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In addition, the Japanese cars are exceeding the requirements for mileage and emissions controls, whereas American auto executives annually go to Washington to demand a relaxation of standards. That is precisely the opposite of Kantrowitz's argument. Japanese productivity has not decreased in the auto industry. The Japanese have penetrated the American market *because* they planned for the future.

A second point not raised by Kantrowitz is that most research by the US has been funded for the purpose of developing weapons. A comparison of the number of physicists in secret, compartmentalized jobs in the US with the number in Japan might be instructive. There is more profit in cost-plus weapons systems than in competitive consumer electronics. The percentages of engineers and physicists involved in the development of weapons systems in the US, Japan and Germany probably will show an inverse relation to productivity.

There are interesting questions concerning our decline in productivity. Kantrowitz missed some of them by concentrating on the public's health concerns and on the neo-Malthusians.

DAVID R. DAWDY
3/92 *San Francisco, California*

I heartily agree with Arthur Kantrowitz that we are plagued by exploiters of fear and ignorance who exaggerate risk, discourage innovation and burden the economy with unwarranted litigation. But in seeking the source of those burdens, I think he is off the mark in implying that religion is to blame—as when he writes that "the quest for a risk-free society and the Malthusian pretense are striking in their similarity to the medieval ecclesiastical assertions that science is 'dangerous' and 'futile.' "

If one examines the ideological backgrounds of the scaremongers, one finds far more left-wing, anticapitalist thinking than proreligion, antiscience attitudes.

Sociologists Ronald Stark and W. S. Bainbridge, in *The Future of Religion* (U. California P., 1985), paint a picture far different from that of Enlightenment warriors against religion. And E. J. Dijksterhuis, in his *The Mechanisation of the World Picture* (Princeton U. P., 1986), shows that medieval scholasticism was actually the birthplace of modern science.

Among scientists, an antireligious posture that ignores neoscholastic research has been dominant in Western society since the Enlightenment. Such views have helped to divide it into warring camps, strengthening antireligious, collectivist economic ideas and weakening efforts to promote individualist entrepreneurship and individual exercise of reason and high ethical standards. Part of the reason for our "diminished expectations" may lie in that division inherited from the Enlightenment. The quest for a risk-free capitalist society is another embodiment of the Marxist quest for perfect economic security.

Neoscholasticism should have a counterpart in a neo-Enlightenment. Neo-Enlightenment would embrace science, reason and capitalism, but reject war on religion and its moral–ethical systems.

LAWRENCE CRANBERG
3/92 *Austin, Texas*

KANTROWITZ REPLIES: Steven C. Hill rises to defend "Malthus's true insights." Malthus's errors must also be pointed out, since they continue to mislead so many to this day.

A recent UN Food and Agriculture Organization report states that chronic undernourishment in developing regions has declined from 36% to 20% in the last 19 years.[1] In the same period, the report notes, population in those countries has *increased* by 1.3 billion, or 50%. The public acceptance of the Malthusian pretense deflects attention from this remarkable triumph, which I have not seen mentioned in the lay press. If our young people knew about it and about the science-based technologies that made it possible, it could help to persuade them to devote themselves to the pursuit of such powerful technologies.

Hill gives seven examples of unpredicted "harmful consequences," some of which were related to new technology. I did not imply and I do not believe that innovation is risk free. We can reduce the harm by objective analysis. However, I am convinced that the pretension to prophecy will not improve the human condition. The great imperative in my opinion is to improve the communication of what science knows and especially what science does not know so that professional knowledge can play its proper role in informing the public perception. In what Hill calls "guessing the future," we must not allow opportunists to exploit the confused signal that science too frequently sends today.

The exhaustion of resources is well known to economists and does not account for the decline in the growth of US productivity. I would add that we must remember that elements of nature, including the examples Hill gives, became "resources" only with the advance of technology. Is there any reason to doubt that further advance would be as powerful in transforming other elements of nature into new resources?

David R. Dawdy expresses a series of doubts about nuclear energy that are part of the ruling public perception in the US. Persuasion of the public of the validity of these fears has forced our retreat. The widespread use of nuclear energy in France is based on a different perception. This difference is an illustration of the failure of science to communicate the known objective facts, which are the same in the US and in France.

Dawdy's point about the competitiveness of the US automobile industry is not "precisely the opposite" of my argument, since I made no mention of our auto industry. I have no problem with regulation when the public perception that supports it is consistent with professional knowledge.

Lawrence Cranberg raises very serious issues in examining the "ideological backgrounds of the scaremongers." While it is unfortunate enough for ideologists to distort science for their purposes, it is much more serious for scientists, in assessing scientific facts, to examine the ideological backgrounds of their proponents. While the former certainly has contributed to our difficulties, if we adopt *ad hominem* attacks, we abandon science.

I am concerned with the apparently rising force of ideologies ancient and modern, left and right. Coping with their almost universal antagonism toward the independence of science remains a great challenge.

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Can 'Band-Aids' Close the Ozone Hole?

Patrick Hamill and Owen Toon's fascinating article on polar stratospheric clouds and the ozone hole (December 1991, page 34) brings to mind an obvious but farfetched possibility that deserves to be mentioned once (but perhaps only once) in print.

The only genuine solution to the ozone problem is to stop dumping chloro- and bromocarbons into the atmosphere. Sadly, as we know, even

if this is done immediately, the problem will persist for decades, and in fact will almost certainly worsen over the next 10 or 20 years. We need effective "Band-Aid" solutions as soon as possible.

It is not technically conceivable that we can scavenge chlorofluorocarbons and halons from the atmosphere, simply because they are diffused in low concentration through the immense volume of the whole atmosphere. That would require "Star Trek" technology that will not be available for centuries to come, if ever. However, the polar stratospheric clouds, as large on the human scale and inaccessible as they are, occupy a relatively small proportion of the total atmosphere and thus offer a possible focal point of attack on the cycle of ozone breakdown. It is within the remote limits of conceivability that we might be able to somehow dissipate or melt these clouds or otherwise interfere with the surface-mediated chemistry that occurs in them, at least to a degree that might significantly mitigate the ozone breakdown.

There are a few obvious possibilities: Maybe one could inject into the clouds by high-flying aircraft a material that would either darken the ice crystals enough to cause them to melt or evaporate, or alter their surface properties in such a way as to discourage the harmful reactions. Maybe there is a way one could direct radiant energy onto them during those critical days or weeks at the ends of the polar winter, perhaps using land- or orbital-based mirrors or lasers. (There's a good use for the resources and talent now being squandered on SDI and ICBMs.) Maybe the crystals themselves could be scavenged in some way, or the clouds broken up or diverted to lower altitudes.

All of these suggestions are improbable, and yet they are sufficiently within the limits of bare possibility that they might merit more detailed investigation. I hope that atmospheric physicists, space scientists and others who might be competent to implement them will give them at least a passing thought.

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3/92

HAMILL AND TOON REPLY: The eventual solution to the ozone hole problem is to stop injecting long-lived chlorine compounds into the atmosphere. World leaders have already taken this course, and in a century or so nature should have repaired itself. Over the next decade, however, chlorine levels will continue to rise and ozone loss will worsen globally.

The particular temporary solutions suggested by Kent Peacock do not appear to be practicable. For example, spraying the clouds with soot would not help, because during the crucial time period the clouds are not exposed to sunlight. Similarly, it would be difficult to use lasers or mirrors to melt the particles, because they are in contact with the atmosphere, and it would be necessary to heat a substantial portion of the atmosphere. Energetically, that is not feasible.

Unfortunately, no obvious solution is known, particularly since ozone loss is occurring globally and not just over Antarctica. However, several scientists have suggested possible temporary solutions. For example, Ralph Cicerone, Scott Elliott and Richard Turco recently calculated that annual injections of 50 000 tons of ethane or propane into the lower stratosphere would cause enough active chlorine to be transformed to the reservoir species HCl to effectively short-circuit ozone hole formation.[1] However, it would be difficult to transport these substances to the stratosphere and to mix them uniformly with the air. Furthermore, this would do nothing to mitigate the ozone loss occurring over the Northern Hemisphere. Even more significant is the fact that such injections might not perform as expected. Some calculations indicate that lower levels of propane injection would actually increase ozone loss.

Although there do not seem to be any realistic short-term solutions to the problem, this is a subject in which debate and an interchange of ideas are certainly welcome.

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Nuclear Waste Cures: Hanford and Beyond

The nasty problems associated with the management of accumulated high-level radioactive waste at the Hanford nuclear facility (and their urgency) have been eloquently set forth by Barbara Goss Levi (March 1992, page 17). While most of them seem to have no simple solution, one of the acute problems described appears to have one that can even produce useful products and that does not seem to require the lengthy preliminary studies needed to tackle so many of the others. I refer to the danger of hydrogen explosions in the facility's 177 million-gallon storage tanks.

Hydrogen produced by radiolytic decomposition of water (and some organic compounds) apparently builds up in some tanks despite the ventilation system that adequately serves others. Simply venting those tanks is an obvious expedient that would occur to anybody, so I presume there must be serious objections to doing so, such as the need to prevent the egress of poisons or the entry of hazardous atmospheric constituents (for example, oxygen, which might fuel explosions). Assuming hydrogen is the culprit, there is a well-known method for bleeding it off selectively without allowing anything else to come in. I refer to the permeability of palladium to hydrogen. In the "good old days" a standard laboratory technique for introducing pure hydrogen into a vacuum system was to use a palladium "needle." Illuminating gas contained enough hydrogen so that a gently warmed hollow needle would act as a semipermeable membrane, passing hydrogen from the gas supply into the system and blocking all else. Because the hydrogen passing through would be pure, and tritium and deuterium are essentially the same as ordinary hydrogen in their ability to diffuse through Pd, one could easily collect potentially valuable byproducts.

Of course one would have to breach the container wall to attach the needle, which could be bothersome under existing conditions. But if the hydrogen problem is really serious, this would be only a temporary nuisance, well worth overcoming.

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3/92

I greatly appreciated Barbara Goss Levi's informative news story on the potential hazards due to nuclear waste at the Hanford facility. It is evident that a number of people are concerned about the situation and are taking appropriate action to deal with this unfortunate legacy.

The news story emphasized that no one has found an adequate long-term solution to the problem of nuclear waste. I would suggest, however, a very simple solution: *Don't make it!* Of course this does not help Hanford now, but all of the future Hanfords could be eliminated by a little foresight. I do not wish to belittle the complexity of the political decisions