Letters

APS Report on SDI

I would like to comment on the article "Doubt cast on laser weapons" by Colin Norman (News & Comment, 1 May, p. 509).

The Department of Defense is pleased that the American Physical Society (APS) has chosen to focus the attention of renowned U.S. physicists on key issues that must be resolved if we are to achieve the objective President Reagan set for us in his challenge on 23 March 1983—to seek a better basis for deterrence. We in the Strategic Defense Initiative (SDI) Organization cooperated fully and enthusiastically with the APS Study Team and opened our doors to a full review of our Directed Energy Program, including classified information. We did this with the conviction that only by such an open and impartial review would we confirm our understanding of the basic physics issues underlying the potential applications of directed energy for ballistic missile defense, unquestionably one of the most controversial aspects of our program. We are pleased with the overall content of that report, in that it accurately describes many of the basic technical hurdles that must be overcome and, at the same time, acknowledges the considerable progress made to date. However, it is important to differentiate between the main body, which is factual, and the executive summary, which goes beyond the facts and becomes subjective in its speculation regarding potential rate of progress.

Norman has titled his article, "Doubt cast on laser weapons" and asserts that the report is likely to be the most damaging assessment to date. Straightforward analysis of the actual *facts* presented in the APS report indicates that indeed we may have orders of magnitude in performance to go in some of the technologies necessary for incorporation into directed energy weapons for Ballistic Missile Defense. Nowhere however, is it stated that any physical principles are known that preclude the attainment of the necessary performance.

We believe that the study's unduly pessimistic estimate for the time required to resolve the basic technical issues concerning applications of directed energy to ballistic missile defense are a consequence of emphasizing how far we need to go, rather than how far we've come. In fact, even in the time interval between the final draft report and release, significant progress was made in areas specifically cited as essential. To mention just two examples, researchers at the Culham Laboratory (in the United Kingdom) demonstrated a continuous negative ion beam source which, in a laboratory setup, exceeds many of our goals for a neutral particle beam system for interactive discrimination. The second example involves a substantial increase in the brightness of an electron beam source required for a free electron laser (FEL). This has been a key accomplishment essential to scaling of high power FEL's down to visible wavelengths.

Norman is quite correct in implying that our country must have reasonable confidence that more advanced systems, such as those based on directed energy, may be developed before we can make a decision to develop and deploy a first-phase defense system based on more mature technologies, such as kinetic energy interceptors. We agree that we have not yet reached that point of confidence in our program.

A vigorous SDI program must be conducted to resolve the important issues outlined in the APS report. We believe the likelihood of determining that defenses are both feasible and reasonable, from the scientific, engineering, economic, and policy points of view, is sufficiently high to warrant a strong investment. Further, the downside risk of not finding out what can be done, and finding it out soon, is too large.

To the degree that Norman states that great deal must be learned before a decision can be made to develop and deploy a defense, his article is correct. We have no illusions about that. But that fact should not be cited as "criticism" of or "damaging" to the SDI. No one should be criticized for doing his homework before making a decision. Making a negative decision without doing one's homework is unthinkable. The SDI program was established by the Administration to do that homework. We fully recognize that there is a great deal of homework yet to be done—but let's not forget how far we've come and how rapidly we are progressing. I can assure *Science* readers that when the time comes for the country to make its "informed decision" on development and deployment, all parties, including the community of physicists, will have ample opportunity to review the basis for that decision and make appropriate recommendations.

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The recently released American Physical Society report on SDI deals with the state of the art of various exotic technologies, whether they may provide the basis of a nuclear "defense," and how soon we might learn of their potential viability. In other words, the report tries to gauge whether or not one kind of a strategic nuclear defense might be *possible*. This 18-month study was an effort to find an answer to but one question or one dimension of a complex issue which begs the far more relevant questions: Even if we *could* build these SDI systems, *should* we? Will we increase or decrease our security? Will we increase or decrease crisis stability? In the nuclear age, and in an age of vastly increased technological potential, we can no longer proceed, as in earlier times, with "if it *can* be done, let's *do* it."

Some of the matters we must all reflect on before rushing headlong into technologies that might yield to our technical ingenuities are as follows.

1) SDI is a threat to the Soviets because they perceive it to be a shield behind which we might hide after conducting a first strike on them. SDI might turn out to be adequate enough to protect us from a ragged, much weakened Soviet retaliatory strike. Whereas we don't view this scenario as realistic, the Soviets must, as we are continuously adding "first strike" weapons such as the MX, the Pershing II, and Trident II (D5) missiles to our arsenal. If the Soviets are threatened, then we too are threatened.

2) If SDI could work as envisioned, was itself impregnable, could destroy all ICBMs (all big "if's" of very low probability), it still would be of little strategic value because it could not prevent nuclear bombs from being delivered by low-trajectory submarine-launched missiles, cruise missiles, or airplanes.

3) As we develop new defensive technologies the Soviets, and we, continue to develop offensive weapons. The latter tend to be available more easily, more rapidly, and more cheaply than the defenses they must overwhelm.

4) Countermeasures to defensive systems are now known and available at a tiny fraction of the cost of a defensive system, which will work against known, as-yet-untested or even uninvented SDI systems.

5) Each part of an SDI system must work and the whole system must work in harmony the first time, flawlessly. The system can never be tested under realistic conditions, even if the 10 million or more lines of computer code could be written and trusted to be error-free.

6) The mutual vulnerability of space-based SDI systems gives an enormous advantage to the one shooting first, making it easier to contemplate a preemptive first strike in time of crisis. Thus, crisis stability and deterrence are both weakened by SDI, lessening our national security.

7) The old comparisons of offenses and defenses are meaningless in the nuclear age.

A defense must be better than 99% effective (99% still could allow 100 Soviet nuclear bombs to destroy 100 American cities), whereas an offense is catastrophically devastating if it is only a few percent effective.

8) Can we expect the Soviets to bargain away their offensive missiles while we retain and continue to add first-strike missiles and build a shield from behind which to launch them?

9) The SDI systems now being sought, if even partially successful, would be of greatest threat to existing and future satellites and thus to the SDI's own systems in space. SDI sows the seeds of its own destruction.

10) Rather than slow or stop the arms race, SDI will create a whole new defensive arms race layered upon a renewed and accelerated offensive arms race. Technology development never ceases; it is open-ended. Continuous development of sophisticated defensive technology will be followed by even more sophisticated offensive technology, followed by . . . ad nauseum, ad holocaust.

SDI could end up costing us far more than merely our money and resources.

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Bipedal Locomotion

James O. Farlow (Letters, 17 Apr., p. 243) discusses the parallel evolution of bipedal locomotion and chastises anthropologists for not looking to other taxa as models for the evolution of human locomotion. Students of paleoanthropology, however, have good reason not to be preoccupied with modeling the locomotion of humans after that of theropod dinosaurs or kangaroos, since the three forms of bipedal locomotion share few features aside from a common adjective.

The development of a two-legged gait in dinosaurs was channeled by the constraints of a reptilian vertebral column flexible mediolaterally, combined with relatively rigid pelvic and shoulder girdles. A bipedal stride would likely involve a forward movement of both limbs on the striding side simultaneously, or keeping the upper body immobile, to produce a lurching or waddling stride. Nonprimate mammals, with backbones more flexible dorsoventrally, move as bipeds (exemplified by the kangaroo) with both anterior limbs moving together and both posterior limbs moving together—a hop. Both groups maintain balance with the aid of a large tail. Humans, generated from an arboreal lineage marked by flexibility of the hip and particularly of the shoulder, stride with the opposing forelimb forward. Balance is achieved in the absence of a tail through rotations of the thorax and pelvis in opposite directions (*1*).

As is usually the case in parallel and convergent evolution, the similarities among the three groups are superficial, which makes it unlikely that the evolution of hominid locomotion could be modeled effectively by recourse to other groups.

Anthropologists have realized that the uniquely derived locomotor features of the different taxa serve as effective contrasts to one another. Hooton, in both editions of *Up from the Ape* (*2*), figured the skeleton of a kangaroo in this regard. Howells, in *Mankind in the Making* (*3*), also gave a cursory contrast among the bipedal groups. A more recent review of hominid locomotion includes a photograph of one of the authors actually locomoting alongside a kangaroo (*4*).

Further, hominid bipedalism, although it is the biological hallmark of our clade, is nevertheless a learned behavior, and there is no evidence that this is the case in other taxa. Major studies therefore assume that the distinctness of human locomotion does not require further belaboring (*5*). Indeed, it does appear to be the case that, as Farlow puts it, "the shift from quadrupedalism to bipedalism is fundamentally different from one vertebrate group to the next," mechanically, historically, and developmentally. The emergence of these derived locomotor features across taxa is no more amenable to a singular explanation than is the parallel loss of an *os baculum* in spider monkeys, tarsiers, and humans (*6*); reduction of the tail in pottos, hominoids, and Manx cats; or the loss of teeth in birds, baleen whales, and hockey players.

It is possible, finally, that the problem perceived by Farlow is the result of a terminological laxity: while "bipedalism" is not uniquely human, "walking" (as biomechanically defined) is (*7*); and that is the focus of the anthropological investigations reported by Lewin (Research News, 27 Feb., p. 969).

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REFERENCES AND NOTES

1. J. Maynard Smith, *The Theory of Evolution* (Penguin, Baltimore, ed. 2, 1966), p. 266; B. Newman, *Biol. J. Linn. Soc.* **2**, 119 (1970).
2. E. A. Hooton, *Up from the Ape* (Macmillan, New York, ed. 1, 1931; *ibid.*, ed. 2, 1946).
3. W. W. Howells, *Mankind in the Making* (Doubleday, New York, 1967) [see also B. Campbell, *Human Evolution* (Aldine, New York, ed. 3, 1985) and J. Buettner-Janusch, *Origins of Man* (Wiley, New York, 1966), p. 310].
4. A. Zihlman and L. Brunker, *Yearb. Phys. Anthropol.* **22**, 132 (1979).
5. J. Napier, *Sci. Am.* **216**, 56 (April 1967); J. T. Robinson, *Early Hominid Posture and Locomotion* (Univ. of Chicago Press, Chicago, 1972); H. McHenry and L.Temerin, *Yearb. Phys. Anthropol.* **22**, 105 (1979); S. Kondo, Ed., *Primate Morphophysiology: Locomotor Analyses and Human Bipedalism* (Univ. of Tokyo Press, Tokyo, 1985).
6. P. Hershkovitz, *Living New World Monkeys*, vol. 1, *Platyrrhini* (Univ. of Chicago Press, Chicago, 1977), p. 118.
7. J. Charteris *et al.*, *J. Anat.* **128**, 803 (1979).

Immigrant Entrepreneurs

The article on the economic impact of immigration by George J. Borjas and Marta Tienda (6 Feb., p. 645) omits mention of one very important factor—entrepreneurship. The authors discuss the impact of immigration as a matter of competition for jobs. This conventional approach does not acknowledge that immigrants are creating jobs for themselves and others through entrepreneurial pursuits. Such an omission has serious policy implications. To the extent that the problem is viewed as a static jobs allocation issue rather than a dynamic jobs creation issue, some credibility is lent to a familiar congressional reaction to immigration: *They* are stealing jobs from *our* people. Any such implication is unjustified and unfortunate because, clearly, it is not the position of the authors nor is it one implied by their results.

Evidence from my own studies (*1*) of minority and ethnic entrepreneurship complements that in the article. Statistical analysis of microdata from the 1980 Public Use Sample shows that the odds of someone being self-employed increase significantly if the individual has immigrant characteristics. It is high time that labor economists take account of entrepreneurship in their methodology and also recognize that immigrant groups have revitalized many previously run-down urban areas, for instance, the Cubans in Miami and the Koreans in Los Angeles.

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REFERENCES

1. P. Bearse and P. Johnson, *A Comparative Analysis of Minority and Ethnic Entrepreneurship in the U.S. as of 1980* (Office of Research, Minority Business Development Agency, Department of Commerce, Washington, DC, 1986).

Erratum: In the letter "Tanker 'dumping' regulations" by T. S. Wyman (5 June, p. 1160), the years of amendations to the International Convention for the Prevention of Pollution from Ships, 1973, mentioned in the second paragraph, were incorrect. The amendations were made in 1978, 1984, and 1985 (not 1987).