EIR Document

European Air Defense Initiative: a crash program for beam defense

The following document was written in February 1985 by the staff of the Fusion Energy Foundation, in cooperation with Executive Intelligence Review.

West German Chancellor Helmut Kohl's endorsement of the American Strategic Defense Initiative (SDI) has cleared the way for major participation by the Federal Republic in the development of directed-energy defense. Added to Japan's pledge to contribute to the SDI, made a year ago, the German endorsement will most likely induce other major allies of the United States to follow suit. From the American side, President Reagan, Secretary Weinberger, and General Abrahamson have repeatedly stressed their offer and request for the active participation of U.S. allies in the creation of the new "defensive shield" against missile attack. Now that the basic political preconditions for such participation have been achieved, the next question is, "What concrete form must this cooperation take?"

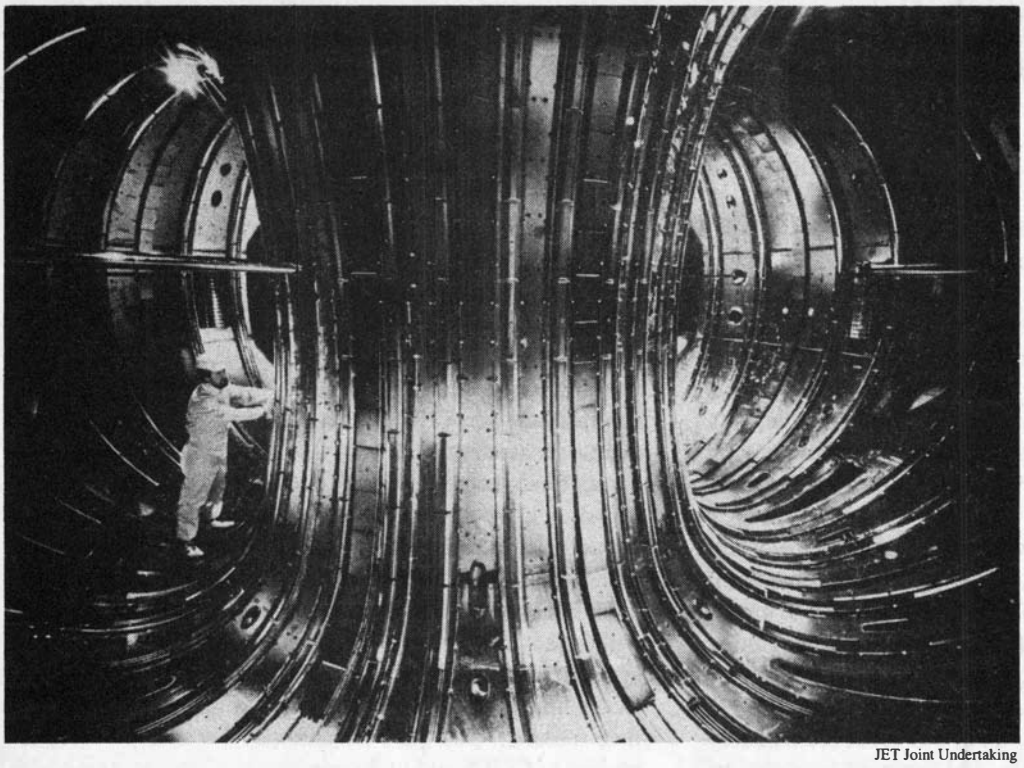
Most thinking on this subject, voiced in Europe so far, has been totally inadequate, because most European observers have failed to grasp the full magnitude of the scientific, technological, and strategic revolution to which the United States is irreversibly committed.

Should the European allies fail to mount a major effort of technological development of their own, in cooperation with the United States, then European efforts will fade into insignificance against American developments. In this case, Europe will have to obtain virtually all the technology for its defense from the United States, and will have to compete industrially in a world flooded with the thousands of American high-technology spin-offs from the SDI program. Not only the SDI itself, but the creation of specific systems suitable for the immediate defense of European territory would be dangerously delayed relative to what could be achieved by pooling the scientific and industrial resources on both sides of the Atlantic.

Therefore, there is no acceptable alternative to a well-conceived crash-program effort on the part of the European allies, directed toward accelerating the SDI, as well as developing certain specific systems for European defense. We shall go through some crucial guidelines for such a program in the following pages.

First, we must attack the objection voiced by certain quarters, that a European crash program is "impossible." This objection is usually backed up by several points of argument: (i) the resources which Europe can mobilize for directed-energy weapon development are a small fraction of those available in the United States; (ii) financing is not available; (iii) bureaucratic inertia precludes any rapid efforts; (iv) cooperation between Europe and the United States in such a field is hard to imagine; and (v) cooperation between European allies is hopelessly difficult, inefficient, and costly.

As objections to mounting a crash program, these objections are irrelevant. They serve only to indicate the problems which are to be solved, and indeed, the need for a crash program in cooperation with the United States. SDI is the ideal context in which to solve these problems. However much people may complain about difficulties and inefficien-



JET Joint Undertaking

Interior of the vacuum vessel of the Joint European Torus (JET), the world's largest tokamak, in its construction stage.

cies, the Airbus, the Spacelab, the Arianne, the JET fusion reactor (largest in the world), the Concorde, and countless other advanced-technology joint projects among European nations and with the United States have worked!

What is holding Europe back?

The only real problem involved in launching a European crash effort to develop laser- and particle-beam technologies for tactical and strategic defense, the real problem of which the above-mentioned points are merely symptomatic, is one of economics. Why is it that, although the West European GNP nominally exceeds the GNP of the United States, the real scientific-industrial strength deployable for such a project in the United States dwarfs that available in Europe by nearly an order of magnitude? "European nationalism" and lack of integration, often cited as explanations, do not suffice to explain this qualitatively greater technological strength of the United States.

Let us not forget that, from the beginning of the century through World War II, the greatest concentration of advanced industrial and scientific power was Germany. The World War II war mobilization in the United States, the Manhattan Project, and the later NASA space developments upon which the rise of American industrial predominance was based, were made possible by a massive influx of European scientists and European know-how. Although American capabilities were significant prior to World War II, the density of realized scientific breakthroughs applied in the generation of new industries was incomparably larger in Europe than in the United States at the turn of the century. One might mention merely the examples of the electrical and chemical industries, radio and automobile production.

Such was the strength of German science and engineering, that notwithstanding the economic devastation of the post-Versailles period, the austerity of Nazi Economics Minister Hjalmar Schacht, the destruction and chaos of the war bombing and the irrationalism of the Nazi regime, the Peenemünde project brought rocket technology to a stage of advancement not reached in the United States or Russia until the 1950s—and then, in both cases, on the basis of captured German scientists and engineers. Peenemünde was the forerunner of the Apollo Moon landing.

Why should it appear impossible to mount in Europe a crash program of similar or greater intensity than the Peenemünde project, to develop beam technology? Glancing at the thick forest of short- and medium-range nuclear missiles aimed at Western Europe from Warsaw Pact territory, are we facing less than the annihilation of Europe? Should the maneuvers carried out by the Soviet army in the German Democratic Republic over the last year not remind us that preparations for defense, should a war occur, will have to be made before the outbreak of war?

The truth is, that relative to the vastly larger resources invested in industrial and scientific R&D in Europe today, the "technological mobilization potential" of West European economies is mediocre when compared even to the depression-ravaged Europe (or even Germany alone) of the pre-World War II period. The reason is to be found in the chronic mismanagement of European economies in the postwar period.

· The state of the French economy is a case in point. Although France possesses a strong nuclear-power sector, good railways, steel, and a handful of large, advanced aerospace and electronics industries, the country lacks the in-depth industrialization, the vast expanse of medium-size, high-tech industries, which is the gut of U.S. industrial power. Beneath a glossy upper crust, relative backwardness prevails.

West Germany was never allowed to regain its full potential strength after the war. The fate of the High Temperature Reactor (HTR) project is illustrative. When, 10 years after the war's end, German scientists were again allowed to work on nuclear technology, a group of scientists and industrialists framed an ambitious project for rapidly regaining a leading world position in industry, and at the same time for opening up the full potential of peaceful application of nuclear energy for mankind.

Their concept was to apply the much higher temperatures generated in nuclear reactors as against conventional combustion plants directly to advanced metallurgical and chemical processes. The German HTR concept, for integrating nuclear energy with steel and chemical industries in a new type of industrial complex, was by far the most advanced to be worked out anywhere at that time. The subsequent history is one of delays, more delays, and repeated attempts by political and industrial factions to sabotage the project, or scale it down, or shut it down altogether. Little is left of the original thrust. Similarly, Germany's leading position in nuclear-powered commercial shipping—achieved by the remarkable success of the nuclear ship "Otto Hahn"—was simply abandoned and the "Otto Hahn" dismantled without a follow-on project. Dozens of similar stories in civilian and military technology could be recited. The effective *Verbot* against research into laser-induced thermonuclear fusion—supposedly because of its relation to hydrogen bomb physics—has played a significant role in imposing relative scientific mediocrity on the Federal Republic.

Similar stories could be told for Great Britain, Italy, and the other Western European countries. In each case, the countries' economies are functioning at a level of scientific and technological innovation far below that which the size and educational level of their populations would permit.

Triumph of the 'Eurofederalists'

While some measure for the blame for this state of affairs can be found outside Europe, in the policies of the "superpowers," the present economically backward state of Europe corresponds quite well to the expressed views of many self-declared architects of an "independent Europe": people like Jean Monnet, Count Etienne Davignon, the assorted aristocrats of the European Commission. The presently backward state of Europe corresponds quite well with the policies being taught at the European Institute for Administration and Business (Insead) at Fontainbleau and the International Management Institute at Geneva. If Japan threatens to throw Europe out of every significant high-technology export market, this is no mystery: One need merely compare the managerial incompetence of the European Commission with the competence represented by such Japanese institutions as MITI.

The case of Europe's first joint scientific venture, the vast particle accelerator laboratory known as the European Center for Nuclear Research (CERN), near Geneva, is a case in point, and one of immediate relevance for the problem of beam-weapon development in Europe. The founding of CERN was accompanied by great fanfares to the effect that CERN would restore Europe's preeminence in scientific research. Leading "European integrationists" prided themselves on the contrast between CERN's orientation toward "pure" fundamental research and the "dirty" American methods of combining fundamental and applied research (they were referring primarily to the development of the atomic bomb). The founders of CERN promised that CERN's research—in contrast to the Manhattan Project—would be of great benefit to mankind, because its research would produce "pure knowledge" without any military or civilian industrial application! Thereupon, great amounts of money were poured by the European Community and the individual nations into elementary particle research. The most talented physics students were recruited to CERN and to the national institutes working with CERN. The vast particle accelerator machines at CERN are marvels of ingenuity. And, true to promise, the quarks, gluons, and "quantum chromodynamics" developed by CERN researchers have had absolutely no industrial application—except perhaps in the entertainment industry!

Meanwhile, CERN has become a hotbed of the European anti-nuclear and "peace" movements, as well as a pipeline for the leakage of sensitive scientific and technological know-how to the Soviet Union. The cream of Europe's young scientists, squandered! Given the initial conception behind CERN, this result was predictable.

Who, besides outright Soviet agents, is screaming the loudest against President Reagan's Strategic Defense Initiative? The advocates of the "post-industrial society," of *télématique*. Now these people are screaming that President Reagan has broken all the rules, by initiating a new high-technology industrial boom in the United States.

But, the SDI is a fact, and if Europe does not revoke the post-industrial strategy accordingly, she will be left hopelessly behind. Conversely, a forced development of military and civilian applications of directed-energy technologies can be the key for Europe, as for the United States, to revitalization of industry, the labor force, and the entire economy. In other words, the European beam-weapon effort should be seen as the central component of a re-tooling of industry. This re-tooling, in turn, is the key to achieving the economic strength necessary to meet all necessary defense expenditures, and to reverse the social disintegration—symptomized by high unemployment, by the "Green" movement, the spread of drugs, and so forth—which has become a major security

problem for Western nations as a whole.

It is not possible to enter here into the full scope of a European industrial renewal program. In the following pages, we shall focus on the European beam-weapon effort, and lay down some necessary guidelines and proposals for ensuring its success. The points to be taken up are as follows:

1) Determination of the proper relationship between European and U.S. efforts in the field of directed-energy weapons development.

2) The proper framework for inter-European cooperation.

3) Determination of principle fields of priority for European beam-weapon R&D.

4) Application of "General Staff" methods of short-circuiting bureacracy, and assembling the proper combination of manpower, technology, and financial resources.

5) Industrial policy necessary to support beam-weapon development and maximize the benefits of technological "spin-offs."

6) How to finance the European effort.

7) The crucial importance of Lazare Carnot's reforms for European defense today.

1) Relationship of European, U.S. efforts

Since the Strategic Defense Initiative is a national security priority of the United States, the success and timing of the U.S. program will not be permitted to depend on the success and timing of European efforts. Apart from possibly a very few specific items, it is not to be expected that the European program will be integrated into the flow-chart of the American program. The United States is pursuing certain specific areas of close cooperation on a bilateral basis. Furthermore, although the flow of technical information regarding U.S. developments may increase, including the 5% basic research component of the SDI, which will be "open," it is not to be expected that the United States will entrust the most vital secrets of its beam-weapon program to European institutions. Hence, the broad form of cooperation between Europe and the United States must be a "dialogue" between two self-contained programs, in which each can benefit from and be accelerated by breakthroughs in the other, without depending absolutely on the other. Besides the "dialogue," joint projects will be pursued in specific areas, including U.S. funding of certain projects in Europe, and vice versa.

This is not to suggest that the Europeans should attempt to duplicate all U.S. developments. Rather, a straightforward division of labor, in terms of main focus of efforts, suggests itself. The United States has pledged to extend its planned strategic defensive screen, including space-based systems, to defend European allies against long- and medium-range missile attack. Although U.S. spokesmen have indicated that defense against other threats, including short-range missiles, cruise missiles, and aircraft, is also under consideration, the particular geographical and military situation of Europe recommends that these areas be the priority of the European program. The suggested division of labor is therefore as follows:

(i) The United States program will place first priority on strategic "layered" defense against long- and medium-range nuclear missiles, with special emphasis on exoatmospheric systems for boost-phase intercept.

(ii) The European program will focus on development of endoatmospheric systems for defense against short-range missiles, cruise missiles, and aircraft, and on the "retooling" of "conventional" forces with tactical directed-energy technologies.

The area of terminal and point-defense systems, will be a fruitful area of mutual stimulation and acceleration of U.S. and European programs. The European effort will enhance development of U.S. defenses against the relatively short-range submarine-launched ballistic missiles (SLBMs) as well as strengthen the defense of U.S. military installations in Europe. The American effort will provide the means for neutralizing most of the threat from the medium-range SS-20 missiles aimed at Western Europe. European concentration on endoatmospheric systems will have applications to tactical defense of aircraft and naval vessels, and so forth.

2) Inter-European cooperation

All efforts should be made to secure the unanimous support of Western Europe for the SDI. However, launching a European program should not be contingent on the agreement of all West European countries with the SDI and the guidelines proposed here. Those nations which whole-heartedly support cooperation with the SDI should be integrated in the European program, the others not (until they change their minds).

It is therefore proposed that the European effort be coordinated by an independent institution set up jointly by those countries which desire participation, in a similar manner to the European Space Agency and other international organizations, with appropriate formal relations with NATO and the various defense ministries and institutions of the participant countries. The "European Air Defense Initiative" (EADI) Commission will coordinate the national efforts organized by the "General Staff" approach described in Point 4 below, as well as direct the planning, financing, and operation of joint projects.

The establishment of a new, independent institution, the EADI, for this purpose, is recommended for reasons similar to those that guided the establishment of the American SDI: the priority nature of the project, the need to cut through red tape and other institutional inertia, the specific, advanced-technology features of the project, the need to focus efforts on the solution of specific problems, etc.

A poster of the Fusion Energy Foundation in Italy; it reads: "The war threat and economic crisis can be resolved jointly: Beam Weapons Against Depression. Join the association which has changed U.S. policy."

3) Priorities for European beam-weapon R&D

Pending a more detailed study of European capabilities and needs, the proposed division of labor suggests the following preliminary list of primary areas for rese opment under the EADI:

(i) Propagation of laser and particle beams in the atmosphere, particularly in the lower levels of the atmosphere. Complex problems arise here, different from those posed by exoatmospheric and upper-atmospheric beam systems. Optical phase conjugation applications.

(ii) Primary beam generation development. Emphasis should be on development of compact, robust high-energy lasers for installation on land, sea, and airborne vehicles; land-based laser- and particle-beam systems for ranges of 5 km to 50 km; high-power tunable lasers for all-weather capability (Free Electron Laser, frequency-shifting devices, etc.).

(iii) Development of ultra-high-velocity projectile accelerators for endoatmospheric applications, in particular of magnetic rail gun technology, for anti-missile, anti-aircraft, and anti-tank weapon applications. Aerodynamic studies on small, high-density projectiles at ultra-high velocities in dense atmospheres, target damage studies.

(iv) Breakthroughs in high-resolution; multi-band radar and lidar (laser radar) for target acquisition; tracking and pointing of directed-energy weapons; new methods for efficient target discrimination, including multi-band spectroscopy and artificial intelligence. Realtime fast computers for fire control applications.

(v) Forced development of optical (laser) communication systems and optical computers, for jam-proof, high-density data transmission and ultra-fast computing.

(vi) Development of stabilized platforms, pointing systems, optics, and power supplies for mobile basing of directed-energy weapons.

(vii) Basic research into short-wavelength lasers (from visible through ultra-violet, X-ray and gamma-ray lasers), with special emphasis on tunable systems such as the FEL; nonlinear optics of very short, high-intensity laser pulses; structural changes induced in materials by resonant absorption of shaped laser pulses; self-organized structure of charged-particle beams with application to stability and propagation of such beams in various atmospheres; use of plasmas as intensive microwave sources; use of plasma discharges for charged particle acceleration. Plasmoid accelerators.

(viii) Introduction of improved, automated production techniques for the rapid fabrication of lasers and related optical systems (including coatings) of high reliability and reduced cost.

(ix) Acceleration of European development of satellite and aircraft-based remote sensing systems for surveillance of Warsaw Pact operations in Eastern Europe, including "instant warning" of missile launches.

(x) Immediate upgrading of existing air defense systems, including the Patriot, to fill the gap until successive phase-in of new directed-energy and related technology.

4) 'General Staff' methods

With all due respect to hard-working individuals in the various European R&D institutions, private and governmental, it should be obvious that the proposed crash program simply will not work if entrusted to existing institutions and "normal channels."

The way the EADI will be made to work is very simple. The European nations do possess significant numbers of bright, aggressive, and innovative individuals who know "how to get things done and make things work," individuals with scientific and engineering expertise in key areas. Typically, the creative drive of such individuals is stifled and "checkmated" by surrounding mediocrity, bureaucratic inertia, financial constraints, and other forms of effective har-

assment in the typical institutional setting. Success of the EADI depends upon freeing up such potential, assembling the right team of hubristic and capable scientists and engineers, and providng them with the necessary means to get their job done.

Therefore, set up an initial fund of some tens of millions of dollars for the purpose of "raiding" scientific research institutions, universities, industry, and the military to pull out a hard core of the most innovative, aggressive, and capable minds. Attention should be restricted to patriotic scientists and engineers who can develop a passionate commitment to the project. High salaries and security (e.g., 10-year appointments) should be offered. This hard core must be empowered with decision-making authority on the initiation of projects, selection of manpower and contractors, allocation and distribution of funds, and overall conception and coordination of the EADI.

Given basic national commitments to the EADI, the "General Staff" will acquire prestige and political clout sufficient to implement the crash program.

In order to succeed on the urgent time schedule which political and military reality dictates, the decision-making process in the EADI must break sharply with prevailing methods of "systems analysis" employed in weapons-systems evaluation, cost-benefit analysis, resource allocation, and so forth. The neat scheme of pure research → laboratory tests → scale up, simulation → prototype → systems integration → system tests → operational systems, must be discarded in favor of the apparently more wasteful (but actually more effective) approach of going operational immediately with whatever crude and clumsy systems that can be built right away, and then refining and revolutionizing them in waves through an intense interaction of basic research, engineering, shop-floor experience, and operational experience. "Playing it safe" by delaying actual production of deployable systems until the last decimal point of laboratory tests and computer calculations is available to systems engineers, is wasteful folly. Instead, the best scheme available—however crude—should be pushed through all the way to deployment, and then scrapped as soon as a better system is available. Operating experience with the crude system, under realistic conditions, will invariably teach the scientists and engineers and production managers far more than they could learn from "pure research," computer simulations, and polished calculations.

This recommended practice, breaking with "business as usual" approaches, corresponds to what must be done under actual wartime conditions. It corresponds to the approach taken in Peenemünde, in the Manhattan Project, and numerous other less prominent examples, such as the development of radar and of military aircraft. This approach emphasizes bold innovation to solve real problems, as opposed to systems analysis optimization of old schemes in order to squeeze out an additional 1% efficiency on paper. The only forms of systems analysis permissible in EADI decision-making are *nonlinear* analytical methods of the sort exemplified by the LaRouche-Riemann economic model. In such "nonlinear systems analysis," *rates of technological advance* are the primary data, rather than the "ephemeral" systems parameters of technologies which are about to be superseded.

5) Industrial policy

The key to success of the EADI lies in an integrated approach to scientific, military, and economic policy-making. It is nonsense to conceive of the EADI as a purely military effort. Conservative estimates of the key-sector industrial productivity increases to be obtained by widespread introduction of laser materials-processing (e.g., welding, cutting, drilling, and heat treatment), run on the order of 300%. This productivity increase takes into account only present laser applications and the cheapening of laser production costs as a result of improvements in manufacture—but not the spinoffs of future breakthroughs in laser technology. It is such productivity increases in civilian industry which will repay—with interest—the investments into directed-energy beam-weapons development. Conversely, large-scale operational deployment of directed-energy defense, and retooling of "conventional" forces on the basis of directed-energy technology, will not be possible without the widespread integration of laser- and particle-beam technologies into industry. Finally, the quantum leap in industrial productivity which will result from a forced introduction of directed-energy technology throughout industry is the only visible way out of the stagnation, inefficiency, and crushing overhead costs brought on by two decades of "post-industrial" policy.

The first priority of EADI industrial policy must be to force through the "beam revolution" in the machine-tool sector. It is through the mediation of new generations of laser- and particle-beam-based machine tools that the high energy-flux-density and increase in speed, precision, and applicability to new "exotic" forms of materials, inherent in directed-energy technology, can most rapidly be spread to all branches of industry. By making the higher energy-flux-densities of beam technologies—densities of the order of between a hundred million and several trillions of watts per square centimenter—available to industrial processes of all kinds, we increase the "fire power" of our economies in the same way as the introduction of beam weapons increases the fire power of our armed forces.

Simultaneous with the retooling of industry, R&D must be accelerated in advanced areas such as laser-induced controlled thermonuclear fusion; laser chemistry; development and application of x-ray and gamma-ray lasers for fundamental research in medicine, biology, and nuclear physics; space exploration, etc. Thereby we ensure that a *second wave* of "breakthrough" technology is on the way, at the same time Western economies are absorbing the *first* generation of beam

technologies.

Necessary credit policies to achieve this "beam revolution" in industry are outlined below. The required stimulation of the capital-goods sectors of the European economies can not be generated purely internally, but must be driven by a massive expansion of high-technology capital-goods exports. The developing-sector countries as a whole both require, and are ripe for absorbing, the major portion of these exports. We shall not pursue this matter further in this location, but merely point out, that a reordering of "North-South" economic relations to the effect of achieving rapid agricultural modernization and industrialization of the developing sector through capital-goods imports from the advanced sector, is a matter of urgent strategic concern for the United States and Western Europe. Unless present depression conditions are replaced by an export-stimulated boom in high-technology capital-goods industries, the success of the SDI and EADI, even in the narrowest military sense, is highly doubtful. In broader terms, the stabilization of the world economy through real economic development is in the vital strategic interest of the Western Alliance.

6) Financing the European effort

Utilization of directed-energy technologies in myriad branches of industry will, without any doubt, cause vast increases in total economic productivity, revolutionize methods of production and processing, create new industries and a large number of new, highly-skilled jobs. In the United States this is customarily referred to as the "spinoff effect" of the Strategic Defense Initiative. The generally accepted calculation of the "spinoff effects" of the far less ambitious Apollo Project demonstrates that each $1 expended by the U.S. government resulted in $10 of real earnings in the economy beyond the investment and employment generated by that initial $1. In other words, each $1 of government funds spent on the Apollo Project paid itself back at a ratio of 10:1.

Given the higher energy-densities entailed in laser and other directed-energy technologies, and the even broader range of industrial applications of directed-energy technologies in comparison to those developed in the course of the Apollo Project, it is conservative to expect a "pay-back" ratio considerably higher than NASA's 10:1.

This conservative estimate, however, is iron-clad proof at the outset that the SDI effort more than pays for itself. This assertion contains no element of speculation. As against those who claim that, even if *technically* feasible, the defensive beam-weapon development is not feasible by reason of allegedly immense costs, the truth is that effective defense against ballistic missiles can be achieved for less than nothing in fiscal terms of reference.

The present condition of governments' budgets in the United States and in Western Europe makes it a financially and politically irresponsible enterprise to expect governments to incur additional budgetary debt, with the attendant increased weight of debt-service payments on government debt, to finance the beneficial effects of the "spinoffs" of directed-energy beam-weapon development by means of budget expenditures alone. The current condition of budgets is, however, hardly the only, or most important reason, why successful realization of defensive beam weapons must not be considered a matter of expenditures of governments' defense budgets, or general budgets.

The build-up of industrial, logistical, and production-oriented research capacities, including those investments required both in Western Europe and the United States to overcome possible bottlenecks in production of directed-energy defense-systems, is properly the task of the private economy. In a detailed analysis of direct investments required within 10 years of economic mobilization to implement the SDI program, *Executive Intelligence Review* concluded that $200 billion of budget expenditures will generate, conservatively estimated, a volume of associated civilian investments in the U.S. economy of $1.5 trillion. Government can and must play an initiating and guarantor role for this volume of generated investment, but it can not be the task of government to finance such a volume of investment out of budget expenditures alone. This holds, quite clearly, even were the picture presented by current budgets far more rosy.

OFF-BUDGET FINANCING: From the very outset, financing the West European EADI must explicitly include significant volumes of long-term, low-interest credit "off budget."

The argument, derived from the falsely imputed "immense costs" of ballistic-missile defense, that "financial resources are too scarce," is politically motivated by opponents of the ballistic-missile defense effort. This opposition is motivated either by vested interest of a financial/economic nature in the maintenance of the Mutually Assured Destruction (MAD) strategic dogma, or is ideologically motivated—or both.

Financial instruments are the tools of state policy. In stark contrast to Keynesian "pump-priming" of economically unproductive activity, the economic success of directed-energy weapon-related technologies is guaranteed. It is notable that these economic effects are never put in doubt even by the most vociferous opponents of the strategic policy of ballistic-missile defense. Therefore, responsible financial instruments must be created to permit the intellectual, scientific, and economic potentials to be realized.

THE "DIRECTED-ENERGY TECHNOLOGY FUND": Let us take the example of the Federal Republic of Germany.

The appropriate mechanisms for creating sufficient long-term, low interest "off-budget" financial credit devoted to investments, establishment of research and development groups in industry, and procurement of equipment related to directed-energy technology development and production, are best established in the Federal Republic in the framework of the Kreditanstalt für Wiederaufbau (KfW). The KfW is suited to this task, due to its experience in the reconstruction of

West German industry and provision of investment credit to innovators, as well as on account of its particular institutional credit facilities. It is recommended that the KfW be equipped with a "Directed-Energy Technology Fund" in the volume of 25 billion deutschemarks for dispersal over a five-year period.

The "Directed-Energy Technology Fund" should function as a "credit window" for generally 5-10 year credit at between 3-4% interest. Funds from this credit window are to be provided to worthy entrepreneurs from the facilities of the Deutsche Bundesbank, as a special discount facility, as already occurs for export financing over the KfW and a number of other investment-credit functions of the KfW. Thus, the "Directed-Energy Technology Fund" is not to be created by squeezing other present and essential functions and resources of the KfW, any more than all of the necessary directly military-related expenditures can be squeezed out of defense budgets in their current condition.

The recommended DM25 billion volume of the "Directed-Energy Technology Fund" is estimated to be an appropriate, if moderate volume, when used in combination with larger credit resources of the private banking system.

In the United States, a still valid institutional framework exists for such credit mechanisms to function in a non-inflationary, unbureaucratic, and economically effective way. Our recommendation for the establishment of "Directed-Energy Technology Funds" in EADI participant-nations are made with a view to effectively utilizing proven experience with similar mechanisms in the United States.

The Defense Production Act of 1950 in the United States, for example, is an excellent model for such mixed credit-creation for financing of investments and projects accorded national defense priority status. On this model, priority investment contracts are granted government guarantees, and the Federal Reserve System acts to provide funds to the private banking system to finance the priority contracts. Under the "V-Credit Program" section of the statutes of the Federal Reserve System, credit facilities are established for the purpose of assisting contractors who lack necessary working capital for executing production orders for essential defense goods and materiel. The Departments of the Army, Navy, and Air Force; the Commerce, Interior and Agriculture Departments; the General Services Administration, the Department of Energy, and related agencies, are empowered to guarantee credits issued by private financial institutions.

7) Importance of Carnot's reforms

We conclude with the most urgent recommendation of all: All decision-making associated with the EADI must be based explicitly upon the principles employed by Lazare Carnot in his reforms of the French Army beginning in 1793.

A thorough acquaintance with the history of these reforms, and particularly with the role played by the Ecole Polytechnique under Carnot's direction, must be required of every candidate for a leading position in the EADI effort. If Carnot's principles are understood, everything else follows. If those principles are not understood, then the whole project may flounder amidst the catastrophic muddleheadedness, bureaucracy, and inertia predominating in NATO and in the defense establishments of the United States and leading West European nations.

What Carnot and his associates accomplished, the secret behind the spectacular victories of the French army in the period 1794-1806, was to deploy the science and technology of rapid economic progress to increase mobility and firepower in warfare. How were the cannon for massed, mobile field-artillery fire produced? Carnot et al. launched the most impressive industrial revolution in modern history, and developed the Ecole Polytechnique as the world's center of coordinated work in both fundamental scientific research and the problems of quickly and effectively mastering the application of scientific advances in large-scale production. "Pure" scientific research, in isolation from large-scale production, becomes sterile and useless. Any attempt to solve the deep strategic crisis facing the West, without harnessing the Promethian potential of fundamental scientific breakthroughs, is doomed to failure. What we require is exactly the same "dangerous mix" of scientific, industrial, and military-science revolutions, which Carnot and his collaborators were able to set into motion starting 1793.

Carnot's methods were at the base of the Prussian military reforms following 1807. It was largely through Carnot's direct influence on the Freiburg Academy, Göttingen University, and the Berlin circles of General von Muffling, Crelle, and the Humboldt brothers, that the 19th Century "golden age" of German science and industry was set into motion. It was for good reason that von Muffling ordered the Prussian General Staff to learn synthetic geometry and attend scientific seminars on the latest developments in mathematical physics. Carnot's methods were the basis later of Professor Felix Klein's *Göttinger Verein*—the elite circle of top industrialists and Göttingen physicists and mathematicians, which coordinated crash programs for harnessing the latest scientific breakthroughs in productive technology. The *Göttinger Verein* was the main instrument for implementing Klein's famous educational reforms in German gymnasiums and universities, reforms responsible for the production of three generations of the world's best scientists and engineers. The Göttingen Institute for Applied Hydrodynamics, established by Klein and his collaborators, was the springboard for German development of jet propulsion
and 1940s.

The Peenemünde project, the Manhatten Project, the NASA Apollo program—these are all models for what must be accomplished under the SDI and EADI. In each case, Carnot's methods were the key to success. It is therefore of urgent importance that Carnot's principles be adopted as the explicit basis for military, scientific, and economic policy-making in the coming period.