Physics and National Security: Of Missiles, Mines, and Morality

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Greg Root

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not inherently expensive. All the basic elements of such systems are contained in amateur radio transceivers, which sell in quantity for considerably less than $5000.

Reference

1. A. D. Hibbs et al., in *Detection and Remediation Technologies for Mines and Minelike Targets V* (Proc. of SPIE, no. 4038), A. C. Dubey et al., eds., SPIE, Bellingham, Wash., (2000), p. 564.

LOWELL J. BURNETT
Quantum Magnetics Inc
San Diego, California

Never before have I reacted so strongly to an article in PHYSICS TODAY. "The Evolving Battlefield" by John S. Foster and Larry D. Welch may be a reality that cannot be dismissed out of our wishes for a more peaceful world; however, my negative reaction stems from a moral element to the article.

Essentially 99% of the article pertained to changing technology needs for national security with a dubious amount of relevance to the physics that the reader is expecting. The conclusion, however, was a feel-good appeal to scientists who may decide to use their talents to "improve the human condition," as the authors put it.

Outside the ivory tower, many people don't believe it is a net positive to wage battles without offensive combatant losses or to have pinpoint accuracy destructive power hundreds of miles from the target. Perhaps the V-2 rocket was the first unmanned weapon to have long-range accuracy. This was considered a machine of terror, not just a weapon of war.

Certainly smart weapons kill fewer unintended victims, but that should never be confused with improving the human condition. If scientists wish to use their abilities to build more effective and efficient killing machines, then they should do so without cloaking it in some fabricated moral justification.

GREG ROOT
(groot@ma.ultranet.com)
Worcester, Massachusetts

It was sadly ironic that the true millennium ended with the special issue of PHYSICS TODAY (December 2000) featuring contributions on future challenges for physics and technology in warfare. Sidney Drell says that "history teaches us that new technologies have had a major influence on the structure, tactics, and strategies of military forces, and that technological advantage can prove decisive to the outcome of military conflicts." Although military battles clearly may be won with technology, history shows that military forces with extraordinary technological and economic advantages do little to end mankind's fundamental conflicts and that arms and violence beget arms and violence; consider, for example, the conflicts in the Middle East, Ireland, Chechnya, Sri Lanka, Yugoslavia, Vietnam, Indonesia, and Africa—and even the failed high-tech "war on drugs." Furthermore, history shows that the true end of conflict comes with interdependence, communication, education, and economic prosperity. These are not the present objectives of our national defense budget.

The continuing overwhelming focus on weapons and military technology ignores history and prevents interdependence. The cell phone and Internet will likely do far more to ensure future peace than any gadgets developed at seemingly unlimited expense by scientists working on secret defense projects. The biggest contributions that the scientific community can make for world peace are to encourage young scientists and engineers to shun military work; to focus on the challenges in energy, civilian communication, and the environment; and to promote leaders who recognize these priorities.

ERIC W. MCFARLAND
(mcfar@engineering.ucsb.edu)
University of California, Santa Barbara

DRELL REPLIES: The last section of my introductory article—A special responsibility—briefly touches on that very issue, asking each physicist to define his or her own response to the important challenges raised by applications of scientific advances.

SIDNEY D. DRELL
Stanford Linear Accelerator Center
Stanford, California

NIF's Value Questioned, Affirmed

The article by Jim Dawson on the NIF controversy (PHYSICS TODAY, January 2001, page 21) quotes Burton Richter as saying that it would take Lawrence Livermore National Laboratory (LLNL) two or three years to bring the National Ignition Facility (NIF) laser up to full performance, and that this was typical of projects of this kind. That viewpoint is not supported by the story of LLNL's previous laser, called Nova. In their 1980 laser program annual report,[1] LLNL researchers calculated an expected performance for Nova of 9–10 kJ/beam at the third harmonic. In their 1981 annual report (p. 2-28), at the start of Nova construction, they proposed operating criteria of 4–7 kJ/beam. The 1981 report also stated that the "primary programmatic objective for Nova," using an eventual 20 beam lines, would be "demonstrating the ignition of thermonuclear burn." The Nova laser worked poorly when it was completed. After several years of fixes and upgrades, the useful energy for laser-target hohlraum experiments at the third harmonic reached 3 kJ/beam. The ignition goal for Nova was discarded.

Ed Moses is quoted as saying that there has been no loosening in any way of the criteria for project completion of NIF. LLNL specifications for NIF had been 9.4 kJ/beam in a shaped 20-nanosecond pulse, with 98% of the energy focused to within a 600-micron spot size, with optical beam smoothing. LLNL scientists calculated that about 9 kJ/beam is needed to drive their target design to ignition; 20-ns-long pulse shapes are needed to create ignition conditions; the 600-μm focal-spot size is needed to fit the laser light through the entrance holes of their hohlraum target; and the optical beam smoothing is needed to control laser-plasma instabilities. This time, to reach ignition, there would be 192 beams. NIF would also use a different laser design than Nova.

The Department of Energy submitted draft NIF milestone definitions to Congress on 15 September 2000, and then to a NIF review panel on 16 November 2000. These milestones call for acceptance of the first eight beams in December 2004 with 5 kJ/beam of third-harmonic light in an unshaped 5-ns pulse. The full 192-beam system would be accepted in September 2008 with 5.2 kJ/beam in an unshaped 5-ns pulse. The draft includes no specifications on focusing or beam smoothing. This watering down of the NIF milestones is important because the scientific prototype of NIF, called Beamlet, was never operated simultaneously at full energy, full pulse duration, conversion to third harmonic, with focusing.

Sidney Drell is quoted as saying that he supports NIF, independent of