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- GETTING AROUND
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CAN HELP SAVE
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- PHOTO ESSAY:
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"Grown-ups tell us, 'Just say no.' That's easy for them to say."

"Maybe they forgot what it's like.

"At parties, at school, kids are saying to try this or do that, and they're my friends. I mean how many times can I hear I'm a loser.

"Sure I'm scared of drugs. It's just there's so much pressure. You want to say no. But you can take a lot of heat for it."

Simple yes-no decisions aren't so simple when they involve kids and drugs.

That's why IBM has helped develop a computer-based, interactive video program that's now in schools. It simulates realistic social situations, and allows kids to make choices—about drugs, about alcohol, about themselves—and to experience the consequences, but without getting hurt.

The program is sponsored by the National Federation of State High School Associations, and preliminary results have been extremely encouraging.

To learn more about this program, write to us at IBM, P.O. Box 3974, Dept. 973, Peoria, IL 61614.



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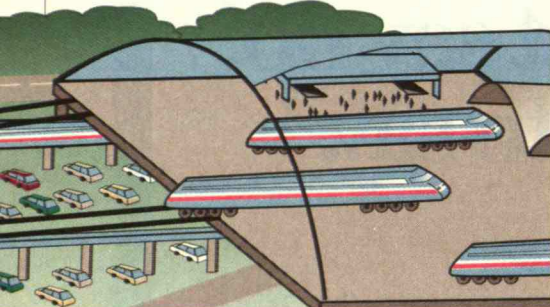
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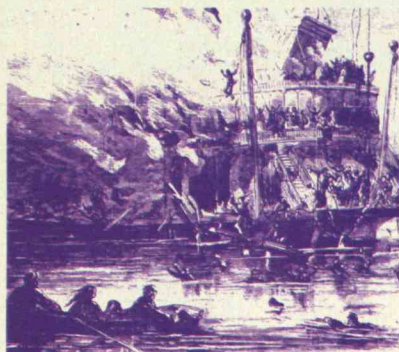


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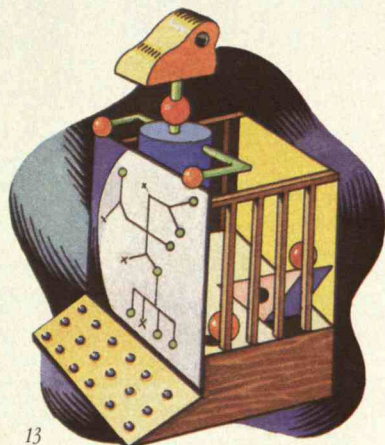
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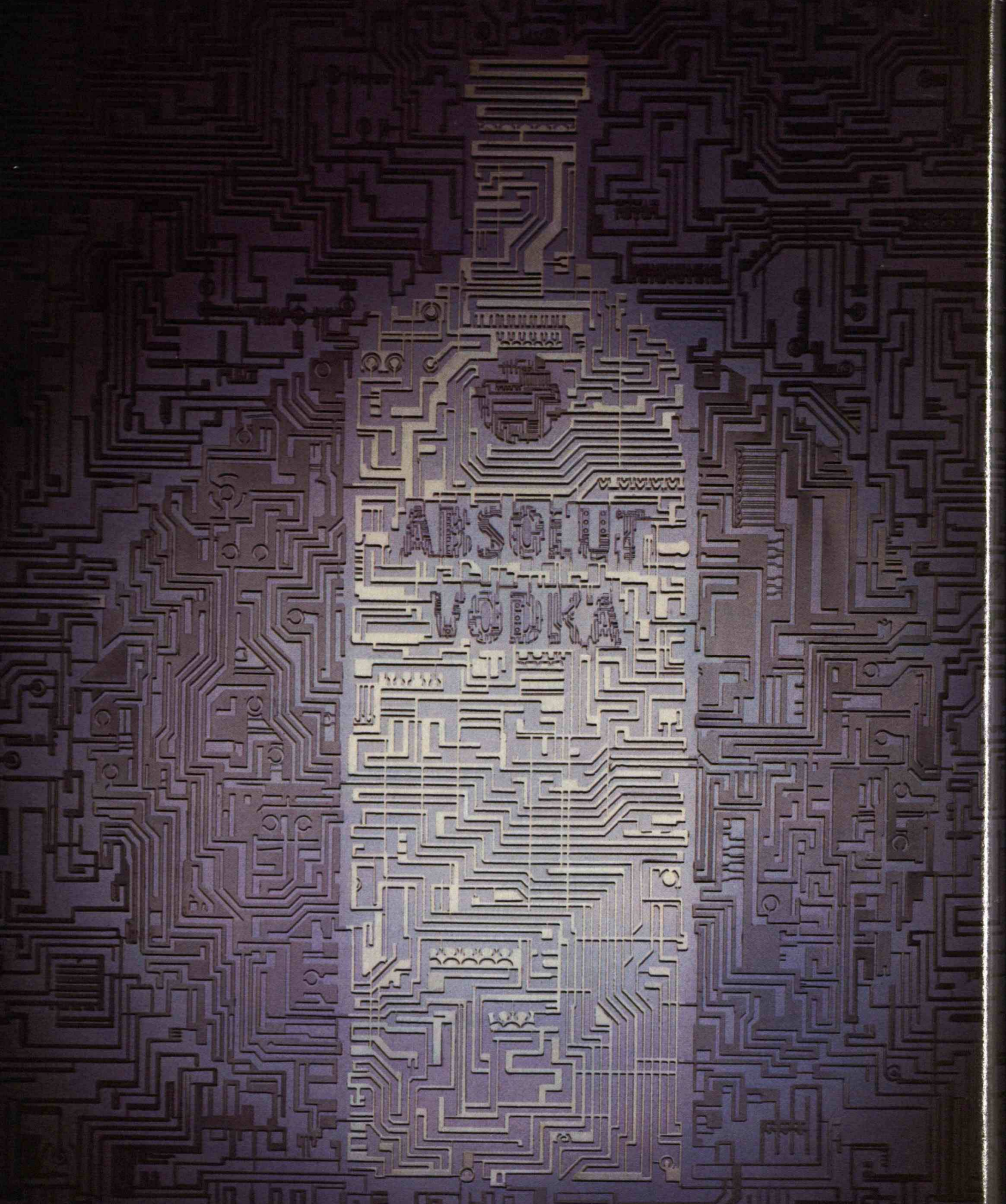
Airplane Band-Aid, Sky Maps, Chemical Canaries, According to God, and more.

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Nuclear Terrorism

THE Iraqi war has focused world attention on the combined threat posed by nuclear weapons and terrorism, a case where the whole is more fearsome than the sum of the parts. Having used chemical arms, Saddam Hussein might not balk at wielding atomic weapons. The anti-Iraq coalition has sought to prevent him from securing them by bombing reactors with weapon-grade fuel and plants to build centrifuges for enriching uranium. Unfortunately, bombing suspicious facilities will merely aggravate the nuclear threat; only diplomacy can resolve it.

The problem with bombing is that, even if Hussein is obliterated, others will follow in his footsteps. Those who are concerned about Iraq will not find it comforting to know that Libya and Iran are also thought to be seeking nuclear weapons, or that South Africa may already have them. The broad progress of technology will eventually allow any nation to join the nuclear club. It is easier to build almost anything today than 50 years ago, including the bomb.

A particular obstacle to stopping nuclear-weapon technology is that the peaceful atom is hard to isolate from the military atom. Centrifuges that enrich uranium for power plants can also enrich it for bombs. France and other nations are recycling fuel for power generation: they send spent fuel rods to plants that extract plutonium for reuse. The International Atomic Energy Agency may inspect some such plants under the aegis of the Non-Proliferation Treaty, but as Marvin Miller, an MIT nuclear engineer, wrote in *Technology Review* (August/September 1987), it is impossible to detect the theft of 1 percent of the plutonium—enough to make perhaps 20 bombs a year. If a nation or terrorist group stole plutonium or enriched uranium, thus securing weapon-grade material, “only modest machine-shop facilities that could be contracted for without arousing suspicion would

be required” to make the bomb, according to the congressional Office of Technology Assessment.

U.S. strategists seem hardly to have considered the political outlines of a world in which nuclear weapons are proliferating. This is not surprising since during the Cold War these strategists pushed ahead with developments such as multiple-warhead missiles without pausing to think how much more dangerous the world would be when the Soviets duplicated the technologies. Fortunately, the bomb itself helped keep the United States and Soviet

*Other ruthless
leaders may well achieve
Saddam Hussein's goal of
making the bomb. Then
what will we do?*

Union at a stand-off. Fears that any conflict could escalate to mutual destruction may have contributed to bringing both superpowers to the bargaining table.

If a small nation, particularly one with a ruthless leader, acquired the bomb, things might not work so evenhandedly. A few crude atomic weapons would put that leader nearly on par with the U.S. president. If the leader delivered an ultimatum and claimed to have smuggled a “suitcase” bomb into New York, what would the president do? Patriot missiles would be no consolation.

The growing ability to make nuclear weapons suggests that Third World conflicts could take three broad directions. First, diplomacy could settle conflicts before anyone resorts to nuclear terrorism. Second, some participants could acquire atomic weapons and bring others to the bargaining table with a nuclear gun at their heads. The third and most awful possibility needs no elaboration.

Bombing nuclear facilities is only

likely to exacerbate antagonisms that make the third possibility more likely. Besides, there are too many potential weapon states to attack, and the advanced nations will find it expedient to leave some of them alone, as was the case with Hussein before last August.

For all its difficulties, diplomacy is the only route. A start would be to strengthen the Non-Proliferation Treaty (NPT), which is due to expire in 1995. Despite loopholes, it provides a moral framework condemning the development of nuclear weapons. Many Third World nations want to strengthen the treaty but also want weapon states to stop nuclear testing, fulfilling the treaty's injunction to curtail their arsenals. The Soviet Union has agreed, but the Bush administration refuses. Its logic is hard to follow. Continued testing may make weapons more reliable, but we know they work well enough, and they must never be used anyway. Testing may also improve weapons' resistance to accidental explosion, but any minor gain pales beside the dangers if the rest of the world walks out of negotiations to curtail nuclear proliferation.

Congress should promote the NPT by refusing to authorize nuclear-weapon testing. In 1984, in response to a Soviet pledge not to test an anti-satellite weapon, Congress cut off funds for testing the U.S. counterpart, and both programs died. It was a significant victory for arms control. The House has similarly sought to prevent nuclear tests, but so far the Senate has restored funds.

Progress in superpower arms control came only hand-in-hand with improved diplomatic relations. Addressing nuclear-weapon proliferation will similarly require better relations between the industrialized North and the developing South, as well as among regional rivals in the Third World. The developed world could take positive action in this direction by working to redress extremes of wealth and poverty—extremes that have played a key role in the Iraq conflict as well as in others around the world.

JONATHAN SCHLEFER

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Letters



GLOBAL-WARMING DISPUTES

"How to Stop Global Warming" by José Goldemberg (*TR November/December 1990*) has a fatal flaw: it totally ignores nuclear power as a source of clean electricity.

Nuclear power plants in operation worldwide number more than 400, and in industrialized countries they provide from 20 to 80 percent of the electricity. In almost all cases, they replace fossil burning plants (mostly oil, some coal) without contributing to greenhouse gases in the atmosphere. I can only conclude that José Goldemberg is (a) ignorant about nuclear power or (b) so prejudiced against it that he cannot bear to suggest it as part of the solution to the global-warming problem.

CHARLES L. LARSON
Sunnyvale, Calif.

The author responds:

Nuclear energy can indeed replace coal, oil, and gas for electricity, but it does not replace fossil fuels used for any other purpose—for example, transportation or domestic and industrial needs. The truth is that electricity accounts for only about a third of the energy used in the world, and nuclear energy wouldn't even take care of all of that, although it might make a large dent in it.

Moreover, in developing countries, where most of the growth in consumption is occurring, electricity accounts for far less than a third of the energy used. Nuclear power will face many problems in these countries before it makes any significant contribution. This is even the case in industrial nations other than France and Japan—although not altogether for the same reasons. In the United States, for instance, nuclear power has come to a standstill.

HYPERTEXT HYPE

"Hypertext: The Smart Tool for Information Overload" by Robert Haavind (*TR November/December 1990*) leaves one critical issue unexamined: Who will be the hypertext authors?

Consider the following hierarchy: writing a novel, producing a dramatization of that novel for radio broadcast, and producing a movie version. Each step is harder, because each presumes the previous one and adds another level of complexity. Radio adds to the written word qualities like tempo and tone of voice and perhaps even background music. Film adds a world of color and shade, of figure and face. The sense of authorship also changes. A single author may write a book, but a movie, though it may have a single director, involves the talents of many actors, musicians, and others.

Hypertext documents are likewise complex—people predict that they will include images, music, voice, and animation. And every aspect of that complexity is sure to present a challenge. Take animation. I recently spent two months (and about \$50,000) producing a 200-second computer-animated videotape of a flight around the earth. Good animation is hard! Much harder than writing a textbook. Even drawing a good figure or taking a good photograph is hard.

Moreover, hypertext can supply many connections, but that doesn't compensate for the quality of any given one. A good textbook not only presents interesting morsels of information but orders them so that the reader can understand them and see the big picture. I believe that the best hypertext textbook will be much better than the best standard textbook on the same subject, yet I also believe that the worst will be far worse. Authors will need enormous concentration to work with the multi-dimensional hypertext lattice of relationships—and mountains of practice, too.

My greatest fear is that hypertext could consume so much time and so many resources as to restrict it to mass-produced works by the same dull, run-

by-committee publishers responsible for my high school textbooks.

WILLIAM MENKE
Tappan, N.Y.

LEAKS IN THE SCIENCE PIPELINE

I leaked out of the pipeline that Wade Roush talks about in "Science and Technology in the 101st Congress" (*TR November/December 1990*)—the one that "transmits scientifically adept young people from grade school to graduate school to careers." It didn't happen until after a two-year postdoctoral research associateship at Brookhaven National Laboratory. On the verge of a full-fledged career in academic science, I found there were simply no opportunities available here in these United States. I thus have been unable to make the contribution to society that might reasonably be expected of me, given the quarter-of-a-million-dollar investment my family and my Uncle Sam made in my training in high-energy theoretical physics. Instead, I am working as a consultant to an intellectual-property law firm.

Unfortunately for the future of American science, my experience is not an isolated one. Most, if not all, of my former colleagues are having the same kind of difficulties. One physicist I know, married and just barely still thirtysomething, is in his third postdoc and seriously considering a fourth poor-paying job that would last at most three years and offer no possibility for advancement or entry onto the fabled tenure track. A second physicist of my acquaintance, married with two children, has managed to find an assistant professorship at \$36,000 a year, but he has to pay nearly \$2,000 a month in rent in New York City—an impossibility without help from his wife's family. A third friend, a gifted young physicist whose work has won the approbation of Einstein's intellectual heirs at the Institute for Advanced Study in Princeton, languishes in his second postdoctoral holding pattern, trying valiantly to support his wife and two children in Boston on a grand total of \$23,000 a year.

Needless to say, he has to depend on continual support from his parents.

And this miserable condition is not limited to the abstruse and ethereal realm of high-energy theoretical physics. My friends in biomedical research tell similar horror stories. All these scientists work long, hard hours that would put any Wall Street greedhead to shame. There is a sardonic saying among them that "the extremely long hours are compensated by the extremely low pay." Is it any wonder that this country is falling behind other world powers technologically?

The federal programs described in Roush's article are steps in the right direction, but the leaks in the far end of the pipeline to science careers are nevertheless in serious need of repair. Doubling the federal government's budget for basic research and development would help.

RANDALL C. FURLONG
Boston, Mass.

DEFENSE WITH A DIFFERENCE

In "Setting a New Agenda for Global Arms Control" (*TR November/December 1990*), Randall Forsberg suggests that the world should take a new approach to defense. While this goal is not without merit, it doesn't stand a chance of being reached.

First, Forsberg is mistaken in saying that industrialized countries no longer want to influence the government or economic system of Third World nations by sending large numbers of young men to die in civil wars. What does she think is happening in the Persian Gulf? What about Nicaragua, Granada, Panama, and Libya? Didn't she ever listen to the Great Prevaricator expounding on the danger that Texas might be invaded if our "freedom fighters" failed to defeat the vassals of the Evil Empire? She might claim that the gulf action is in accord with a United Nations resolution, but the truth is that in dozens of cases the United States has been the only country—or one of the two or three countries—voting against

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MIT Reporter

WILL THE PUBLIC SAY YES TO NUKES?

 The gap between nuclear power advocates and critics is summed up in their differing views on the Three Mile Island accident. Opponents think the event exemplifies the failure of nuclear power in the United States because the reactor's core partially melted. Proponents think the accident affirms the safety of nuclear power plants because so little radioactivity was released.

The dormant industry won't revive unless the public reaches a consensus about the need and safety of this power source, according to Michael Golay, director of MIT's Program for Advanced Nuclear Studies. Without such agreement, he adds, it is likely that nothing will come of discussions about new "fail-safe" reactor designs and nuclear power's ability to supply energy without contributing to the greenhouse effect. With that viewpoint in mind, Golay has started a series of symposia to explore public attitudes toward nuclear power and to come up with ideas for making the technology more acceptable.

An international group of expert analysts and proponents from industry, government, and academia were the main participants at the first meeting. Only a few moderate critics attended, although Golay says he asked groups

skeptical of nuclear power to participate. However, the MIT program did not invite organizations that believe nuclear power should never be used.

This point was not missed by Peter Grinspoon, Greenpeace's national anti-nuclear campaigner. Speaking of the organizers, he says, "They say they want a consensus, but exclude the groups they really need to convince to get one."

Golay responds that including such organizations in future meetings would be useful only if the groups would consider that the technology might be made acceptable in the future.

A Lack of Trust

The speakers at the symposium acknowledged that a meeting of the minds about nuclear power might not be easy. University of Oregon psychology professor Paul Slovic pointed out that according to attitude surveys he has conducted, nuclear power inspires more fear than any other technology. Many perceive its hazards as the worst sort possible—involuntary, catastrophic, and fatal. The images nuclear power conjures up are so negative that people can't see any benefits from it, Slovic said.

Most members of the public don't really understand the risks of nuclear power, but experts' technical discussions of safe reactor designs may not

help, said Jan Beyea, a senior scientist with the National Audubon Society. "People judge the players, and won't believe the claims of nuclear power advocates once they have been proved wrong on a major point"—such as downplaying management problems at reactors.

Lawrence Lidsky, an MIT nuclear engineering professor who has helped design one of the new fail-safe reactors, offered a radical way to demonstrate their safety mechanisms: by staging the worst accident possible. Engineers would drain the cooling water around the reactor core, put a "malicious operator" in charge, and pull out all the control rods, which capture neutrons and thereby stop the nuclear chain reaction. "The ability to withstand a worst-case, absolute test is a minimum requirement before nuclear power can play a significant role in the future," said Lidsky.

Acknowledging that such a test would likely never be authorized, Lidsky hinted that researchers could "sneak up" on one. They could withdraw the control rods a little way to find out how the system reacts, then repeat the action—assuming the system continued working safely—until they had pulled out the rods entirely. The cooling water could also be drained bit by bit, Lidsky suggested.

For now, the 110 working nuclear power plants in the United States *must* operate safely and efficiently, said Andrew Kadak, president of Yankee Atomic Electric Co. in Massachusetts. Radiation emissions, valve failures, and control-room mishaps only reinforce the nuclear industry's negative image.

Moreover, government and the industry must figure out how to dispose of radioactive waste safely, noted John

Michael Golay, director of MIT's Program for Advanced Nuclear Studies, says fears of nuclear power may not last. Steam boilers met with similarly stiff opposition in the 1800s, but despite explosions like the one on the steamer Magnolia, the technology improved and public attitudes turned around.

