vision's inspections and demands for rework, operators regard its paper checks as burdensome, line managers see its staff as troublemakers, and owners believe that its primary mission is to stave off the Nuclear Regulatory Commission and protect the utility license. This is not normal. It does not represent the farthest reaches of our capacities to organize. It represents instead a particular history of negligence, insularity, and shortsightedness that includes activities verging on the criminal, such as cheating on requalification exams and tampering with production records.

Strikingly, though Perrow is an organization theorist of great originality, he fails to pursue the organizational issues in any depth. For example, in analyzing the paradoxes of organizational design in high-risk systems he suggests that we have reached a cultural and organizational cul-de-sac. We need centralized systems to ensure obedient responses in emergencies, but we need decentralized systems so that workers can use their talent and initiative to help solve unexpected problems. Can we ever combine the two?

The paradox is imaginary. There exist close to 3000 factories, designed according to "sociotechnical principles," in which close coordination is achieved between workers and work teams without resorting to hierarchy (see my *Beyond Mechanization: Work and Technology in a Postindustrial Age*, MIT Press, 1984). In such settings, workers are multiskilled, are paid for what they know rather than how hard they work, and belong to semi-autonomous teams that are loosely supervised. Experience in these settings suggests that workers are vigilant and committed to production quality and safety because of their desire to learn, their understanding of plant dynamics and policies, and their close relationships with teammates. Automated factories and high-risk technologies pose new organizational problems, but these are by no means insurmountable. We can run organizations that efficiently deploy and monitor human effort. We've done that well for a century. But today we must learn to develop organizations that organize, distribute, and deploy attention. As we come to understand the economics, sociology, and psychology of attention the normal accident will become increasingly abnormal.

Perrow's conclusions are puzzling. He ranks nuclear power, nuclear weapons, and DNA as the technologies with the greatest catastrophic potential. But nuclear weapons are meant to destroy. Their catastrophic potential is not accidental. Perrow's discussion of DNA, as he admits, is speculative. This leaves nuclear power, the central metaphor of the book. The public dreads this technology. Perrow argues that such dread expresses the public's "social rationality." They fear technologies that have catastrophic potential and are out of their control. But if dread is social is it necessarily rational? Consider driving: We don't control many of the conditions that affect the safety of driving. The "other driver," the speed limit, the car's safety, all intrude. Yet, as many studies suggest, we behave as if we were in control, neglecting for example to use seat belts. We accept the risk only by denying it, by imagining that "it can't happen to us."

These examples suggest that we dread just those technologies that puncture our defenses, our fantasies of being in control. Modern technologies provoke radical ambivalence. They are life-giving yet potentially death-dealing on a large scale. When they are life-giving they symbolize our capacity to push back death. As cultural artifacts they help sustain the necessary myth that our species is immortal and that individuals might one day live forever. (This is the not so secret hope of the DNA revolution). But when they pose risks they threaten to kill us. This ambivalence clarifies what Perrow calls our "dread." Dread emerges, as Freud recognized, when the "repressed returns" in the form of chronic anxiety. The repressed is the deeper knowledge that we will all die and our species will someday disappear. Nuclear power as a metaphor has become the cultural repository for this ambivalence. (Though paradoxically, as Perrow reminds us, nuclear power may be the best answer to the catastrophe of the "greenhouse" effect caused by the burning of fossil fuels.)

Perrow's work reflects this ambivalence, but not self-consciously. He reminds us that social elites have constructed our technologies and that we can abandon them. They are social inventions. Yet he simultaneously evokes a picture of transcendental technologies that defy our organizational capacities. His argument appears, paradoxically at first, to be almost religious in tone; the great "unknowable" now resides in our machines rather than in the heavens. Indeed, in the past religious feelings have been one response to feelings of dread. We acknowledge the superiority of forces we can't control. Perrow has committed himself to such a religious vision of our technological dilemma. Yet his technical competence and organizational savvy highlight the weakness rather than the limits of our organizational grasp. Perrow ignores his own evidence. We can make the normal accident abnormal if we tend to the lively problems of social organization.

LARRY HIRSCHHORN
Management and Behavioral Science Center, Wharton School, University of Pennsylvania, Philadelphia 19104

Nuclear Safety: Early Efforts

Controlling the Atom. The Beginnings of Nuclear Regulation, 1946–1962. GEORGE T. MAZUZAN and J. SAMUEL WALKER. University of California Press, Berkeley, 1985. x, 530 pp. + plates. $28.95.

Between 1946 and 1962 nuclear-powered electricity generation was developed to the point of commercial viability. Concurrently, the Atomic Energy Commission (AEC) evolved procedures for safety regulation whose basic structure persisted through the 1970's. In *Controlling the Atom: The Beginnings of Nuclear Regulation, 1946–1962*, George T. Mazuzan and J. Samuel Walker, historians with the Nuclear Regulatory Commission, give a comprehensive history and interpretation of nuclear regulation during this period, detailing the roles and interactions among the AEC, the executive branch, the congressional Joint Committee on Atomic Energy (JCAE), the Advisory Committee on Reactor Safeguards (ACRS), and state governments.

The book discusses the controversial decision to promote private, rather than government, investment in nuclear power plants, even at an early stage of development. This sets up the major themes that underlie the study: first, the conflict between promoting private uses of nuclear power and regulating its safety; and, second, the gap in the AEC between the developmental and safety research programs and the licensing arm of the agency, a gap that both contributed to and grew with increasing formalization of the licensing process.

Mazuzan and Walker discuss controversies and areas of general agreement regarding nuclear policy during the 1950's. Though there was substantial controversy and lack of confidence concerning the AEC's control of radiation releases—cases discussed include weapons fallout, uranium mining, and waste disposal—the public and politicians were in agreement over the desirability of developing nuclear power technology.

Controversies about nuclear power in this period were centered on how best to rapidly develop the technology, despite uncertainty over risks.

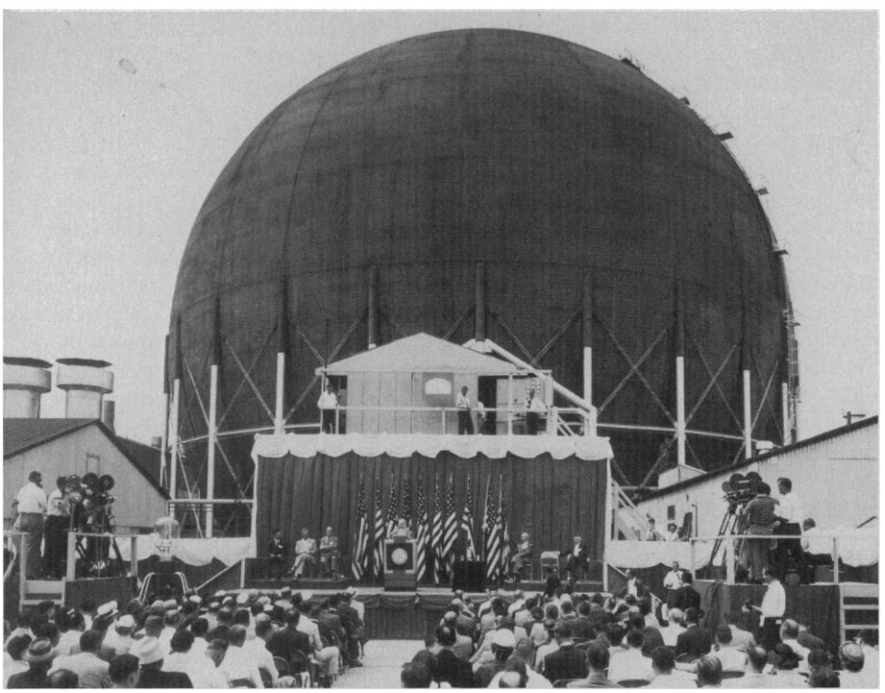
The study includes an excellent discussion of the Power Reactor Development Company (PRDC) case that illustrates these themes and resulting problems. In 1955 the PRDC proposed building a fast-breeder reactor fairly close to a populated area in Michigan. Because the AEC's own breeder-reactor research program was proceeding concurrently with the PRDC's schedule, little information existed as to the safety of the proposed design. Consequently, the ACRS recommended against the proposed application, citing the desirability of further experimentation at a remote site. This recommendation set off a major controversy between the AEC and JCAE that resulted in major licensing changes: opening of procedures to public scrutiny, formalizing of procedures, and, ultimately, separation of regulation and promotion within the AEC and establishment of formal construction-permit hearings.

Opening the AEC process to the public and to independent review was viewed by Congress as a means of improving technical review of reactors, as well as strengthening public confidence in a program where the extent of risk was uncertain. The result of controversy over radiation risks combined with support for nuclear technology was a system of formal review and regulation that lacked an underlying consensus about safety. But, as the authors explain, the hope of Congress and the AEC was that the regulatory procedures instituted in the early 1960's would enable the development of a consensus about safety and nuclear technology.

Mazuzan and Walker state at the outset that a purpose of their history is to provide policymakers concerned with regulation with information "about the context in which previous decisions of a similar nature were made." In this they succeed admirably. But the more sobering conclusion that can be drawn from this study is that many of the current problems with nuclear regulation surfaced 30 years ago at the outset of commercial development, and, similarly, that major issues that were debated then and that the regulatory procedures were designed to resolve—accident risks, potential radiation releases, adequate site rules, waste disposal—remain debated and unresolved today. Understanding why these issues have not been resolved is probably crucial to attempts at reforming nuclear regulation to allow further investment in nuclear power technologies. This book provides valuable background: it will be of interest to the nuclear industry, policymakers, and the general public.

LINDA COHEN

Brookings Institution, Washington, D.C. 20036



"Ceremony on occasion of first electricity generated by General Electric's prototype plant at West Milton, New York, July 1955." The Reactor Safeguard Committee established by the AEC "never assumed that safety for populated areas depended solely on isolation. The locations of the large government reactors at Hanford, Savannah River, and the Idaho National Reactor Testing Station were selected, in large part, because of their isolation. But other . . . facilities constructed in the early 1950's, such as [that] at West Milton, . . . signaled the need for . . . engineered safety features that would compensate for their proximity to population centers. The . . . designers of the West Milton reactor set a major safety precedent by enclosing it in a large shell containment structure." [From *Controlling the Atom*; credit, National Archives]

The Vallecitos Case

The Atom and the Fault. Experts, Earthquakes, and Nuclear Power. RICHARD L. MEEHAN. MIT Press, Cambridge, Mass., 1984. xvi, 161 pp., illus. $13.95.

In this short book, Meehan warns that he gives a personal and by no means complete or even scholarly history of scientific-legal controversies concerning the licensing of nuclear power reactors in California during the last two decades. He should not be too modest, however, for he grapples with abiding moral and philosophical questions dressed in new clothes. The centerpiece of the book is the case of the Vallecitos Test Reactor in California's Coast Range, west of Livermore and 35 miles from downtown San Francisco. The reactor was operated by General Electric as the first (in the United States) privately financed nuclear power plant, the first commercial test reactor, the first commercial neutron radiography facility, and the producer of half of the free world's supply of medical radioisotopes.

In the summer of 1977 the reactor's operating license came up for renewal, and the Nuclear Regulatory Commission insisted that General Electric perform geological explorations to check for active faulting in the vicinity of the reactor. A geotechnical company of which Meehan was a partner was retained by General Electric to do the explorations, and Meehan was able to observe at first hand the consequent drama that stretched until the autumn of 1983, when the NRC approved the decisions of the licensing and appeals boards that the reactor could be operated safely. During the intervening six years, the test reactor remained fully manned but shut down and General Electric lost its medical isotope business to the Canadians and others.

The book also contains less personal treatments of other licensing cases, such as the attempts by Pacific Gas and Electric Company to construct nuclear power