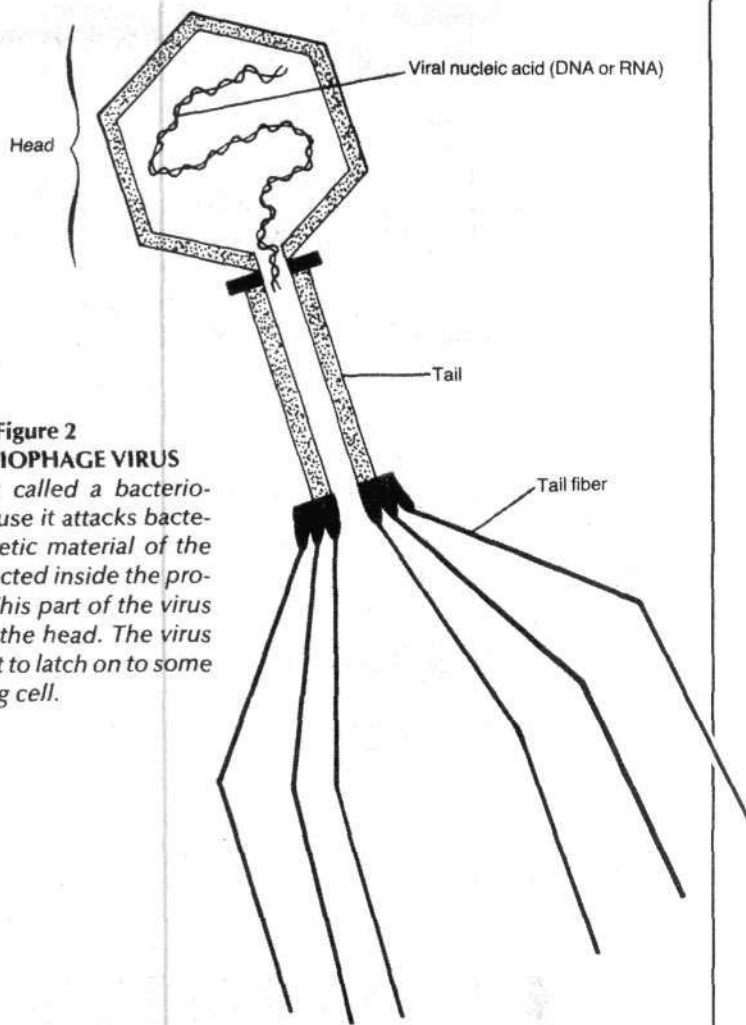


Figure 2
A BACTERIOPHAGE VIRUS
This virus is called a bacteriophage, because it attacks bacteria. The genetic material of the virus is protected inside the protein cover. This part of the virus is known as the head. The virus tail enables it to latch on to some unsuspecting cell.

sticks to the viral DNA. Thus, when the virus particle assembles with this nucleic acid in the head, it acts like a shuttle bus, driving a host cell's gene from one place to another.

"What good is this?" you may ask.

This virus "shuttle bus" might provide the transportation for a very useful gene that scientists want to transplant from one organism to another.

Another way of doing gene transplants is using plasmids, or little, independent pieces of the genetic material of bacteria.

The areas in which viruses are used widely for transplanting genes are agricultural and medical research. For example, some forms of plant life like apple trees can photosynthesize

better than others like corn, wheat, and most cereals. That is, the apple tree can more efficiently convert the energy of sunlight into sugar (which provides energy for the tree, much as food does for human beings). By using viruses to improve the efficiency of photosynthesis in plants, scientists can produce more food for man.

To take another example, many infants are born with errors in their genes that may cause early death or life-long handicaps. PKU, phenylketonuria, is a one-gene defect that results in the inability to use a chemical, phenylalanine, commonly present in foods. If undetected, the defect causes brain damage and retardation. PKU can be predicted in the

unborn child by sampling fluid from the womb, and the effects of the disease can be reduced with a restricted diet. PKU can be cured, however, only if a way is found to insert correct gene copies for phenylalanine use into the child's body cells.

Viruses, remember, may become part of a host's own genetic information. Thus, they can act to transport correct genes and insert them into defective cells. Of course, to do this, scientists have to know how to prevent the virus from transforming back to its infectious state. Viruses are also limited by the amount of genetic information they can carry in their heads. They cannot transport more than a few genes at a time.

A Medicine Factory

Viruses can be used in yet another way. They can transport genes that code for useful chemicals into other organisms, usually bacteria, that multiply the genes and their products manyfold. This multiplication occurs when the virus reproduces. Thus, what might otherwise be a rare chemical can be produced in large enough quantities to be a practical medicine.

Insulin, a hormone absent or present in only small quantities in diabetics, who cannot use sugars and starches properly, is an example of the kind of products that could be and are now being produced in useful amounts. *Interferon*, a body protein apparently important in fighting off diseases of various kinds, is another example.

You can expect to hear more about viruses as scientists learn more about them and how they relate to the living world. All the news won't be bad. Some day you may want to catch a specially designed, custom-made virus.

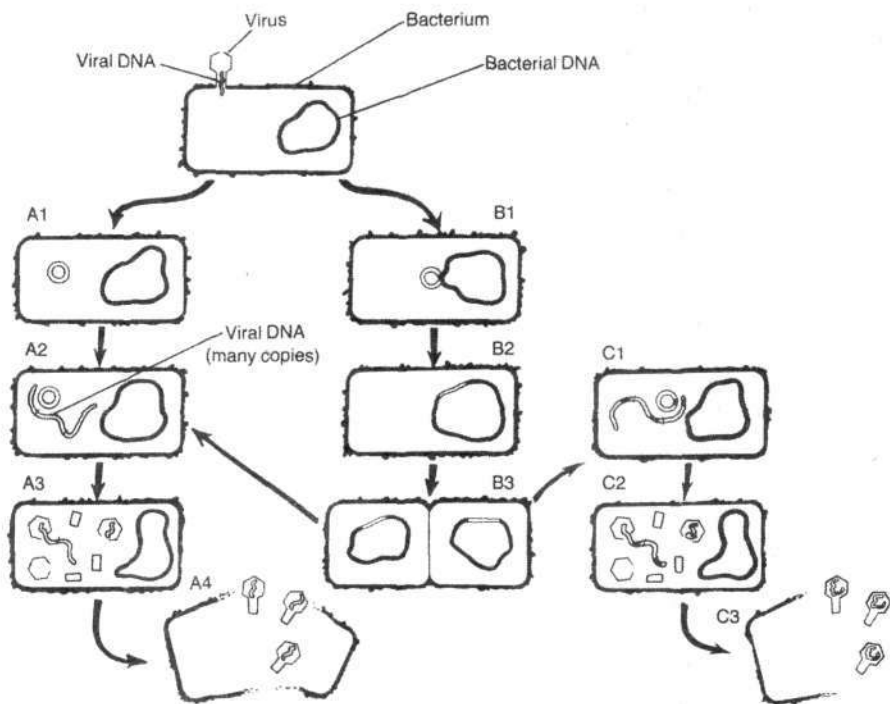


Figure 3
HOW A VIRUS ATTACKS A CELL

When a virus attacks a cell, it attaches to the surface at specific sites and injects its nucleic acid into the cell. The nucleic acid usually forms a closed loop (A1), and new viral DNA is made in a long string using the host cell's chemicals (A2). New virus heads and tails are also made (A3), and the viral DNA is cut to the right size and incorporated into the heads. When the virus particles are assembled, the host cell bursts.

Sometimes, however, the viral DNA hooks up with the host DNA (B1-2) and is duplicated when the host divides (B3). This can go on for many generations, before the viral DNA uncouples and follows path A.

Rarely, when the viral DNA uncouples, it takes a piece of the host DNA with it. Then, when the viral DNA duplicates (C1), it also duplicates the host fragment. This gets assembled into a new virus (C2-3) and can be transmitted to other cells.

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Books

Margaret Mead Wasn't Your Grandma

Margaret Mead, A Life
by Jane Howard, New York:
Simon & Schuster, 1984
\$19.95 hardcover, 527 pp.

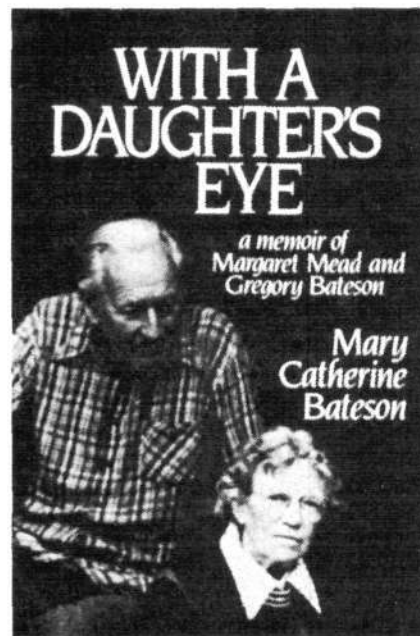
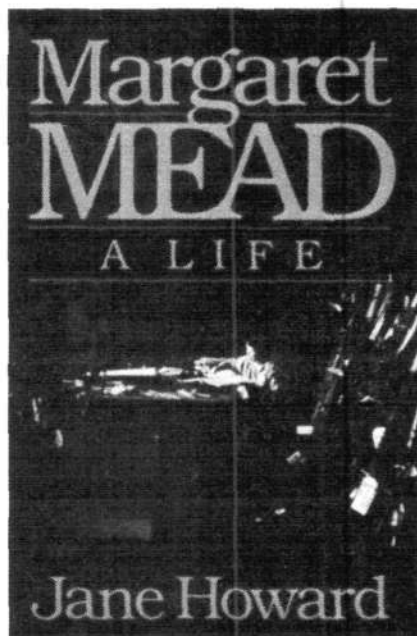
With a Daughter's Eye
A Memoir of Margaret Mead and Gregory
Bateson
by Mary Catherine Bateson, New York:
William Morrow & Co., 1984
\$15.95 hardcover, 142 pp.

Every time you see a young person with puffy, red-rimmed eyes and a vacant stare, shuffling down the street, in sync with a transistor radio wired into his or her ears—you should know that you have Margaret Mead and her three husbands to thank. That being the case, I would not recommend that you rush out to buy either of the two biographies that were released last year.

Each in its own way is meant to convince you that Margaret was a real dear. In fact, Jane Howard tries to turn her into a grandmother from the get-go because of her close relationship to her own grandchildren. However, it does not take too much reading between the lines to determine that dear Margaret was a domineering, ambitious schemer, who would stop at nothing in order to push forward her own professional career.

But who really cares! The important thing about Margaret was expressed in her collaboration with a group of anthropologists whose purpose was to engineer the counterculture. She was first deployed to Samoa by anthropologists Franz Boas and Ruth Benedict to defend the thesis that sexual libertinism during adolescence correlates positively with the mental health of a culture. Right before the start of World War II, she and her third husband, Gregory Bateson, studied Balinese culture.

Bali was already a haven for homosexuals, opium smokers, and modern artists from the United States and Europe. The focal point of the culture was the Balinese dancers who performed



in a state of trance, and in other aspects of their life maintained a schizophrenic state of dissociation. How effectively they were able to translate this experience is clear in those aspects of Gregory Bateson's career that his daughter does not think important to mention—such as his promotion of LSD among youth.

Bateson was the coordinator of those various programs which, in the 1950s, spread this mind-destroying psychedelic drug among unsuspecting layers of the population, such as veterans and young people who were attracted to rock concerts. Bateson established the LSD research center at Palo Alto Veterans Administration Center in California and sponsored Ken Kesey (of *One Flew Over the Cuckoo's Nest*) and the Merry Pranksters.

According to her daughter, one of the few things Margaret reproached herself for was her stupidity in advocating the "legalization" of marijuana instead of calling for decriminalization. Using the honest term had aroused too great an opposition in the population.

On the other hand, Margaret prided

herself on her collaboration with Dr. Benjamin Spock. Together they created the preconditions for the counterculture by convincing mothers to manipulate rather than discipline their children. The general banality of post-war suburban life in the United States weakened the moral fiber of the nation—but every aspect of the Mead-Spock program was carefully planned to induce hedonistic values in children, along with an unwillingness to accept the necessary restraints of a work ethic.

Mead Under Attack

The two books were probably written as an answer to an attack on Margaret Mead that has made the headlines. In February 1983, Derek Freeman, an Australian anthropologist, documented that Margaret's account of life on Samoa was a complete hoax. It appears that the culture was paranoid and embittered rather than as she pictured it, relaxed and easy-going. Both Jane Howard and Catherine Bateson go to some length to defend Margaret Mead from the charge of deliberate dishonesty by pointing out that anthropological studies are necessari-

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ly biased and incomplete.

This is contradicted, however, by the internal evidence provided by Howard herself. The same issue was a matter of bitter dispute between Margaret and another of her husbands, the anthropologist Reo Fortune. They did field research together in New Guinea. Mead, of course, was given the opportunity of widely publishing her views, while the career of her quickly divorced husband was ruined. Anyone reading these two books will come away absolutely, and correctly, convinced that anthropology is a fraud.

As I said, though, neither of these books is worth reading. They do not explain that the purpose of anthropology is brainwashing whole cultures. Mead, and her teachers and husbands, studied primitive, paranoid, small cultures in order to test their theories as to how to turn the United States into such a collection of paranoid communities.

Who really cares that Margaret had a lesbian relationship with Ruth Bene-

Conference Report

Continued from page 59
 current Indian perspectives.

Next, Thai member of Parliament Pongpol Adireksarn showed how the Kra Canal would open up the entire area for economic development. He elaborated the history of the Kra Canal project, stressing that the new generation of politicians in Asia—represented by himself and Rajiv Gandhi—are keenly aware of the necessity for this kind of development. He also stressed the tremendous boon for the entire area resulting from the large industrial areas on either side of the canal.

The last speaker was the former Indian ambassador to Thailand, Mr. Dalal, a staunch supporter of the Kra Canal project.

The *Financial Express*, India's main financial daily, covered the conference in detail, in an article titled "Kra Canal Holds Hope for Engineering Unit." The article surveyed the immense benefits for India of the proposed Kra Canal, including tremendous opportunities for Indian engineers, the Indian steel industry, and the ports of India's east coast.

—Douglas DeGroot



Institute for Intercultural Studies
 Mead in Samoa (left): sexual libertinism.

dict among others—or that Gregory suggested to his daughter that they have a sexual relationship? (These were not the kind of mass murderers of whom it can be said: "Oh, but they were so good to their family.") The important thing is that they tried to "turn on" the youth of the United States and Western Europe to perversion. And this neither author finds exceptionable, or worth reporting in detail.

An interesting sidelight on the books is provided by the Derek Freeman controversy. Margaret Mead was sponsored by Franz Boas as part of his promotion of cultural relativism in place of the more overt racism of the Harri-man-sponsored eugenicists of the Museum of Natural History. This was the liberal wing of anthropology; the soft fascists who would deny the backwardness of these primitive cultures as a way of forever condemning people to the backwardness imposed upon them by the domination of their various imperial masters.

The more open racists—the same people who exhibited a stuffed Eskimo in the Museum of Natural History—defend the view that "backwardness" is biologically determined. Freeman is of this latter school, which—sadly, but not surprisingly—is having a resurgence today.

—Carol White



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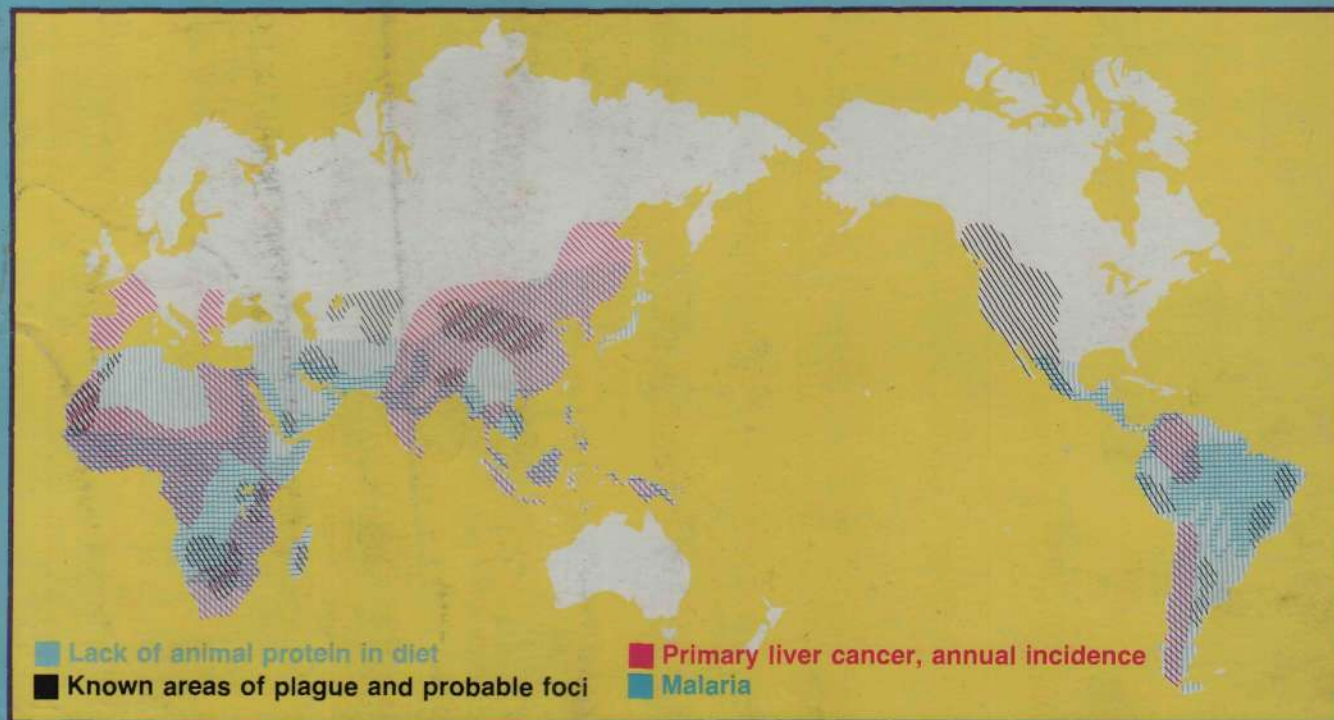
In This Issue

WE NEED A MILITARY MOBILIZATION TO WAGE A WAR ON DISEASE

The rapid spread of disease and famine throughout the continent of Africa is not some unfortunate accident but the predictable outcome of deliberate Malthusian policies. We can save Africa—and the rest of the world—from an otherwise inevitable biological holocaust by launching a military-style war on disease and a crash program to build infrastruc-

ture and industry. We have the science and technology to do it now. Warren Hamerman discusses the extent of the present biological and ecological destruction, how this was predicted 11 years ago, and what to do about it. Col. Molloy Vaughn outlines a specific military-style program for emergency aid, making use of retired military experts.

THE BEGINNING OUTBREAK OF DISEASE PANDEMICS



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