own conferences and their own journals; their papers have scientific-looking diagrams and only experts see that sometimes not even the most simple laws of physics seem to be known to the authors. In this way, any serious work in these fields is severely hampered.

▸ The damage done by the attempt to make every piece of science look "relevant" again may be greater than Eimerl indicates. If an author has found some new fact by measurement, he is tempted not only to report it but also to demonstrate any practical consequence he can think of. This often leads him to discuss speculations, qualitative possibilities without consideration of numbers. Again, this contributes to bad science. We should realize that, for example, a screw is a very irrelevant thing. Even if it is used to hang one's hat on, a nail would do the same job cheaper. A chair, yes, that is relevant; one can sit on it. But a screw can only hold a chair together; it is, as such, not relevant. We should be honest enough to point out that exactly the same reasoning applies to many a scientific work. Eimerl is correct when he says that the referee can help in this regard. Just yesterday I turned down a paper because the author, not satisfied with reporting some very interesting and important measurements, felt that he had to embark on a series of unfounded hypotheses to give a more "relevant" color to his findings. I pointed out that without these additions, the paper would be a good one.

HANS DOLEZALEK
Office of Naval Research
4/4/78 *Arlington, Virginia*

Lasers for fusion

I suggest that the Nd:glass laser should be included in the list of candidate advanced lasers in "Laser Fusion" by C. Martin Stickley in the May issue (page 50). In this article, CO_2 lasers are considered the leading candidate for a fusion-power-plant laser, but other lasers are reported to be under study in case target/laser-beam interaction studies find that shorter wavelength lasers are needed. Thirteen candidate lasers are listed including Tm:glass and flashlamp pumped iodine. Stickley states that Nd:glass lasers could be made to operate with high average powers only with the perfection of techniques that have not yet been demonstrated. It should be pointed out that none of the "candidate lasers" are now suitable for driving fusion reactions. As with Nd:glass lasers, all lasers will require the perfection of techniques that have not yet been demonstrated.

Approximately ten years ago Nd:glass oscillators achieved efficiencies of 8% in the free-lasing mode of operation. The same Nd:glass material in other lasers achieved 30 pulses per second repetition rates. Over the last several years significant improvements have been made in glass composition, glass manufacturing techniques, and laser system engineering. The large amount of successful work already done on Nd:glass lasers gives a high degree of credence to new flashlamp-pumped Nd:glass laser-system designs that project efficiencies greater than 1% and repetition rates of several pulses per second. These designs do not rely on any new or unproven physics, only on careful design and engineering. With the development of new pumping technologies and/or improved laser glasses, both quite probable if pursued, suitable Nd:glass lasers should achieve efficiencies of several percent.

In searching for reasons that the Nd:glass laser did not appear on the list I considered and rejected the following possibilities:

▸ It couldn't be because it's a solid or a glass laser, because one glass laser and three other solid lasers were listed.

▸ It couldn't be because of flashlamp pumping because the flashlamp-pumped iodine laser was listed.

▸ It couldn't be because of the 1.06-micron wavelength because lasers with both longer and shorter wavelengths were listed.

▸ It couldn't be because projected efficiencies are only 1–4% because three other lasers are listed with efficiencies as low as 1%.

▸ It can't be because existing lasers were not to be listed, because the iodine laser was listed under the heading "existing lasers."

Nd:glass lasers have been the workhorse in most laser fusion research laboratories where they have had to be "up and running" while Brand X lasers existed only on paper. In the course of being scaled up to the present kilojoule levels, Nd:glass lasers underwent certain growing pains not yet experienced by other potential lasers. This emotional background may explain the omission of Nd:glass lasers from Stickley's table; the technical capabilities of Nd:glass lasers do not explain this omission.

GEORGE DUBÉ
Owens-Illinois
5/25/78 *Toledo, Ohio*

THE AUTHOR REPLIES: Although Nd:glass lasers have been operated in long pulse modes with reasonable efficiency and have been operated at high repetition rates with low output energies the simultaneous achievement of these attributes at powers, energies and pulse lengths of interest in laser fusion has not been demonstrated. Current Nd:glass laser systems for fusion are on the order of 0.1% efficient.

George Dubé states that the extension of Nd:glass laser technology into the high repetition rate (1–10 pulses per sec), high efficiency (>1%), short pulse (approximately 10 nanosec) regime requires only "careful design and engineering." Our analysis, based on studies sponsored by the Office of Laser Fusion, is that the design of such systems is far from trivial, being made rather complex by the need to provide for sufficient cooling of the glass so as not to degrade the system's optical performance. Although these laser systems appear technically feasible to construct, it is not clear that the overall system efficiency (including cooling loops, and so on) will be as high as Dubé estimates.

Given the complexity of these designs and the reliance of Nd:glass lasers on flashlamp pumping, our basic approach has been to concentrate on efforts on laser systems which appear to be more promising. The advanced lasers being considered do include some solid state systems but these have been selected because they potentially can be efficiently pumped and should contribute less waste heat to the laser host material. As for flashlamp pumping of advanced lasers such as iodine, I stated in the text of my article that we are considering the iodine laser as a serious candidate only "if a considerably more efficient pumping technique than flashlamps can be developed for it." As we presently see the situation, flashlamps do not seem to be suited for use in a laser-fusion power plant from either the viewpoint of efficiency or reliability.

To sum up our position, we are not, of choice, abandoning a laser technology that has been and continues to be the workhorse of laser-fusion research. Rather, we believe we are being somewhat realistic in our view that it is not necessarily advantageous to attempt to force this technology into a regime where it appears to be ill suited. Instead we are looking to develop alternative technologies to serve our future needs.

C. MARTIN STICKLEY
Department of Energy
6/12/78 *Washington, D.C.*

Coal overoptimism

In my letter in December 1976 (page 9) I showed that if US coal production grew at a steady 10% per year, US coal would last between 44 and 57 years, and that if production grew 5% per year, which is the goal of the Carter administration, US coal would last between 74 and 100 years. Readers may wish to compare the results above with the following statement in an article "Coal's Clouded Post-Strike Future" under the heading "Energy" in *Time* Magazine (17 April 1978, p. 74).

> Certainly the coal is there. Beneath the pitheads of Appalachia and the Ohio Valley, and under the sprawling strip mines of the West, lie *coal seams*

rich enough to meet the country's power needs for centuries, no matter how much energy consumption may grow. (Emphasis has been added)

We can not wonder that the American people are confused about the energy crisis.

ALBERT A. BARTLETT
University of Colorado
5/12/78 *Boulder, Colorado*

Even fewer students

In his article "The APS in 1977" in April (page 23) George Pake gives a projection of the college age population as a function of time up to the year 2000. The projection shows a decline from a peak of 18 million in 1980 to a figure of 14 million in 1990 followed by an upturn to about 18.5 million in 2000. Pake points out this 1977 projection is an appreciable downward revision of an earlier 1964 projection.

Unfortunately for the future market for physics teachers, this 1977 projection is also almost certainly too high. If the current fertility rates of 1.7–1.8 (births per woman) are maintained until 1982, the college age population (18–21 years) in the year 2000 will be slightly above 13 million people.[1] Immigration is included in this estimate.

It should be noted that the current college age population is about 16 million.

Reference

1. *Statistical Abstract of the United States: 1977,* US Dept. of Commerce (September 1977); page 6.

GERALD M. DANIELS
Massachusetts Institute of Technology
Lincoln Laboratory
5/1/78 *Lexington, Massachusetts*

Opportunities in sales

On the subject of career opportunities for physicists, I wonder how many are aware of a terrible shortage of highly qualified sales personnel in the high-technology industries. Not just door-knockers, or even "sales engineers," but people with an ability for quick understanding of a novel complex problem of a customer, who knows what can and cannot be done technically, who can devise a proposed solution, write it up as a proposal, persuade the customer to buy, and then follow up afterward.

As president of a company that needs such people, I know how very scarce they are. As a professor of physics (University of Pittsburgh), I also know the abundance of people on their second or third temporary soft-money postdoc appointment, and the concerns of the assistant professor with no chance of getting tenure. Some changing of career goals can help solve both problems.

Being a "Technical Representative" is certainly not for everyone. But for the person with a few years of good diversified post-doctoral experience, who likes to interact persuasively with people and has a good personality and appearance, who enjoys bouncing from one technical challenge to another, who can write, who would like an income potential substantially better than that of the average practicing scientist and perhaps eventually want to move into corporate management, and practice a profession that is in demand while using his physics background, this new career should be considered. The career opportunities in technical representation will expand just as surely as technology will.

I will be glad to go into more detail about this new field of opportunity for physicists with anybody who wants to know more, with the warning in advance that if his background is right, he is apt to get a job offer.

WADE L. FITE
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5/4/78 *Pittsburgh, Pennsylvania*

Technical controversies

Controversies on several scientifically oriented topics appear to have led to unreconcilable and almost uncontrolled debate in the political arena and in the letters sections of several publications. Demonstrations and counter-demonstrations also continue to be used to emphasize particular points of view. At the time of the writing of this letter, energy legislation proposed by President Carter had been languishing in Congress for about 15 months, largely because most senators and representatives apparently endorse what they believe to be the best regional interests of their constituents rather than trying to reach an understanding as to what is in the best interests of the nation as a whole. The nuclear-energy debate appears to have no possible satisfactory conclusion. Other controversies include the pitting of ecological and environmental proponents against advocates of economic growth, the so-called "soft" energy path advocates against the "hard" energy path advocates, and debates over the B-1 bomber, the neutron bomb and military equipment sales to the Middle East. Often in these debates "experts" with scientific background appear to contradict one another. The contradictions often seem to arise because the experts do not clearly indicate when they are no longer quoting facts but are expressing opinions. Sometimes I wonder if they are themselves aware of the transformation.

Occasionally a decision has been reached, at least temporarily. In one such decision Congress decided shortly after World War II to establish the Atomic Energy Commission with the express purpose of developing nuclear energy. We can look in retrospect and wonder if that decision was wise, but we must remember that hindsight always has a better chance of being correct than foresight. Even in hindsight only three possible decisions existed for the Congress at that time, since only coal, solar energy and nuclear energy existed in sufficient quantities to provide viable alternatives to oil and natural gas.

One may ask why Congress did not establish a Solar Energy Commission at the time it established the Atomic Energy Commission. However, in the late 1940's we already had enough experience to know that the per-kilowatt initial capital costs of solar energy were extremely large, at least in comparison with the capital costs of fossil-fueled electric power stations. On the other hand we were flushed with success from our one application of nuclear energy in World War II. The development of nuclear weapons had been so easy that it appeared likely that peaceful uses of nuclear energy could also be made into a relatively easy success story. It was impossible to foresee all the political, environmental and economic controversies that would rage regarding nuclear energy during the next few decades.

As I look at the many current controversies that require some degree of scientific or technical knowledge, I sometimes wonder if we still possess the capability to do long-range planning of the type we need to maintain a reasonably decent standard of living. Controversies appear to be growing both in numbers and in complexity. I see no real ability in any agency of the Federal government or in any other group to settle them. Indecision may prevail even more strongly in Congress than in the Executive Branch and among the general public. These observations lead me to wonder how long our democracy can survive before it is inundated by its inability to make decisions, especially decisions that require the use of scientific and technical information of a reasonably sophisticated nature.

C. SHARP COOK
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7/5/78 *El Paso, Texas*

Author-written abstracts

In reply to the letter from Andrzej Krasinski in March (page 15), I would like to point out that there is an alternative to *Physics Abstracts.* The American Institute of Physics publishes the quarterly *Current Physics Index*, which is not comprehensive in its journal coverage (it covers about 90% of the US physics literature) but instead gives the abstracts in exactly the form written by the authors and for the major American journals