

SEARCHING FOR SCIENCE CRITICISM'S SOURCES

In his Reference Frame column of August 1993 (page 9), Daniel Kleppner discusses his "Thoughts on Being Bad." Modern science, he tells us, finds itself under a barrage of unjustified criticism. While it is true that over the last 20 years or so, science has dropped in the eyes of the public from the way to salvation to the path to damnation, I believe that some criticism of science strikes at the right place. Over the last half-century we have sold science as the miraculous solution to all problems, from economics to politics, from physics to the environment. It may be time for us to discover and accept the limits of science before it is too late to rehabilitate it in the view of the public and the politicians. If scientists refuse to take the lead in the revision of the role of science in our society, other, less knowledgeable people will do it, with the risks we can imagine.

Let us examine again the criticisms brought forward on the *New York Times* op-ed page by John Lukacs and Czech Republic President Vaclav Havel that are discussed in Kleppner's column. For example, Lukacs's main point (not quoted by Kleppner) is that "it is not given to humans to explain everything, including the universe. When human beings recognize that they cannot see everything and cannot define everything, such limitations do not impoverish but enrich the mind." Contrary to what Kleppner writes, Lukacs does not maintain that "physics is a fraud" (that is, that nothing can be explained) but simply that there are limits to science that are being crossed by high-energy physics. One can argue about the situation of high-energy physics itself, but it is difficult to disagree with the general statement. Obviously, science is an extremely well-working mechanics. It has provided us with many successful methods for understanding the world around us, from physics to biology. However, one must be very careful not to overestimate its breadth.

We find this same idea about the

role of science in Havel's essay. Communism was developed by Marx on the premise that it is possible to explain history, and therefore manage humans, using a scientific approach: dialectical materialism. Although the final product of the so-called Communist countries was far from what Marx predicted, even that premise turns out to be unworkable. Havel rejects science no more than Lukacs does; he merely states that objectivism should be balanced by morality and spirituality.

As scientists, we have maintained that science is all-powerful, that it represents, as Kleppner writes, "a principal source of our hope for the future." However, we have forgotten that the subject of science lies outside the human, by definition. Science cannot account for morality nor for spirituality. In this respect, Kleppner's suggestion that science is moral because many scientists are working in humanitarian movements is purely irrelevant. It is like saying that science is intrinsically bad because there are many more scientists developing weapons than there are working in humanitarian movements. Science is neither good nor bad, since it does not belong to the spiritual part of humanity. It is simply amoral. By refusing to recognize such limits, scientists create a hiatus in the relation between human beings and nature, and so we are, in some way, responsible for the degradation of our environment.

We have assisted over the years in a "scientification" of many fields of research, one of the most obvious examples being economics. Trying to reach recognition as a pure science, economics has rejected the study of humans as individuals, preferring to deal with more numerical concepts like Gross National Product. In doing so, it forgets the real suffering of humans. Such behavior leads to economic theories that are completely disconnected from the realities of everyday life. By neglecting to include nonrational concepts such as morality and justice, economists have created a monster working against our

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civilization.

Science must refrain from claiming to be able to solve moral questions and other human problems. When science falls into this trap, it becomes dangerous for all of humanity. Kleppner himself recognizes these limits and writes that science cannot solve some of the most fundamental problems of our society: "deep-rooted cultural patterns, . . . obsolete political structures" and so on. One can only hope that other scientists will accept that such problems lie outside the grasp of science.

The importance of science as a human endeavor cannot be overstated. However, one must ask whether the omnipresence of materialism, a consequence of the emphasis on realism and objectivity, should not be balanced by concepts as alien to science as morality and spirituality. We can no longer present science as the only source of understanding for the problems of our society. It is time to try to reestablish an equilibrium between science and spirituality, allowing humankind to find again a place in this universe. The importance of science as a source of both knowledge and progress should not be negated, but neither should the nonrational part of us be brushed aside under the pretext that it cannot be quantified. Scientists cannot afford to stand by as spectators while others are reassessing the role of science. Only with scientists taking the lead can science find the position it deserves in our society.

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11/93

Daniel Kleppner deals all too kindly with the modern Luddites for whom science provides a convenient scapegoat with which to cover their own limitations. Perhaps one can conveniently ignore the comic prose of John Lukacs or that of Bryan Appleyard's book *Understanding the Present*. When supposedly thoughtful individuals and policymakers such as Vaclav Havel, members of the Federal Administration and some of the legislators in the US Congress take part in science bashing, however, it is very difficult not to respond. Kleppner has all too briefly put forward the case for traditional science goals. I would like to expand equally briefly on an issue not addressed by Kleppner.

Too often the major ills of the modern world, such as the population explosion, the amplification of the greenhouse effect, the ozone hole and nuclear terrorism, to cite a few mentioned by Havel, are laid at the feet

of science. Kleppner does not believe that the traditional goals of science are irresponsible or that they lead to these potential catastrophes—nor do I. However, I would go even further. Many of the most vocal critics are ignorant of science to the point of irresponsibility. The failures of our society that lead to the disasters and potential disasters facing our civilization are not the consequences of achieving the goals of science. They are the results of the misapplication of science. The goals of science are clear: In broad terms they are the basic understanding of nature and its laws. It is an exercise in self-delusion to think that humankind can make progress without this understanding.

Very few scientists find themselves in decision-making positions in our society. Applications of their results that affect the well-being of society are generally in the hands of those educated in nonscience subjects. At best, scientists and engineers are accorded the "privilege" of giving advice. The few scientists who do achieve decision-making positions act as science-educated citizens, not as scientists. All too often they are co-opted by "the system" and operate on a completely nonscientific basis. The failure, then, is not that of science but of the "movers and shakers" in our society. In most cases these individuals were trained in the "liberal arts"—in the law, in journalism, in business and so forth. All these honorable professions have one thing in common—a total lack of science education in the training that prepares people for them and an almost total lack of understanding of science by their practitioners.

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8/93

I concur in the central concern that underlies Daniel Kleppner's "Thoughts on Being Bad." But I don't find in the long quote from Vaclav Havel the unsophisticated simplicity that Kleppner finds. In fact it seems that Havel may be closer to the mark than Kleppner on the matter that Havel is addressing.

My reading of Havel centers on his warning against "arrogant, absolutist reason." The theme is old and well established.¹ Havel is, I suggest, pointing out that we must be keenly aware of the limitations of our methodologies for constructing solutions to problems. He is saying that science does not necessarily afford straightforward paths to formulations of un-

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assailable solutions to the problems of the world, as arbitrarily selected by politicians. He is saying that the sort of arrogance and hubris exhibited in the construction of "scientific socialism" can only lead to similar disasters in the future. Indeed Havel writes of "the fatal consequences of technology," but he goes on to say, "as though there were a technical defect that could be remedied by technology alone." It seems to me that Havel is highlighting the role of humane human judgment and perhaps a good dose of incremental empiricism.

Certainly every mathematician and every physicist must be keenly aware of the presuppositions that circumscribe, underlie and potentially undermine the application of any particular theorem to real-world problems. In fact math and physics, and biology too, make progress, in great measure, where there lies opportunity in the contemporary structure of the subject matter in question, in fertile syntheses that individuals somehow identify—not simply upon demand of society at large.

Finally, I suggest that here lies a trap: Given the current utilitarian imperative to find avenues whereby one's discipline contributes to solving societal problems, the logical structure of our disciplines may get bent out of shape. Practitioners will try, of fiscal necessity, to force their respective disciplines to goals that are not the natural ones at the moment. Claims such as those of Marx and Engels for "scientific socialism" will attract followings, cause lots of money to be expended, and finally disgrace us all. We must not allow everyone who postures as a scientist, making seductive promises, to carry us away. Plenty of recent instances come to mind.

Reference

1. See Immanuel Kant's *Critique of Pure Reason* and a modern update, J. R. Saul, *Voltaire's Bastards*, Vintage Books, New York (1992).

WALTER L. FAUST
10/93

Daniel Kleppner's "Thoughts on Being Bad" raises moral and philosophical issues requiring further debate.

Kleppner first focuses on journalistic-style attacks on science, such as Bryan Appleyard's *Understanding the Present*. These are easy—too easy—targets for anyone possessed of what Ernest Hemingway called a good crap detector; written in ignorance of science and philosophy, they are superficial and biased and should not be taken seriously.

The piece by Vaclav Havel is a dif-

ferent proposition. Kleppner, of course, is aware of this and treats it with more respect. However, I think he misunderstands Havel, who is correct in attributing Marxism to an excessive belief in "objective science." Marx, after all, claimed to have created a scientific theory of history; it was this "scientific" label that attracted, and fooled, turn-of-the-century intellectuals looking for alternative solutions to society's problems. We now know, with the wisdom of hindsight, that there were many reasons why Marxism could not work, but one such was the illusion that the world of humankind was "objectively" knowable and manipulable by simple techniques.

Science is indeed one of the proudest creations of the human mind; our curiosity, as Einstein had it, is holy. The trouble is not in the knowledge we gain but in the arrogance and wishful thinking with which we use it. And some, at least, of this wishful thinking has to do with the philosophical misconception that the world is objectively knowable. Yet as philosophers of science (such as Paul Feyerabend) point out, this cannot be true even of simple laboratory physics: Every step in an experiment (planning, execution, instrumentation) is theory laden and is not, therefore, strictly "objective." This is most strikingly obvious of large projects, powerful technologies, economic theories and social forecasting (the Rand Corporation's activities were a notorious example)—all of which are plagued by the uncertainties of complex nonlinear systems. The butterfly effect makes a mockery of our efforts to control and predict the future; how can the resulting guesswork be value free and objective?

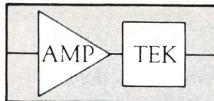
As Kleppner says, it is not socially irresponsible to want to understand nature. But inflated claims of objectivity are self-serving and irresponsible; they reinforce both the scientific community's tendency to exaggerate the benefits of science and its insensitivity to the needs and priorities of people. This is where science critics have a serious point.

IVAN TOLSTOY
9/93

Daniel Kleppner cannot understand how "by some bizarre twist of thought [Vaclav] Havel connects Communism with science and equates the collapse of Communism with the failure of science." I lived under Communism, in the same country as Havel, for 20 years (until 1968), and I should like to try to explain why I think that Havel's thoughts on these matters are not twisted too badly.

Kleppner characterized Communism as "a self-perpetuating tyrannical regime dedicated to the suppression of freedom." While that description is not incorrect, it does not go to the root of the problem. The dominating, all-pervading essence of Communist ideology was the confidence that human affairs are not much more complicated than the affairs of billiard balls or molecules and the consequent belief that, in any domain, rational, "scientific" decision-making and planning are possible, and therefore necessary. This was, and is, a highly idealistic attitude—espoused not only by the early Communists, impatient with the slow and chaotic progress of early capitalism to a more humane arrangement of society, but also by many members of every new generation of young party members. Most of them eventually—under the influence of the realities of life—outgrew this idealism and yet continued to determine, at interminable meetings or within the humongous state and party bureaucracy, the "best" solution to every problem, from the five-year plans for the national economy to what to do about the inadequate supply of toilet paper in Prague. A course in "scientific Communism" was one of the requirements for a degree in physics. The optimistic indoctrination started at an early age: I recall the lyrics of one of the many patriotic songs sung by choirs of youthful "pioneers" to go somewhat like, "We will control wind's blowing and rain's falling." Of course, at the end it turned out that things are somewhat more complicated than Drs. Marx and Engels had us believe, and scientific Communism is no longer taught at the Charles University.

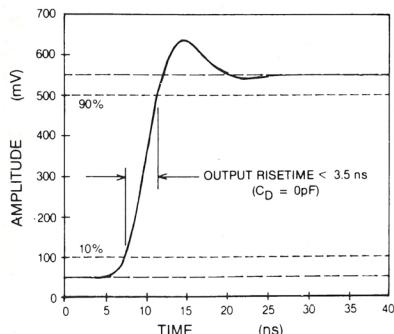
So I think there indeed is a connection between the sorry fate of the Communist ideology and the dangers of the "scientific" attitude, as Havel and his intellectual friends like to call the uncritical reliance on "arrogant, absolutist reason." Havel sees the "modern era" as characterized by "the proud belief that man, as the pinnacle of everything that exists, was capable of objectively describing, explaining and controlling everything that exists," and he defines Communism as "the perverse extreme of this trend." It seems to me that in many aspects Havel exaggerates both the magnitude of the problem of the "objectivity crisis" in the post-Communist world and the need for a radical change in "man's attitude to the world." He is certainly fully aware of the heroic but futile attempt to create a "New Socialist Man" in the recent past, and any radical betterment of human nature will be even more difficult to



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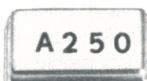


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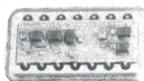
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accomplish by preaching. Also, I am sure he would be the first to agree with Kleppner that "any scenario for a decent future . . . must include a reasonable component of science that is devoted to the search for new knowledge." Nevertheless I think that he is right about the fall of Communism being an occasion to reflect on the limits of human reason—a sobering lesson in humility.

Disregarding the particulars of Havel's (and John Lukacs's and Bryan Appleyard's) criticism, is there evidence that Western scientific culture is in need of sobering up? I think there is. I would suggest that it is the advocates of the "theory of everything" (which would fit on a T-shirt) and their friends busy reading the mind of God who might benefit from reading some more Havel (and perhaps a little Gödel, too). We should not set ourselves up for justified accusations of arrogance and maybe even blasphemy. This does not mean we have to be shy about what we do: I still cannot express my attitude about physics better than what I wrote in a somewhat fanciful contribution to the proceedings of an otherwise completely respectable particle physics conference: "Indeed, the 20th century has transformed physics back to where and how it started: natural philosophy, contemplating, with a mixture of humility and exuberance, all the facets of nature."¹

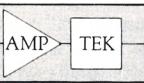
Reference

1. V. Chaloupka, in *Glueballs, Hybrids and Exotic Hadrons*, AIP Conf. Proc. 185, S. U. Chung, ed., AIP, New York (1989), p. 123.

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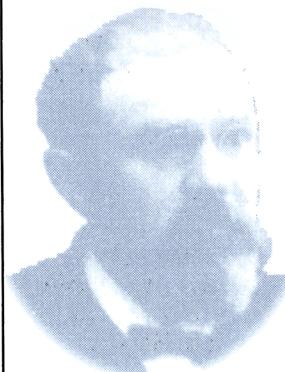
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Physicists from Archimedes to Feynman have exercised their skills by developing "better" instruments of war. It is also true that scientific discoveries have been used in terrible ways by people and their political leaders. Today, with numerous problems to face, society finds it expedient to blame "defenseless" physicists and other scientists.

A democratic society can function only with the informed consent of its citizens. Many commentators have moaned the woeful state of education and its products. Among other efforts to develop better teaching strategies and curriculums, some educators are discussing how ethics can be effectively taught, so that one can learn to apply its precepts to daily decisions.¹

A particular problem of our current culture is its reliance on insular experts: Scientists make discoveries,



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engineers implement them, and politicians use them to their own ends. This partitioning results in decisions' being made in a constricted context, without regard to the ramifications that will affect the whole society. As John Donne said, "No man is an island." (No woman is either.) Thus as children and students we need to be taught how to make ethical decisions and how to take responsible actions. And as adults and citizens (and even as physicists) we need to act not selfishly, but ethically and responsibly, so that the society our children inherit from us is one in which we would like to live. In this way our children are likely to accept Daniel Kleppner's view that understanding nature is socially responsible.

Reference

1. See, for example, G. F. McLean, IEEE Technology and Society Magazine, Fall 1993, p. 19.

L. L. GADEKEN
12/93 Houston, Texas

Daniel Kleppner's occasionally half-baked "Thoughts on Being Bad" deserve some correction and perspective. First of all, a minor quantitative point: The poet John Keats died of tuberculosis at the approximate age of 25 years, 4 months, not 36 as stated by Kleppner. I realize, however, that physicists generally think of life past 25 as, in Keats's words, "a posthumous existence," so the confusion is understandable.

Although I agree with Kleppner that science is receiving harsh and sometimes unfair scrutiny in the press and in scholarly writings, this development should be recognized as the inevitable reaction to decades of science worship at all levels in the Western press. Funny, I don't think too many scientists complained when overblown claims for science led to the growth and expansion of government funding for science! Welcome to the morning after.

If science had indeed restricted itself to its "traditional goal" as defined by Kleppner—"to understand nature"—then perhaps the critics would not have turned against science with such scorn. But as Bryan Appleyard and others are pointing out, there is a significant component of the scientific community that aspires to much more than merely understanding nature. Power, glory and material possessions have seduced many a scientist, leading to the merciless stereotype of science found in Michael Crichton's *Jurassic Park*.

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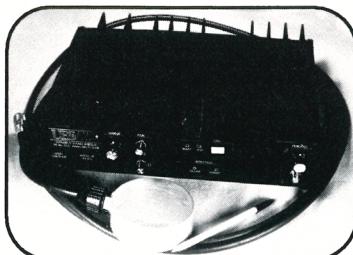
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scientists to stop being "bad" is to curb the abuses and the grandiose claims of science, not to malign the critics.

JOHN KNOX

8/93 *University of Wisconsin, Madison*

Daniel Kleppner's "Thoughts on Being Bad" bashes the science bashers with the standard argument: All knowledge is good, only what people do with new knowledge can be judged good or bad, and moral judgments lie outside science's domain. In other words, blaming science for society's ills is like blaming a chain saw for the consequences of using it to trim your fingernails.

Scientists use this tidy credo to absolve themselves of social responsibility. In Kleppner's words, "Science cannot alter deep-rooted cultural patterns, renovate obsolete political structures or provide broad prescriptions for progress." Here he seems to agree with Vaclav Havel, who says that science "describe[s] the different ways we might destroy ourselves, but it cannot offer us truly effective and practicable instructions on how to avert them." Even Richard Feynman, in his essay "The Value of Science," said that "the question of the value of science is not a scientific subject."

Isn't it odd that scientists who feel free to question long-held beliefs refuse to challenge this one? Science is a tool we've discovered for learning about nature. It comes with no instructions for using it wisely. We learn by trial and error, because no one knows how to predict the consequences of new knowledge. But haven't we made enough mistakes to have learned one important lesson? Excluding from science the study of human values condemns us to dealing with 21st-century technology equipped only with rigid moral, ethical and religious beliefs that haven't changed significantly in most of the world since the Middle Ages.

I think the human race stands its greatest chance of surviving if it applies its scientific methods to rethinking the bases of human ethics and morality. Science's greatest challenge is now to turn its analytical methods inward—to design rational moral and ethical codes, to develop social, economic and governmental institutions that work, and to create new models for human interaction that will save us from extinction. Aren't these the measures by which the value of science will ultimately be judged? To accomplish this goal, however, the scientific paradigm need only be expanded, not abandoned.

T. M. GEORGES
Boulder, Colorado

8/93

There seem always to be those anxious to blame scientists for the uses some politicians make of scientific discoveries. To be consistent, they should also blame her who first harnessed fire. Had she not been so irresponsible, they might argue, many of our present problems would never have arisen. Personally, however, I am deeply grateful to her.

Perhaps the science critics should reflect upon language: Language, like science, has oft been employed for evil purposes. Should she who invented language, foreseeing this evil, have repressed her invention? Lack of language, like lack of fire or lack of science, would have surely prevented most of the world's great problems.

Any philosopher worth his salt can see that all that exists—whether man-made or natural, utilitarian or aesthetic—can be employed for either good or ill. It is each individual's challenge to make those choices correctly. To limit those choices by halting scientific progress, in hope of forcing others into one's own cramped little utopia, is philosophically horrible.

Humanity's nature is to wonder, to strive, to err and then to strive yet again. Bravo to our nature, and a pox on those who would stifle our upward yearning and force us back to hunter-gatherers. My ancestors struggled up through (we think) between 10^4 and 10^5 generations of pain and brutality to bequeath me the rewards of curiosity and a rational approach to problem solving. I would betray this precious legacy were I not to pass on those same gifts to my children.

As a physicist, my task is to try to understand the universe. To me, there is no more glorious or moral a goal. It is the task of all people, myself included, to use the resulting information wisely. To ask me to "edit" my search for understanding and eliminate anything that individuals or their governments might misuse is neither moral nor possible.

D. O. MILES
9/93 *Diamond Springs, California*

KLEPPNER REPLIES: John Knox is quite correct: Keats died at the age of 25, not 36.

A common theme in these letters is that for decades scientists have exaggerated their claims, and that a serious reckoning is now in order. However, except for isolated instances, such as Edward Teller's claim that "Star Wars" technology would make the US invincible to nuclear attack, I know of little evidence for such exaggerations. On the contrary, thoughtful scientists who address the value of science are gener-

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ally cautious about claiming what science can do for society. Max Perutz, in the title essay of his book *Is Science Necessary?* (Oxford University Press, 1991), offers the following sober view:

Science often exacts a price. Most technical advances are subject to Niels Bohr's principle of complementarity, which he formulated to explain that waves and particles are dual aspects of matter. According to this principle, benefits and risks are complementary aspects of each technical advance. Society must judge between them, but such judgment can present us with agonizing choices where neither moral values nor scientific facts lead us to clear decisions.

One of the principal architects of US science in what Vaclav Havel and other postmodernists now deprecate as the modern era was I. I. Rabi, a Nobel laureate and confidant of President Eisenhower. Havel speaks of the "arrogant, absolutist" vision of science. Here, however, are Rabi's views:

Only by the fusion of science and the humanities can we hope to reach the wisdom appropriate to our day and generation. The scientists must learn to teach science in the spirit of wisdom, and in the light of the history of human thought and human effort, rather than as the geography of a universe uninhabited by mankind. Our colleagues in the nonscientific faculties must understand that if their teachings ignore the great scientific tradition and its accomplishments, however eloquent and elegant their words, they will lose meaning for this generation and be barren of fruit. Only with a united effort of science and the humanities can we hope to succeed in discovering a community of thought, which can lead us out of the darkness, and the confusion, which oppress all mankind.

Those words, spoken in 1955 at a lecture at Harvard University, hardly reveal the arrogant, absolutist attitude for which scientists are so casually condemned.

Several letters point out that I misinterpret Havel by failing to understand that when he speaks of "science" he is talking about Marxist science and dialectical materialism, not science as the readers of PHYSICS TODAY, or for that matter *The New York Times*, know it. In *Alice in Won-*

derland, words can mean whatever you wish, but I take "science" to mean science. More to the point, so does most of the US public. Gerald Holton's recent book *Science and Anti-Science* (Harvard University Press, 1993) describes in some depth the danger to science of Havel and postmodernism. For an account of attacks on science from within academia, including the excesses of the postmodern movement, see *Higher Superstition: The Academic Left and Its Quarrels with Science*, by Paul R. Gross and Norman Levitt (Johns Hopkins University Press, 1994).

Normand Mousseau's letter inspired me to reread John Lukacs's op-ed piece in *The New York Times*. Lukacs was opposing the Superconducting Super Collider, then a live issue and a reasonable target for serious criticism. One can hardly argue with his assertion that science cannot explain everything and that we are better off for realizing it, but the main body of his piece is a condemnation of science in such Monty Pythonish rhetoric as the following:

Near the end of the Middle Ages, a few theologians (the "scientists" of that time) persuaded a king of France to give them permission for an experiment that had been forbidden by the Roman Catholic Church. They were allowed to weigh the soul of a criminal by measuring him both before and after his hanging. As usually happens with academics, they came up with a definite result: The soul weighed about an ounce and a half.

We laugh at such things, of course. But remember how much suffering such coarse and foolish ideas about the soul produced in the wars of religion from the transition from the Middle Ages to the Modern Age—not to speak of the fact that the soul-weighing experiment was somewhat less costly than the supercollider.

Such logic leaves one speechless.

DANIEL KLEPPNER

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5/94 Cambridge, Massachusetts

Historical Perspective on New PhDs' Low Pay

Perhaps it is because I grew up during the depression of the 1930s that I find it difficult to sympathize with the complaints about pay for young physicists with families expressed by Peter Duncan (July 1993, page 11). The son