

We may be wrong

Donald Christiansen

A mix of public mistrust of 'technology', the free and open criticism of scientists and engineers by colleagues, occasional cases of fraud, and a certain glee we all seem to share in toppling giants may exacerbate suspicion of fraud. But crying fraud in cases of genuine error could endanger the scientific method itself.

[© 1989 IEEE. Reprinted, with permission, from *IEEE Spectrum*, vol. 26, no. 7, July 1989, p. 19.]

Somehow a good portion of the general public evidently believes that engineers and scientists claim perfection. Experiments performed by scientists are expected to work the first time. Engineers are expected to meet the system specifications—even if the system bears little resemblance to any previously built—and to do so within budget. In the absence of perfection, the public suspects incompetence or even fraud.

Why is this so? The public seems to accept—or at least comprehend—the uncertainty of medical procedures, even of those that are well established. Undoubtedly this is largely because the practitioners of the medical profession find it circumspect to inform the public, their patients, of the uncertainties involved.

However, when scientists are found wanting, it often becomes headline news. Witness cold fusion. When experimenters at the University of Utah and Southampton University found evidence of an unexpected and inexplicable burst of heat from electrochemical cells at room temperature and attributed it to nuclear fusion, fellow scientists who were unable to repeat the experiment accused them publicly of 'incompetence and delusion'. Other scientists called the behaviour of the cold fusion experimenters 'deplorable' because they did not submit their apparatus for independent analysis. Experimental error, such as an artefact in the measurement process, could have accounted for misleading results. But what journalist could resist the temptation to quote such colourful, pejorative statements by esteemed colleagues?

It seems to many but a small step from 'deplorable' science to 'fraudulent' science. But Robert Pollack, dean of Columbia College, where he is a professor of biological science, pointed out¹ that the extrapolation from error to

fraud is not only inappropriate but could endanger the scientific method itself. Those who believe that published science must be free of error are wrong, he said. Published error is at the heart of real science. Noting that 'we scientists love to do experiments that show our colleagues to be wrong' and that 'we agree in advance to reject our own findings when they have been shown to be in error', he concluded that if scientists are asked to forswear error, or worse, equate error with fraud, 'then we cannot function as scientists'.

How do engineers fit into this picture? We may not be as often at the cutting edge of fundamental knowledge as the scientist, but surely we are faced with ample opportunities to fail, overreach, and fall short of our hopes and goals. Failing to meet ambitious specifications the first time, or even ever, does not constitute fraud, or necessarily even poor engineering. Ambitious specifications set as a target may be what helps us get halfway there, and enables us to produce a product far superior to any previously available.

In this regard we employ some of the same techniques of the scientific method that are the stock-in-trade of the scientist. Instead of hypothesizing a fundamental theory, we hypothesize a system to do a certain job. We test the system or parts of it. We find errors in our hypothesis; the system seldom works the way we hoped it would. We fix. Test. Redesign. Test again. Eventually, after many errors and blind alleys, we produce a useful system. Sometimes we don't. Nothing fraudulent here.

What is it that leads an observer—whether he be reporter, congressional investigator, or fellow scientist—to suspect fraud where none exists?

Here are some possible factors:

- An environment in which a scientist is surrounded by attorneys, publicists,

and/or grant officers, any or all of whom might prematurely tout his developments in the interests of establishing a patent position or winning a grant.

- Actual fraud in science and technology—it does sometimes happen. The more frequently it does, the more likely critics are to unjustly suspect fraud.

- Pejorative criticism of scientists or engineers by colleagues, which may trigger undue suspicion of bad faith or fraudulent intent.

- New systems, which, especially where few copies are to be produced, and particularly in the military where hostile environments cannot be readily specified, are frequently subject to performance shortfalls. These are often seized upon by auditors and journalists as worthy of the public's attention.

However, offering to bid on an advanced new system at a price no one believes is close to achievable in order to 'buy into' a programme may indeed border on fraud. This is a less likely scenario if the objective specifications are arrived at mutually by vendor and supplier.

In the end, what may exacerbate suspicion of fraud by engineers or scientists is perhaps a mix of public mistrust of 'technology', the free and open (and sometimes excessive) criticism of scientists and engineers by their colleagues, occasional cases of unequivocal fraud by a few scientists and/or engineers, and a certain glee we all seem to share in toppling giants.

1. In science, error isn't fraud, *The New York Times*, May 2, 1989.

Donald Christiansen is editor, *IEEE Spectrum*, New York.