

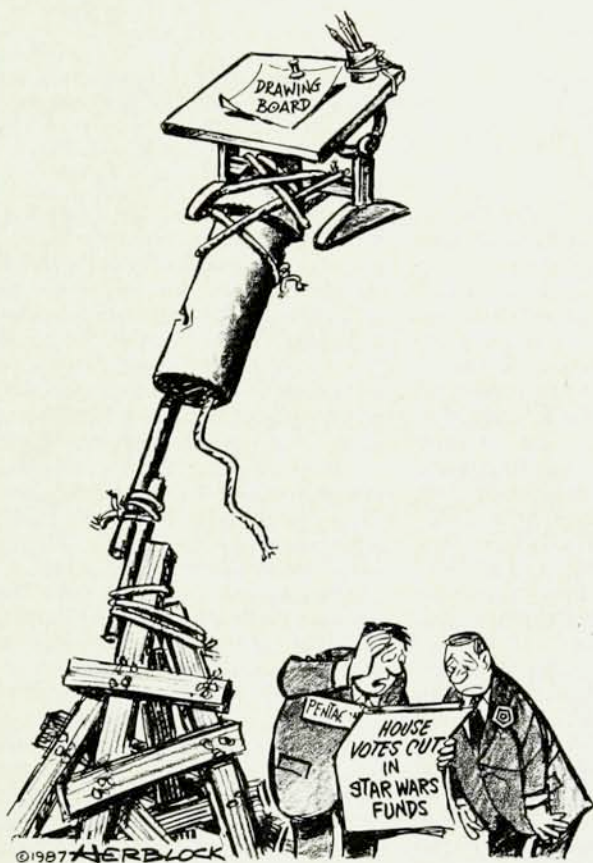
SDI attempts to zap APS directed-energy weapons report

One of the most striking chapters of The American Physical Society's report on directed-energy weapons appeared even before the document was formally issued. The chapter never appeared in print. It revealed the way the Strategic Defense Initiative office tried to influence the press accounts of the report, which bears the title *Science and Technology of Directed Energy Weapons*. (See PHYSICS TODAY, May, page S1, for summary of report.)

As soon as the SDI organization learned that copies of the 424-page report were being handed out to news reporters for background reading before the official release the next morning, the agency distributed a statement of its own. Doing this, SDI apparently reasoned, would allow reporters to have an instant response to the findings of the report in time for the APS news conference at 10 am on 23 April. In fact, SDI had been tipped that both *The New York Times* and *The Washington Post* intended to publish accounts of the report before its release. Accordingly, the Pentagon's decision to put out its own message as early as possible seemed right in the circumstance. The surprising thing was that in the more extensive press coverage that followed (see the news story on page 55) the SDI response was virtually ignored.

Acclaim. This turned out to be a serious deficiency in the coverage of the APS report because the SDI statement and the answers of panel members at the morning news conference were revealing. In its news handout, SDI acclaims the nine technical chapters as "an objective independent appraisal of various technologies." Among the reasons for praising the report, the organization says, is that by performing the study APS "has responded to the President's challenge to scientists and engineers... to join together to seek defensive solutions to the ballistic missile threat. The report offers a challenge to the APS membership to help us seek innovative solutions to the technical issues we must resolve to develop effective directed-energy weapons."

"JUST WHEN WE WERE READY FOR LAUNCHING"



HERBLOCK/THE WASHINGTON POST

The cheering stops abruptly, however, when the SDI announcement boos the report's summary and major conclusions as "subjective and unduly pessimistic." What's more, says the SDI office, the report bears "the additional problem of being a snapshot in time" that shows it already out of date upon publication. According to SDI, "we have made significant progress" in free-electron lasers and neutral particle beams in the seven months since the physicists completed their study last summer. Those advances, SDI asserts,

are "several orders of magnitude" better than the performance reported by the study group. The obvious implication is that directed-energy weapons technologies are developing faster than the APS panel found, thus approaching the levels of feasibility required to transmogrify President Reagan's dream of a ballistic missile defense into the reality popularly known as "Star Wars."

SDI's statement claims that in the intervening months it has scaled the first induction free-electron laser from



Press conference for DEW report attracted some 75 journalists to the American Physical Society meeting in Washington on 23 April. Cochairmen of the study were C. Kumar N. Patel of Bell Labs (left inset) and Nicolaas Bloembergen of Harvard (right).

0.8 cm to 10.6 microns. According to members of the APS panel, the figures are a spurious comparison of power levels and wavelengths, which are unrelated. SDI also asserts that the brightness of the electron beam injector for the free-electron laser at Los Alamos has improved by two orders of magnitude and that the injector, designed to reach 5 MeV, has achieved full beam current without significant emittance growth. The injector now operates at 1 MeV. Further, the SDI statement boasts that a new cw ion source for neutral beam machines, developed at Culham Laboratory in the United Kingdom, now meets the goal for beam quality.

Irony. It is ironic that the Pentagon considers the report outdated, because the publication was held up for some seven months while drafts underwent a circuitous process of security clearance through the SDI office, various other units in the Pentagon, the departments of Energy and State and even the White House Office of Science and Technology Policy. Not every agency considered it politically prudent to release the report, especially during budget-cutting season on Capitol Hill, but only two government offices actually opposed its unclassified publication. In the end the view of SDI's director, Lieutenant General James A. Abrahamson, prevailed. He insisted all along that the report be approved for dissemination, though he acknowledged that some cuts and changes had to be made for security reasons.

In a statement separate from the report, APS's review team, headed by George Pake of Xerox, observed that

there had been "small but significant deletions"—notably in references to possible vulnerabilities and potential countermeasures that might be used against laser light and particle beam technologies of a Star Wars system. The review panel termed the deletions a "minuscule" fraction of the study group's original report. When a reporter asked at the 23 April press briefing whether the government's review had dragged on too long, the cochairman of the study group, C. Kumar N. Patel of Bell Labs, replied that it could have been "compressed" and that many of the Pentagon's complaints were "onesies and twosies corrections," but that none of the changes affected the group's essential conclusions.

The draft report was submitted to security reviews because the study group, whose members all hold clearances, had access to classified information provided in detailed briefings and visits to restricted laboratories. If it had refused classified information about SDI work, the panel would have invited criticism that it lacked essential knowledge or understanding of directed-energy technologies.

Of course the 15-member panel already possessed wide familiarity with the research. Its cochairmen were Patel, who invented the carbon dioxide laser, a possible directed-energy weapon, and Nicolaas Bloembergen of Harvard University, who won a Nobel Prize for his work on nonlinear optics and laser interactions. The other members also are preeminent in directed-energy technologies, working at government or industrial laboratories and at leading universities.

Two A's. Their report had been eagerly expected for months by arms control experts, members of Congress, the Pentagon and the press. When it finally appeared it was greeted with the expected partisanship—though there were some unexpected exceptions. Louis Marquet, SDI's deputy director for technology, for instance, characterized the report as "very responsible" at a news conference called at the Pentagon and underscored the study group's conclusion about the need to achieve a thorough understanding of the physics underlying directed-energy weapons. That a panel of nonpartisan outsiders was able to explore heretofore inaccessible territory and draw detailed charts for future work is really remarkable, observed Marquet. "I think it's probably unique in government annals for an open society to review a classified program." He concluded that "both of us gave each other A's. I think they gave us an A from the standpoint of understanding the technical aspects of the program. . . . There was nothing in their report that says we're completely out of our minds, that some things are beyond the laws of physics."

Gerold Yonas, who was SDI's first chief scientist until he joined Titan Corporation last summer, calls the report "an important contribution, providing understanding and perspective to the debate over SDI. It is the most useful balance sheet for seeing where we are and where we ought to go with directed-energy defenses and, as such, goes well beyond the bumper stickers and newspaper slogans that seem to entertain and do so much to misinform the public."

It was the need to inform public opinion that led Richard DeLauer in 1983, when Under Secretary of Defense, to welcome the APS study and offer DOD's cooperation. DeLauer's enthusiasm was followed a year and a half later by letters of encouragement from Abrahamson and George A. Keyworth II, then the President's science adviser. All three asked the study group to limit its examination of the SDI program to directed-energy weapons (or DEWs, as they are known in defense circles). DeLauer wrote that the panel should concentrate on "the areas of the society's recognized expertise, namely physical analysis, and to refrain from clouding the study with policy evaluations which could detract from its technical credibility." The panel did precisely that.

ETA and ATA. Since President Reagan revealed his grandiose vision of perfect defenses and impotent missiles, laser light and particle beams have occupied a central place in both popular conceptions of Star Wars and SDI's own strategy. SDI's annual report to Congress, made public just two days before the APS report was released, says, for instance, that DEWs "are critical to providing a wide selection of defense options" and "the key to defeating the more serious threats that might be deployed in response to first-generation US defenses." The SDI report speaks of "significant accomplishments" for DEWs, consisting mainly of early stages of design, construction or tests of free-electron lasers (see the news story on page 17), such as the induction linac Experimental Test Accelerator at Livermore and the Paladin experiment using the Advanced Test Accelerator at Livermore; hydrogen fluoride chemical lasers; laser mirrors; and other optical components.

Still, the latest "breakthroughs" in DEWs appeared in SDI's response to the APS report. When a reporter attending the APS news conference asked about the SDI claim of improving the brightness (by two orders of magnitude) of an rf injector for free-electron lasers at Los Alamos, a panel member, Andrew Sessler of Lawrence Berkeley Laboratory, replied that this referred only to a component, a photocathode source, and while it represented a significant improvement, "it is still a long way from a cathode to an accelerated beam and a longer way from an accelerated beam to a free-electron laser." As for the induction linac approach, the report points out, brightness still needs to be improved by a factor of 4. What's more, both rf and induction techniques suffer from sideband instabilities and harmonic generation, and not much is known about the

APS Council speaks out on SDI

A day after The American Physical Society issued a 424-page report on the directed-energy weapons that are being considered as part of the Strategic Defense Initiative, the APS Council, the elected governing body of the society's more than 38 000 members, released the following statement. The statement, adopted after considerable discussion at the council meeting on 24 April, is more far-reaching than the conclusions in the report, Science and Technology of Directed Energy Weapons. It reads:

A major study of the science and technology of directed-energy weapons, conducted by a study group of The American Physical Society, found that:

- ▶ The development of an effective ballistic missile defense utilizing directed-energy weapons would require performance levels that vastly exceed current capabilities.
- ▶ There is insufficient information to decide whether the required performance levels can be achieved.
- ▶ A decade or more of intensive research would be required to provide the technical knowledge needed for an informed decision about the potential effectiveness and survivability of directed-energy weapons systems.
- ▶ The important issues of system integration and effectiveness depend critically on information that does not now exist.

The Council of the APS believes that it has a public responsibility to express concerns about SDI that go beyond the issues of directed-energy weapons covered in the study.

- ▶ Even a very small percentage of nuclear weapons penetrating a defensive system would cause human suffering and death far beyond that ever seen on this planet.
- ▶ It is likely to be decades, if ever, before an effective, reliable and survivable defensive system could be deployed.
- ▶ Development of prototypes or deployment of SDI components in a state of technological uncertainty risks enormous waste of financial and human resources.

In view of the large gap between current technology and the advanced levels required for an effective missile defense, the SDI program should not be a controlling factor in US security planning and the process of arms control.

It is the judgment of the Council of the APS that there should be no early commitment to the deployment of SDI components.

relative importance of such phenomena in oscillators and amplifiers. Accordingly, SDI's developments, said Sessler, are "a small step, an important step, but still a small step."

Nor was another APS conclusion invalidated by SDI's claim of higher beam currents for an ion source for neutral particle beam accelerators, said Bruce Miller of Sandia National Laboratories. The conclusion that such accelerators need to be scaled up by at least two orders of magnitude in voltage and duty cycle was still correct. Another member of the study group, Richard Zare of Stanford University, observed that it is tricky to extrapolate from existing performance levels to higher ones, which SDI officials often did in describing to Congress the case for directed-energy systems.

Reactions. Within hours of its release, the report was praised by Star Wars adversaries in the Senate, such as Wisconsin's William Proxmire and Louisiana's J. Bennett Johnston. Senate advocates of SDI, including Indiana's Dan Quale and Wyoming's Malcolm Wallop, indicated they doubted the study group's conclusion that at least a decade would be needed before a realistic decision could be made about the feasibility of DEWs. A group calling itself the Science and Engineering Committee for a Secure World, under the chairmanship of Frederick Seitz, onetime president of the National A-

cademy of Sciences, Rockefeller University and APS, complained that the APS report is simply irrelevant, because it does not deal with kinetic-energy weapons. KEWs, the group notes, might be developed and deployed by 1993 or 1994, as a first phase in the evolution of a missile shield. Indeed, since the publication of a report on KEWs by the George C. Marshall Institute (see PHYSICS TODAY, January, page 47), which Seitz also heads, Defense Secretary Caspar Weinberger has urged the President and Congress to adopt a phased SDI program for starters.

The APS panel once discussed expanding the study to include kinetic-energy technologies, but decided to stick to the issues designated by DeLauer, Keyworth and Abrahamson. To have included such matters as kinetic kill weapons, as well as battle management, say, and computer software, would have meant adding more panel members with expertise in those matters and taking more time to conduct the study.

Even limited to DEWs the APS report is certain to have a significant impact on the fierce political debate currently being waged on Capitol Hill over how soon to deploy a DEW defense system and how much to fund SDI in the next few years. The report prompted Representative Henry J. Hyde, Republican of Illinois, to send a "Dear

colleague" letter on 6 May under a two-line title:

Falsehood flies on falcon's wings

While truth shuffles along in wooden shoes!

The letter declares that "the report is egregiously flawed in some very important respects" and claims it is a "rather misleading piece of work." To support his assertion, Hyde attached an "SDI watch" column from the 22 May issue of *National Review*, based, according to Hyde, on a paper written by Gregory Canavan of Los Alamos. The article states that the study group's estimates for the electric power required to maintain DEW-equipped satellites in orbit are too high by a factor of 30. In fact, the difference between the report's estimate and Canavan's estimate is about a factor of 2—a reasonable disagreement because no detailed study of scaling SDI architecture has been done by anyone.

Protests. Other objections were raised on 19 May by Seitz, accompanied by Lowell Wood of Lawrence Livermore, during a combined briefing for a scattering of Republican members of the House of Representatives and the press. Seitz, who is chairman of SDI's scientific advisory committee in addition to his other affiliations, protested that the APS report "is not worthy of serious consideration" because it contains "numerous errors, inconsistencies and unrealistic assumptions"—"always in the direction of making... SDI seem farther from achievement of its objectives than it actually is."

Wood's qualms were of a different order. Though Wood based his technical comments on a 60-page paper written by Canavan, his discussion of the APS report often sounded like political polemic. He charged that some members of the study group and the review committee either opposed SDI or "expressed deep reservations in private" about the program. The APS report, Wood argued, is therefore not an objective examination of DEWs. He then attacked the APS Council's statement (see box, page 45) on early deployment, saying the group was passing judgment "on the basis of no technical studies or reviews done by it or under its auspices."

In a telephone interview, Canavan disavowed such remarks. "My paper is strictly a technical review of the APS report," he observed, "and it says very clearly that some of the calculations are wrong. The numerical errors have nothing to do with the personalities behind the report. There was no cabal. It's not even an issue of scaling or architecture. The fault is not in the panel's politics but in its math."

'Boo-boo.' One of the glaring errors Canavan caught is the inconsistency between the first conclusion and the full text. The conclusion says chemical lasers have attained power levels exceeding 200 kW with acceptable beam quality—a factor of 100 below the minimum requirements of an SDI system. In an early draft, it turns out, the APS study group had used the correct number for chemical lasers, only to have this altered by the SDI office during a classification review. Later in the review cycle, however, SDI officials relented and allowed the panel to write that chemical lasers had attained more than 1 MW. The Pentagon's about-face took place because in the meantime *Aviation Week* had printed the correct figure. The APS panel changed chapter 3 but failed to change conclusion 1 accordingly. "It was an editorial boo-boo," says an APS panelist. If the conclusion had been changed, it would have read, "greater than 1 MW and thus a factor of 20." Even so, notes Patel, the APS conclusion is correct in stating that chemical laser output will encounter problems in scaling to higher power levels, probably by two orders of magnitude.

In citing errors relating to laser lethality effects on ablative shielding used to harden ballistic missiles in their boost phase, Canavan argues that the study panel was in error by a factor of 160 in power performance. The trouble with Canavan's recalculations, Patel asserts, is that he specified excimer lasers as the kill mechanism where the report speaks of x-ray impulses. "This is a case where the report doesn't say explicitly x-ray fluence," says Patel. "We should have made sure the section was headed 'Structural damage from impulse loading by x rays.' Canavan caught us out here, but if he had read the report in sequence he would have known we were speaking of x rays."

Many of Canavan's other quarrels with the APS report—particularly those involving the length of time that a particle beam would take to penetrate a missile, the power needs of neutral particle beams and the number and wattage of orbiting nuclear reactors for peacetime "housekeeping" of an SDI system—depend largely on differing assumptions rather than on faulty physics. "My intention was not to discredit the report," says Canavan. "It was always to make it more accurate and complete. I think of myself as a reviewer."

Hearings. In Washington there are those who believe that Canavan's cavils as well as arguments against the APS report by the conservative Heritage Foundation will lead inevitably to

hearings about DEWs on Capitol Hill. Indeed, editorials criticizing the report in the *National Review* and *The Wall Street Journal* are likely to hasten the hearings, especially while both houses of Congress are determined to cut SDI's budget request for fiscal 1988 by \$2 billion or more.

In a letter to the *Journal*, Val Fitch of Princeton University, currently president of APS, writes that the committee members "performed a monumental service to the country. We of The American Physical Society believe that the report is as objective as humanly possible, that it will make an important contribution to the formulation of policy and that it will substantially raise the level of discussion."

—IRWIN GOODWIN

Washington Ins and Outs: Space physicist replaces engineer at NASA

Lennard A. Fisk Jr, a space physicist and vice president for financial affairs at the University of New Hampshire, became NASA's associate director of space science and applications on 6 April. Fisk is highly regarded for his research on the Earth's magnetosphere. He had been a member of the National Research Council's Space Sciences Board, which has sometimes been at odds with NASA policies, especially since the Challenger space shuttle debacle sent planetary science and Solar System exploration off course. As chairman of the Space Science Working Group of the Association of American Universities, Fisk is considered politically savvy, possessing considerable credibility on Capitol Hill, which comes from his frequent testimony before Congress.

Fisk succeeds Burton I. Edelson, who had occupied the job since February 1982. Edelson's appointment had been greeted with hostility by scientists because he is an engineer, having spent 14 years with Comsat, where he was latterly senior vice president, and before that 20 years as a commissioned officer in the Navy. During his years at NASA, several new projects were started, only to be placed on hold for lack of launching opportunities because the agency emphasized the space shuttle over expendable rockets. "In a period when space science is increasingly exciting, with wider horizons and expanding interactions with a larger scientific community, Burt found himself hoist by the petard of higher costs for more sophisticated projects and limits on our accessibility to space," says a friend of Edelson's at NASA. □