Beam-weapon program: boost to productivity

by Steven Bardwell, Military Editor

The national security of the United States, in the classic sense as national security was understood by the great military leaders at the founding of this country, will be determined for the next several decades by the decision to be made in the coming year on the development of directed energy beam weapons. Beam weapons will shape the military boundary conditions affecting foreign policy, but even more importantly, will determine the economic health of the nation without which no national defense system is possible.

After a series of important technological developments over the past 24 months, it is now the consensus in the scientific and engineering community that a high-energy laser beam could be built and deployed as a weapon capable of destroying nuclear-armed ballistic missiles in flight. Even if this assessment be doubted, it is well-known that the Soviet Union is pursuing a program for development of such a device and has constructed one such high-energy laser system which destroyed an ICBM in a successful test conducted a little over a year ago.

The military consequences of beam weapons—which could be achieved in a first-generation form within five years—have been widely discussed: The end of the doctrine of Mutually Assured Destruction, a shift of initiative from offense to defense, the obsolescence of the ICBM, and the so-called "militarization" of space as a defensive base.

Based on an ongoing study of the overall impact of the development and deployment of beam weapons, a Fusion Energy Foundation research group has concluded that the economic and civilian benefits of these weapons will dwarf even the great military benefit. According to this study, the situation with beam weapon development is very similar to that which existed with the development of nuclear power for submarine propulsion during the 1950s. Under the guidance of Admiral Hyman Rickover, the U.S. Navy pursued research and development simultaneously into the use of nuclear energy for ship propulsion and contributed to the very different application of civilian electricity production.

In hindsight it is clear that, while nuclear ship propulsion is an important military technology (and if it were to be applied to commercial shipping would be

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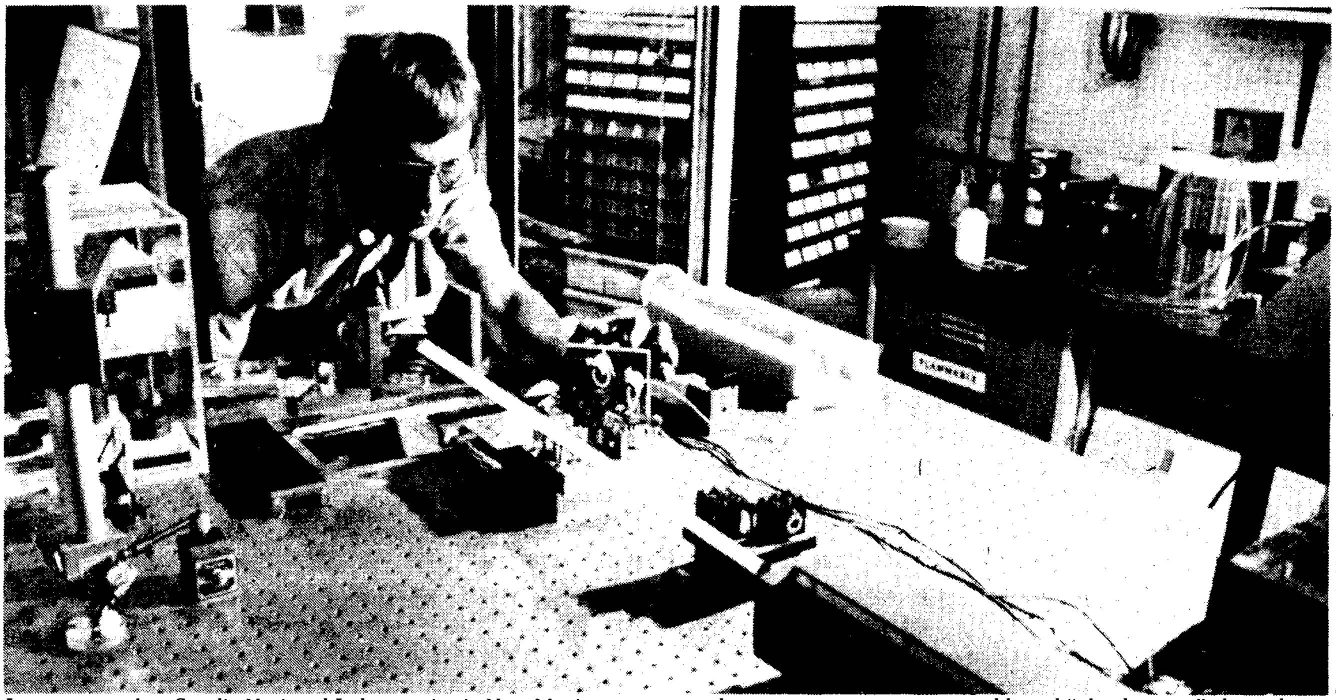

Laser research at Sandia National Laboratories in New Mexico: an energy-beam weapons program would send "shock waves" through U.S. research, development, and industry.

even more important), the civilian impact worldwide of the development of a new source of power, much cleaner, cheaper, and safer than coal or oil, was even greater. The development of beam weapons portends an even greater civilian impact.

The coming of the plasma age

The technological problems that must be solved to create a beam weapon capable of performing the strategic mission of destruction of ballistic missiles from near-earth orbit fall into six basic areas:

1) Sensing and target acquisition: the perfection of long-wavelength infrared sensors and other more exotic telescopes and detectors.

2) Data processing: the development of very large scale circuit integration and new computer algorithms for processing of large amounts of data in real-time.

3) High-energy lasers: gas and chemical lasers in the multi-megajoule range with repetition rates measured in tens of pulses per second.

4) Precision optics: the construction of mirrors at the diffraction limit with diameters of up to 30 feet.

5) Magnetics, materials, and pulsed power: the connected technologies of high-power superconducting magnets, materials able to withstand high radiation density environments, and the pulsed power sources associated with lasers, particle beams, and high-intensity magnets.

6) Space engineering: the capability of launching large amounts of machinery into space and performing in-space maintenance and monitoring functions on that network of

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equipment.

A qualitative examination of these technolgies shows that *if* these technologies were available in the form required for a beam weapon, then the technologies available to the civilian economy would usher in a new stage of industrial processes, which are almost totally dependent on the narrow range of the electromagnetic spectrum in the infrared (heat), the characteristic feature of these new technological capabilities is that they access the full-range of the electromagnetic spectrum, from x-rays through to microwaves. For the first time, it becomes economical to perform chemical, industrial, and agricultural processes using finely tuned electromagnetic energy rather than "brute force" infrared energy. The impact of this general change can hardly be overestimated. The FEF study has identified several central areas:

1) Energy production: the advent of the plasma age is most dramatically shown by the coming into existence of nuclear fusion energy, the second-generation nuclear technology using heavy hydrogen in the same fuel cycle used by the Sun. This technology, which the Japanese project to be on line in the middle 1990s, produces clean, cheap energy from an unlimited fuel source (water), in intensities 100 times those available at present.

2) Materials processing: plasma torch processing, using matter in its ionized state and magnetic or centrifugal separation, makes astronomical increases in the natural resource base of the world economy. It also creates capabilities for new, high-quality metal refining, waste recycling, and elemental transmutation. Applications of laser-isotope separation, the nearest-term of these technologies, include extraction of rare isotopes, nuclear tailoring of material and alloy properties, and chemical process control.

3) Metal working: the use of beams and lasers for more efficient, higher speed, and more easily automated metal cutting, forming, and welding is a well-established technology which awaits cheap high-power lasers for its widespread application. Less well known, but with perhaps greater impact, are applications of surface heat-treating, differential crystallization, and laser annealing.

4) Chemical processing: chemonuclear processes for the production of synthetic fuels (methane, methanol, and heavier hydrocarbons), hydrogen generation, and coal gasification are dramatic improvements on existing thermal and electrical technologies. These become realistic with the intense energies available from fusion. In addition, the use of lasers for control of specific, complex chemical syntheses and processing are a feature of control of broad ranges of the electromagnetic spectrum with food processing, non-destructive sterilization, and preservation being especially important.

5) Short-time process control: the automation and control technologies for processes which occur on sub-microsecond time scales have applications throughout the plasma industries. The ability to master the very high energy densities and inherently non-steady state properties of plasmas depends on both a diagnostic and control capability.

A 'great enterprise' in NASA's tradition

by Marsha Freeman

The development and deployment of a directed energy-beam defensive weapons system over the next decade will be one of the "great enterprises" the nation must embark on. It will require the kind of government investment that the nation has seen in the past in preparations for war, and in the civilian space program. This federal spending has the potential to stimulate increases in the productivity of the nation's economy because it has the ability to increase the rate at which new technology is introduced into the economy.

Such increases in productivity result from the optimism created by national leadership when great new projects such as the lunar landing are stated as national goals; when the spending on the project puts federal dollars directly into our high-technology industry to accomplish the task; and when industry and agriculture apply government-developed techniques to everyday economic activity.

All three of these effects led to increases in productivity during the 1960s period of the NASA Apollo program. By comparison, *none* of these effects were seen as the space program funding was diverted into Great Society social welfare programs after the death of President Kennedy.

In order to deploy beam weapons in space, our civilian space program will have to be geared up to finally provide the in-orbit manned capability that we do not yet have. Large and complex space-based military systems will have to be maintained, updated, and repaired while in orbit, and specialists located in space stations will have to be on call for this purpose. The funding for civilian space programs will have to increase over the next few years until it regains its 1960s real purchasing power.

This will mean tripling the NASA budget by the end of this decade, for the military and industrial move into space. The technology and productivity development from this funding will add to the shock waves of economic growth the development of the beam weapons themselves will provide.

Lasers for industry

Although we cannot predict all of the new technology that will result from the development of directed energy-beam weapons over the next decade, we know that specific technologies, such as the industrial application of lasers, for example, will be propelled into large-scale use. Electron and plasma technologies will be pushed years ahead, as will the