Who will be to blame if in ten years the public asks us what it is getting for its tax dollar, and we can only point to a file cabinet full of accountability forms? If we don't stand up and speak out, it will be us.

ALAN K. BURNHAM
Lawrence Livermore Laboratory
10/90 *Livermore, California*

MERMIN REPLIES: I applaud Alan Burnham's plea for sanity in the support of research. I wish, though, that we could all agree that virtually nobody believes that "I'm so smart, the public owes me the resources . . . ," and stop issuing disclaimers or accusations. Anybody who takes that line as homeless people fill our cities, our schools deteriorate, our bridges fall down, our dumps overflow—you name it—isn't so smart after all. The real issue is, if in its wisdom (or folly) the nation wishes to continue to subsidize science and the training of scientists in the age of no (or at least not nearly enough) new taxes, how this is best done. There aren't easy answers, but Burnham is eloquent on how not to do it.

N. DAVID MERMIN
Cornell University
12/90 *Ithaca, New York*

A History Lesson for NASA Management

I have just read with great interest and mounting frustration your account of the Hubble Space Telescope fiasco (August, page 17). Your reporter states that there is great mystification as to how such a blunder could have been allowed to occur.

The problem, I suggest, is that NASA in recent years has taken to running its projects by bureaucratic committee. No one demanded the necessary tests simply because it was no one's clear responsibility to do so—or more precisely, to *decide* whether or not such a thing should be done. The fact that an investigation has to be mounted to find out who was supposed to be responsible is enough in itself to prove my point.

I think it is obvious that NASA's projects must be managed—or perhaps commanded is a better word—like any genuinely well-run military operation, construction project, surgical operation or deep-sea voyage. There must be a clearly defined chain of command, with one and only one person in charge at each level of activity. Each manager at each level must have complete authority within his or her sphere of responsibility; in turn, he or she must be held completely accountable for failure in that area. Long experience has proven that this is by far the most effective way to carry out any endeavor that demands a very high level of performance and cooperation from many people.

We should recall that Roman generals in Republican times were required to suicide if they lost a battle. This seems barbaric to us, but it reflects the early Romans' awareness of how high the stakes in life really are. I do not suggest that we require NASA project managers literally to fall on their swords if they fail significantly. But until NASA streamlines its command system it will continue to be plagued by embarrassing, costly and occasionally tragic disasters.

KENT A. PEACOCK
University of Toronto
9/90 *Toronto, Ontario, Canada*

Nonlinearity at the Naval Research Office

Peter Carruthers has written (October, page 96) concerning nonlinearity and complexity that "unfortunately there does not yet exist a Federal patron to sponsor this burgeoning and promising field of research." In fact, in 1984, the physics division at the Office of Naval Research initiated a core program on nonlinear dynamics, which has enjoyed monotonically increasing support for topics including chaos, fractals and complexity. An Accelerated Research Initiative on nonlinear phenomena, which was devoted to experimental research, spanned the years 1986–90, and a portion of an ARI (1988–92) on clusters is devoted to fractal aspects of materials. A joint physics and oceanography five-year ARI on the nonlinear dynamics of ocean surface waves will begin in fiscal year 1992. The ONR physics division has also managed Small Business Innovative Research programs on nonlinear iterated function systems for image compression, and large DARPA University Research Initiatives devoted to nonlinear dynamical approaches to fluid mechanics. Programs, such as neural networks, supported jointly by several other ONR divisions would also fall within Carruthers's topic of complexity. These programs have consistently received strong support from the ONR management, especially during our internal program competitions. The Navy has focused on and been an early and strong supporter of the rich and promising fields championed by

continued on page 94