tory force before it is launched, we are driven more and more away from the option of "riding out" an attack. And we are driven more and more toward Rube Goldberg deployment schemes such as MX Racetrack.

The answer to this dilemma is the deployment of Strategic Defense Initiative (SDI) systems, not Midgetman. No attack will be made against our retaliatory forces if any reasonable percentage of ballistic missiles can be prevented from striking their targets, and this can be done with current technology.

So long as we continue to permit Soviet missiles a free ride to their targets, we will move inexorably toward "launch-on-warning"—not through a "change in strategy," but because of a mule-headed insistence on clinging to the dangerous old strategy of MAD. Only SDI will change that strategy.

DANIEL O. GRAHAM
High Frontier, Suite 1000,
1010 Vermont Avenue, NW,
Washington, DC 20005

Response: Although Graham says that only SDI can overcome the Soviet missile threat, Midgetman is intended to serve at least a portion of the SDI function: it will supposedly ensure the survival of land-based missiles. Graham is not alone in viewing it as a threatening alternative to a treasured goal.—R. JEFFREY SMITH

Nuclear Terrorism

The excellent News & Comment article by Eliot Marshall on the *Report of the International Task Force on Prevention of Nuclear Terrorism* (11 July, p. 148) is correct in reporting that U.S. naval nuclear weapons are not equipped with coded locks known as PAL's. The article also states, "Many of the 4800 nuclear weapons stored in the NATO stockpile in Europe also lack PAL's."

To the knowledge of the Task Force, all U.S. nuclear weapons deployed or stored in Europe are PALed, even though the PAL devices on many of these weapons are only primitive mechanical combination locks. The Task Force does note that "a number of tactical weapons stored in the U.S. do not have PAL's." It recommends that all tactical nuclear weapons should be fitted with the most advanced electronic PAL's. As stated in the report (p. 6), "The most advanced PAL and command-disable systems should be used to provide the fullest possible protection against terrorists detonating a stolen weapon or dismantling it to obtain nuclear material."

On another point, the article reports that the main objective of the Nuclear Control Institute (NCI), reflecting my concerns, "has been to prevent the spread of nuclear technology." My concern and that of NCI has been to prevent the spread of *sensitive* nuclear technologies that produce or utilize weapon-usable forms of plutonium and uranium that can enhance the capabilities of nations or terrorist groups to make nuclear weapons.

PAUL LEVENTHAL
International Task Force on
the Prevention of Nuclear Terrorism,
Nuclear Control Institute,
1000 Connecticut Ave., NW,
Washington, DC 20036

Human Genome Sequencing

As noted in Roger Lewin's article of 27 June (Research News, p. 1598), there has been considerable discussion in the past year of the prospects of obtaining a complete nucleotide sequence of the human genome. Much of that discussion has focused on the estimate of the costs of carrying out such a project with the technology that is available today. It has been estimated that it would require 30,000 person-years with the use of current technology, or perhaps as much as $3 billion. This estimate has caused a great deal of consternation among many within the biomedical community—as well it should if that were the best we could do.

What seems to be overlooked by many is that the discussions regarding sequencing soon focus on prospects for improving the efficiency of the sequencing process and on the scientific strategies that might be employed to reach the long-term goal of complete molecular characterization (including the base sequence) of the human genome. At the Department of Energy–sponsored workshop in Santa Fe, which was mentioned in Lewin's article, it was estimated that sequencing technology might in a few years be as much as two orders of magnitude more efficient. That of course would mean 300 person-years and maybe $30 million—a much more palatable figure than $3 billion. Thus, one task for the next few years is to drastically improve the efficiency of sequencing technology.

The preferred scientific strategies for approaching the sequencing question involve the preparation of linearly ordered chromosomal specific molecular maps. Large pieces of DNA arranged in linear order over the length of a chromosome would present not only the ideal starting point for sequencing but would be invaluable for a large variety of applications in basic research and clinical medicine as well as the biotechnology industry.

In short, we should devote our attention to doing what is necessary to develop efficient technologies and not be blinded by cost estimates based on technology that will rapidly be superseded.

DAVID A. SMITH
Health Effects Research Division,
Office of Health and Environmental Research,
Office of Energy Research,
Department of Energy,
Washington, DC 20545

As a participant in the "Informational Forum on the Human Genome" (Research News, 8 Aug., p. 620), I did not sense that the outcome of the meeting was as negative toward the concept of sequencing the human genome as Roger Lewin reports. However, accepting Lewin's reportage, I believe such a conclusion represents a failure of vision, an unwarranted fear of (not very) "big" science.

The sequencing of the human genome *will* be done. There is currently a facile assumption that only 1 or 2 or 5 percent of the genome is "of interest." I am not convinced we know that. Surely, in an evolutionary sense, much more will be of interest. Knowledge of the variability among the genomes of individuals will surely shed light on variations in physiology and susceptibility to disease, as well as on questions of human origin.

Having developed an institutional process to sequence the human genome will enable biologists readily to sequence other genomes: the chimpanzee, the mouse, the fruit fly, the nematode, maize, yeast, and so forth. The science of biology, the quest for the understanding of the processes of evolution and development, will be lifted to a new plane of endeavor.

ROBERT L. SINSHEIMER
Office of the Chancellor,
University of California,
Santa Cruz, CA 95064

Japanese Automation

There is more to the issue of Japanese industrial competitiveness than education and management style (Science in Japan Issue, 18 July). Often overlooked is the role demographics played in Japan's industry of today.

In 1971, demographers warned the Japanese government that because of its low birth rates, the country faced a major domestic labor shortage in the 1980's and 1990's. The government tried to encourage

an increase in the birth rate by offering, among other things, financial inducements to mothers. But the Japanese people, over 100 million on a small chain of islands, showed good sense in deciding to stay with their modest population growth rate. That left the government with two choices to solve the coming labor shortage. One was to invite *Gastarbeiten*, as western Europe did, but Japan refused to alter its immigration policies. The only other choice available was to automate, and that the Japanese did with a speed unmatched in other industrial countries.

Japan today has more industrial robots than the rest of the world put together, and *that*, not their managerial expertise or inscrutability, is the key reason for their industrial dominance. Japan had a 10-year head start on the industrialized West with regard to automation. Furthermore, they automated industry with the full support of the workers, who saw automation not as a threat, but as a powerful tool of productivity.

In our country, with its great labor surplus (what else do you call millions without jobs?), any further attempts at automation will be strongly resisted by workers who see it as a threat, and our attempt to overtake or pull abreast of Japanese industrial and economic growth will never get off the ground. Unless, of course, another 500,000 highly skilled workers are prepared to be laid off.

JAMES S. MELLETT
Department of Biology, New York University, New York, NY 10003

Effect of Growth Hormone on Cows

An overlooked concern about the potential impact of genetically engineered bovine growth hormone on the dairy industry (News & Comment, 11 July, p. 150) is the effect of daily administrations of this hormone to hyperstimulate cows to produce 20 to 40 percent more milk.

Under present intensive husbandry conditions, the average dairy cow is spent by the time it is 4 to 5 years of age because of so-called production-related diseases. It is highly probable on the large dairy farm that hormone-stimulated cattle will burn out at an even faster rate, hence the concern that this treatment will increase their suffering as well as the incidence and severity of production-related diseases (*1*).

As for the purported economic savings, these cows will eat more food in order to produce more milk: you don't get something for nothing. Second, with a higher turnover rate of dairy cows, the rate of replacement with young cows would increase as would the cost, since it takes time and money to raise a young calf to maturity. This is one of the hidden costs of this new biotechnology that has so far been overlooked.

MICHAEL W. FOX
Humane Society of the United States, 2100 L Street, NW, Washington, DC 20037

REFERENCE

1. M. W. Fox, *Farm Animals: Husbandry, Behavior, and Veterinary Practice* (University Park Press, Baltimore, MD, 1984).