Letters

Probability Estimates

Eliot Marshall (News & Comment, 27 June, p. 1596) should be chained to a roulette wheel in Atlantic City until he understands the nature of a probability estimate and the Monte Carlo fallacy.

Richard Feynman estimates the risk of a solid rocket booster failure on the shuttle at between 1 in 50 and 1 in 100. The fact that there was a failure on the 25th shuttle launch (50th booster launch) bears no relation to this estimate. If the first shuttle launch had failed—or if there had been no failure for 500 flights—Feynman's estimate could still be right. There is no relation between the probability of an event and the history of the event's occurrence.

Even worse is the imputation that NASA expects no failures in 280 years of daily launches. They are reported to expect a failure with a probability of 1 in 100,000 on every launch. The odds of one or more failures in 100,000 launches are thus over 63%. This is a far cry from expecting "not one equipment-based disaster."

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NASA's Bureaucracy

I have been much disappointed by the Rogers Commission report on the shuttle disaster. After brilliant work reconstructing the physical circumstances that produced the disaster, the Commission displayed no understanding of the management style that produced our government's historical successes in technological innovation.

NASA needs a "safety division" like a hole in the head: it would become another layer of faceless bureaucrats. If another disaster should occur, we would still be asking, why? We would find no one to blame.

The project stage of a technological innovation must have a "maestro of technology" in sole charge—as Teddy Roosevelt understood when he put George Goethals in charge of building the Panama Canal and as F.D.R. understood when he sought and found the maestros who gave him aviation gasoline, synthetic rubber, radar, operations research, and the nuclear bomb. For an endeavor as complex as the nuclear bomb or the shuttle, many maestros must work together as a team—cooperating but often competing—with a presiding General Groves ready to make a quick choice when the maestros disagree.

Maestro of technology: Someone with a passion for the engineering objective, not for position in a permanent organization. Someone with a consuming appetite for knowledge of the details of the job, especially details that might affect success or failure; the maestro will visit the workplace at 2 a.m. to see how things are getting on when white-collar supervisors are absent. Someone with the brains, training, experience, and luck to pull off the job.

Along with many of today's bureaucracies, both commercial and governmental, NASA has a structure that does not permit it to identify its maestros. Its junior workers do not discover their potential to assume leadership.

There is a better institutional structure: a "flexibly extensible" bureaucracy with few layers above the shop floor, operating in an atmosphere of trust and needing little paper. For the institution's major tasks, working managers organize ad hoc, autonomous teams under leaders whose honesty, skill, and commitment the managers have learned to trust. Leadership of teams for smaller, less important tasks provide junior workers with apprenticeships in which they find themselves. When leaders are needed for larger tasks, managers know whom to advance.

Japanese manufacturing industries understand the advantages of this flexibly extensible management structure. We must find ways to introduce it into our government's bureaus in charge of technology.

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The crisis at NASA is a cameo of a conflict in American society. It portends a struggle with tremendous stakes, because at issue is the kind of society we are and want to become. It is a struggle between the bureaucrat and the innovator.

Among the living, who are the heroes to emerge from the shuttle disaster? They are the few scientists and engineers who did not allow their integrity to be compromised by political pressures and bureaucratic convenience. They include the two Morton Thiokol engineers who, in response to their factual testimony on problems with the "O-rings," were at first put down by both public and private officials. They also include Richard Feynman, the scientist who provided an objective assessment of the risks of shuttle-flight failure and reported it as he saw it, without mincing words to suit purely political sensibilities. If people of this sort had been in positions of influence at NASA earlier, the dead heroes would be with us yet, alive.

The battles within NASA, within Morton Thiokol, and within the Shuttle Disaster Commission are symptomatic of a quiet struggle going on daily between the bureaucrat and the innovator—a battle that has waxed and waned in one form or another throughout American history.

The main reason why the outcome of this old battle is so important now is that we live in a society where the basic driving forces are scientific and technological. Its outcome will affect all of us in many ways. It will not only influence the ability of NASA to accomplish its mission; it will affect many of our other missions as a people. Will we be able to become competitive in the world economy? Will any of our systems be safe? Will we achieve peace or nuclear holocaust?

To answer these hard questions and fulfill our national missions, we should give more responsibility, power, and authority to the innovators and less to the bureaucrats. Let us see more scientists and engineers in positions of responsibility in politics and in the upper-level counsels of government. Let us not only foster entrepreneurship but "intrapreneurship" within large private and public organizations. Let the plain-speaking individualism for which Americans have become known around the world speak out and not become just another 19th-century myth here at home. Let us honor the innovators and the whistle-blowers and, above all, those whose stock in trade is *what* they know, not *who* they know.

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Protein Structure

In the Research News briefing "Unexpected size pattern in bacterial proteins," by Roger Lewin (16 May, p. 825) the "cylcol hypothesis" is attributed to T. Svedberg. The *cyclol* hypothesis was proposed by Dorothy Wrinch (*1*) and contained the suggestion that proteins were composed of covalent six-membered ring structures, not peptide bonds. Svedberg's hypothesis (*2*) was that proteins are aggregates of subunits of 17,600 molecular weight. The two proposals came at about the same time, and both were important in the development of our understanding of protein structure (*3*).

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REFERENCES

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2. T. Svedberg, *ibid.* **139**, 1051 (1937).
3. J. S. Fruton, *Molecules and Life* (Wiley-Interscience, New York, 1972).