made? Similarly, how much knowledge in other fields remains classified?

More important, how much talent and work have we wasted over the last few decades? The advances in physics and technology that were required to cancel atmospheric distortion and to observe transient gamma-ray events are no small achievements; there have clearly been some creative, brilliant minds at work here. How many more such minds are focusing their efforts on ever more accurate cruise missiles or command-and-control software, instead of (let's say) more efficient high-speed trains or better models of climate change? We have used the work of many of our best scientists to make stockpiles of weapons that now have little or no use. I hope that we can recover, intellectually and economically, from this squandered investment.

GLENN COOPER
Bartol Research Institute
2/92 *Newark, Delaware*

US Nuclear Stockpile Safety: Review No. 2

Sidney Drell, in his November 1991 letter (page 9), writes that "last year we [the three-man House Armed Services Committee Panel on Nuclear Weapons Safety that he headed] did the first (*and only*) comprehensive review of the safety of the US nuclear stockpile since World War II and the subsequent buildup to more than 20 000 warheads" (emphasis added).

At the request of several members of the United States Senate and House of Representatives, I also prepared a technical report on the same subject, entitled "Report to Congress: Assessment of the Safety of US Nuclear Weapons and Related Nuclear Test Requirements" (UCRL-LR-107454, Lawrence Livermore National Laboratory, Livermore, California, July 1991). Drell knew that I was preparing such a report and was included among those to whom it was distributed.

My report deals with many, but not all, of the topics dealt with in his report. The converse is also true. In particular, my report discusses in some detail the question of how many nuclear explosive tests would be needed to implement different options under consideration for improving the safety of the US nuclear weapons stockpile, and how long it would take to complete them. His panel's report is silent concerning this politically important technical question.

Copies of my report are available from the National Technical Information Service, US Department of Commerce, 5285 Port Royal Road, Springfield VA 22161.

RAY E. KIDDER
Lawrence Livermore National Laboratory
12/91 *Livermore, California*

Physics Departments: Don't Chop the Shop

After years of watching physics departments being herded down the wrong path by forces they were unable to resist, I finally feel compelled to write. I refer to the virtual disappearance in the US of the open departmental physics machine shop. Before World War II and the advent of government research contracts for university research in physics, physics departments usually had very little money for *buying* things, but they had good university-supported facilities for *making* things. The open physics shop was just as much a part of physics education as the library. As far as I know, the Berkleley physics department is the last bastion of this arrangement in the US, and its members, such as myself, are bloody from the recurrent strife involved in defending it against administrators for whom a university-supported research facility (other than the library), existing outside the usual system where almost everything related to research is charged to a grant, is an anomaly foreign to their experience. My thesis is that everyone is out of step but us. My concern is, Can anything be done about it?

With an open shop, a physicist and his or her students who want to try something new can spend their time designing an apparatus, submitting it to the shop for fabrication, and testing the idea when the shop work is complete. Without the open shop, the physicist has to start by trying to get a grant—a procedure that we all know is long and arduous even if the idea is smashing. The short turnaround time that an open shop permits is especially important to the young assistant professor, who has to involve students and make his or her mark as a productive and innovative researcher within strict time constraints. (Our open shops at Berkeley have given us a real edge in recruiting gifted young experimentalists, by the way.)

And look at it from the other end. In the open shop the mechanicians are busy making *things*, not making *estimates* and keeping books. In the open shop, where orders pile up, the mechanicians' goals are to have the physicists and students satisfied and "off their backs" as soon as possible, a climate that stimulates their ingenuity to make things simpler and easier to fabricate. In the shop that depends on recharges for its existence, the goal (unconsciously, of course) can become one of stretching jobs out to increase revenues.

I understand that in Britain the university grants committees will not even consider funding a project unless the university supports adequate shop facilities independently of the grants. If that is so, our British cousins have been wiser than we.

What can be done? I think this is the sort of issue that the National Academy's Government–University–Industry Roundtable, which has been finding ways to improve the collective national research enterprise, ought to address. A start would be to have those institutions that substantially support research fabrication in their own shops receive automatic and generous credit for that support by the funding agencies when their projects are being evaluated for institutional cost-sharing. I submit that open shops make even more sense for universities than cost-sharing on expensive pieces of equipment. Open shops nurture the research enterprise across the board. And innovative homemade instruments are more apt to lead to scientific and technological advances than off-the-shelf ones.

Nor should one forget the importance of supporting open shops for physics courses. Creative teaching of lower-division courses and of experimental courses in the upper division requires good shop facilities that are freely available as a resource to the instructional staff.

I see no reason why faculty and administrators should be opposed on this question. Our libraries are supported in part by overhead monies derived as legitimate indirect costs of contract research. Why not shops as well?

Maybe other physics departments are fighting the good fight and still maintaining open shops. If so, we would like to hear from them. Solidarity forever! Maybe things can be turned around.

JOHN H. REYNOLDS
7/91 *University of California, Berkeley*

Don't Omit Population from Energy Equation

In their article "US Energy Transition: Getting from Here to There" (July 1991, page 22), John H. Gibbons