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dents outside the classroom, so even more students are reached.

Dietrich Schroeer is especially to be commended for his hard work in developing course material and for his willingness to share it with his colleagues. My own course had its beginnings with material he graciously supplied me.

Each of us physicists has something unique to bring to the question of the nuclear arms race. I hope that the visibility and undergirding that efforts in teaching about the arms race has gained from this issue will be the catalyst for even more opportunities for informed and professional discussions of the issues involved.

FRED WILSON
Rochester Institute of Technology
3/83 *Rochester, New York*

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The dramatic Japanese painting of the firestorm at Hiroshima as well as the child's drawing of the mushroom cloud (page 23) form an appropriately penetrating and emotionally charged introduction to the nuclear education theme of the March issue. You are to be commended for your courage in entering the public arena not only with words and hard scientific facts but with visual image and color. Distinguished scientists illuminate the technological facts in ways the layman can comprehend, while child and surviving victim call us to the dark side of that which we are creating.

It is time we dare to reach across the boundaries of our academic disciplines not only to share what we know but to allow ourselves to be touched by what is as yet unknown. It is with this intent that I write.

By way of background I will mention that I am a clinical psychologist in the practice of individual psychotherapy and group dreamwork. For thirty-five years I have been married to John Jungerman, now a professor of physics at the University of California, Davis. Three years before I met him, while he was a graduate student working on the Manhattan Project, my husband witnessed the first nuclear explosion on the Alamagordo desert. Many times he has told me the story of how witnessing that event altered his consciousness. There in the early dawn of that morning in 1945, with the blinding vision of the now familiar mushroom cloud before him, he knew the world would never be the same.

In the past year, my husband and a colleague have presented an upper-division physics course at our university campus called "The Science and Technology of Nuclear Weapons and Nuclear Arms Control." Response to the course offering was gratifying, for even with class space for one hundred and eighty, students had to be turned away.

I followed my husband's participation in this course which was challenging, exciting, and at times anxiety-producing for him beyond anything he had taught before. About halfway through the quarter there were rumors that students were feeling depressed and hopeless. We talked of his bringing in someone who could encourage the acknowledgment and expression of the emotional impact of the material of the course. A female psychologist from the Counseling Center staff who was brought in as a guest lecturer was able to lay the groundwork for students to express themselves. Enough students spoke out in the large class to break the ice and give voice to the fact that immobilized them. Some offered personal reflections and a few told of dreams they were having of nuclear war. (It was later learned through a questionnaire devised by a student as a class project, that dreams of nuclear war were twice as frequent after the course as before.) That a turning point had been made in the class was evident not only from positive comments but from the heightened emotionality and resolve toward action expressed by students. Thus the students finished the class not only better informed technically but also having confronted the emotional denial that prevented them from challenging their fear.

I do not look upon the dreams of nuclear war or the fears they represent in a negative way. It is not the fear but the avoidance or denial of fear that is most destructive. Here I draw directly from my dreamwork and my experience with people in crisis. Turning points are heralded by crisis and carry with them paradoxical overtones of both tragedy and opportunity. Nightmares and other vivid dreams are most likely to present themselves to us in times of crisis. We often forget that they carry within them the seeds of transformation. As I see it, we have a choice: We can shrink from the nightmare as a harbinger of tragedy or we can learn to accept fear and excitement as opportunities for creative change and cultural transformation.

For several weeks my husband and I together have been offering our complementary perspectives on the nuclear arms dilemma to public groups. Audience response suggests that the two perspectives form a balance that mitigates against avoidance and emotional denial. I hope this recognition will be as encouraging to your readers as it is to us.

NANCY K. JUNGERMAN
5/83 *Davis, California*

Unexplained glass flow

I have followed with interest the article on the physics of glass in February 1982 (page 27), by James Phillips of Bell Telephone Laboratories, and the subsequent discussions in the letters to the editor. The latest comment I saw was by Jay Pasachoff, who quoted expert opinion that there was no possibility of flow in glass once it had dropped below 400 °C. (February 1983, page 95).

I would like to relate a surprising example of glass flow which I found accidentally in 1967, for which no physicist has yet given me an explanation. Most of them refuse to comment, probably suspecting a hoax. On that occasion I had borrowed a box of wine glasses for a party, and afterwards they were washed and re-packed loose, with no padding, in a cardboard box ready for their return.

The box was placed for a while on a low window sill, about 2 feet above a wooden floor. Unfortunately, the width of the sill was barely adequate to balance the box, which, on being accidentally touched, tipped over onto the floor. The majority of the glasses survived this experiment, one breaking in a normal manner and one in a very abnormal manner. The second glass had a shattered bowl, the foot remaining intact, but the stem was bent sharply through about 90° (see photograph). I still have the object in my possession.

I cannot think of any way in which glass could be made to flow at this rate at room temperature. The bending must have occurred in a period of milliseconds, and the force required would also be very large, although the conditions of the accident seem to preclude this.

I would be interested to hear from any experts on the structure of glass or strength of materials whether this behavior can be considered normal or whether we are dealing with an abnormal phenomenon.

Not surprisingly, I have tried experi-

ments on bending glass rods at high speed with no success whatever. The bend in the stem follows a very smooth curve, both on the inside and outside of the bend and there is no folding on the inside, which one often obtains when making a sharp bend in a heated glass rod. There are some strain marks visible at the bend and below it, when observed in a polarizing viewer.

G. ELLIOT
4/83 *Chelmsford, England*

THE AUTHOR COMMENTS: This certainly looks like a hoax. But, as Shakespeare said, "If 'tis a hoax, 'tis a pretty hoax."

JAMES C. PHILLIPS
Bell Laboratories
5/83 *Murray Hill, New Jersey*

Radioactive waste disposal

I should like to comment on Robert Pohl's article in December (page 37) on radioactive waste disposal. Pohl calls human intervention "the most serious threat to the long-term isolation of high-level waste."

Pohl suggests that 100 or 1000 years after the waste has been buried, unsuspecting mining companies would start solution mining of rock salt, used by 15 million people for culinary purposes in or near a nuclear-waste repository some 2000 feet underground.

This scenario presupposes that:

- Information on the location of the (very large) repository is permanently lost everywhere on Earth—that neither written records nor scientists aware of the repository's location survive anywhere on Earth
- A new civilization with a population density of 15 million people in the area surrounding the repository has arisen within the 100 or 1000 years after burial of the waste
- The new civilization has a need for, and the ability to carry out, solution mining at 2000 feet underground, but has neither reinvented the Geiger tube nor been able to interpret the original purpose of the (remnants of) today's nuclear reactors.

While a catastrophe of sufficient magnitude to destroy all human records everywhere on Earth is imaginable—an all-out nuclear war fought to the bitter end, or another collision of Earth with an asteroid—it seems highly unlikely that the second and third presuppositions above could reasonably be made. Books do not need to eat and drink as people do; if the catastrophe is of such magnitude that even books do not survive, a population density of 15 million in the (desert-type) area surrounding the depository cannot reasonably be expected within 3 to 30 generations. Without such a population density, nobody will have a need to do solution mining 2000 feet underground. And finally, one could place a large granite pyramid, with the universally understood symbols of a skull and crossed bones on its sides, on top of the repository. Or are we worried about poisoning the E.T.s?

Meanwhile, the very urgent problem of providing a source of sufficient energy for the next or next-but-one generation of Americans remains unsolved because people do not want to proceed with the development of nuclear reactors until the waste-disposal problem is solved.

If future human intervention is indeed "the most serious threat to the long-term isolation of high-level waste," then it seems to me that the problem does not exist in the first place.

PAUL F. SCHMIDT
5/83 *Allentown, Pennsylvania*

THE AUTHOR REPLIES: The calculation referred to by Paul Schmidt was performed by a team of scientists at the Battelle Northwest Laboratories. I quoted their results to demonstrate that the integrity of a repository must be guaranteed for periods longer than 1000 years (see page 44, end of final paragraph).

If we were to provide sufficient energy for future generations by means of nuclear fission, as Schmidt suggests, we would require not one, but tens or even hundreds of waste repositories. In that case, it would be foolish to rely on information passed along for thousands of years to preserve the integrity of waste repositories. Instead, they would have to be designed to minimize any breach of their integrity. Rock salt, as an important natural resource and one which is furthermore water-soluble, seems to be a particularly bad choice for this purpose.

ROBERT O. POHL
Cornell University
6/83 *Ithaca, New York*

Information security

In "What price security?" (February, page 42), Dale Corson has presented the case for "scientific freedom versus national security" and used, as examples, the last minute "withdrawal" of papers from the 1982 Tucson OSA meeting and San Diego SPIE seminar.

Being a citizen of Israel, a country with sensitivity to security that has no parallel in the free world, I feel that freedom of science is an essential ingredient of the security of a nation, be it as small and fragile as Israel or as mighty as the US. The strength of the US does not come from the size of its population (compare China or India). It comes from the ability of the American people to innovate—an inevitable spin-off