EXPLORATIONS

Three Mile Island: A Case of Disinformation

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About eleven miles south of Harrisburg, Pennsylvania, on an insignificant sand bar of an island, Metropolitan Edison (Met Ed) built two large nuclear power plants. On March 28, 1979, at Reactor Unit Two at Three Mile Island (TMI), a series of individually minor mishaps escalated into the worst accident of the American nuclear power program; for five days, the causes, extent, and severity of the accident were not clear. Public anxiety was high, about 144,000 inhabitants evacuated the area, and the plant was at one point within an hour of a "meltdown," the uncontrolled overheating and melting of the uranium core that threatens to breach the containment dome and release lethal radioactivity. Now, almost four years later, the plant is at a safe if tenuous stability, but 500,000 gallons of highly radioactive water must still be removed and the containment building decontaminated, a process that will require careful attention to safety, more than one billion dollars, and several years.

Throughout the accident, many attempts to prevent or mitigate it failed. The crucial reasons for the failures were not operator error or equipment malfunction; generally, the operators acted as they had been trained and the equipment worked as designed. Nor were the failures primarily the fault of Met Ed, the Nuclear Regulatory Commission (NRC), or the major contractors, though all were lax and irresponsible in important ways. Rather, individuals failed to make sound technical and political decisions for two closely related reasons: essential information was unavailable, unclear, distorted, or ambiguous; and the nuclear power plant itself was not understood sufficiently well for individuals to recognize the significance and implications of the information they had. As a result, plant operators and technical experts made decisions that exacerbated the accident. Outside TMI, inadequate information and understanding led to crisis management by the NRC and ill-informed personal and political decision making.

The accident began simply enough.[1] At thirty-seven seconds after 4:00 A.M. that Wednesday, a series of feedwater pumps supplying water to TMI's steam generators "tripped," i.e., stopped. With no water being added to the steam generators, there would soon be no steam; so the plant's safety systems shut down the steam turbine and its generator, and turned on emergency feedwater pumps. Immediately, the temperature of the reactor coolant rose, because the generator feedwater was no longer taking heat from the reactor coolant. As the reactor coolant water heated, it expanded, increasing pressure in the coolant lines and their pressurizer tank, from which plant operators get their readings about coolant pressure and level, and from which excess pressure and coolant can be vented. When the pressure reached too far above normal, a valve on the pressurizer, the electromatic or pressure-operated relief valve (PORV), opened automatically, as it is designed to do, to relieve the pressure; reactor coolant, which is radioactive, flowed through the valve and (eventually) into the containment building. Since the pressure continued to rise, at 4:00:44, eight seconds into the accident, the reactor "scrammed," i.e., shut down. Everything functioned as it should have; nothing serious or disastrous had happened, just a minor malfunction that was common, though troublesome.

Five seconds later, however, the story changed. The PORV should have closed, since the pressure had dropped to a safe level; indeed, the electric current that keeps the PORV open went off. So did the light on the control room panel

1 This presentation of the accident draws its facts primarily from the following fairly full descriptions: Nuclear Regulatory Commission Special Inquiry Group, *Three Mile Island* (Washington, D.C.: Government Printing Office, January 1980), commonly referred to as the "Rogovin Report"; The President's Commission on the Accident at Three Mile Island, *The Need for Change: The Legacy of TMI* (Washington, D.C.: Government Printing Office, October 1979), commonly referred to as the "Kemeny Report"; *Spectrum* 16, no. 11 (Institute of Electrical and Electronics Engineers), a special issue entitled "Three Mile Island and the Future of Nuclear Power"; and reports in *The New York Times.*

that indicates that electric current is keeping the PORV open. Since the valve shuts automatically, the light's going off indicated that the valve had closed.

It had not. It was open, and would remain so for more than two and a quarter hours, draining essential reactor coolant and allowing the core to heat dangerously. A LOCA—Loss of Coolant Accident—was occurring. In the first 100 minutes, 32,000 gallons of coolant, one-third of capacity, escaped. By 7:50 P.M., nearly sixteen hours after the valve stuck, the reactor was finally put in a somewhat stable condition. But the reactor core had been partially uncovered and melted, the plant crippled, and the containment building filled with radioactive water, radioactive gases at high pressure, and hydrogen. Not until five days later was it assured that major radioactive releases were very unlikely and TMI relatively secure.

From the onset of the accident, the four trained and licensed plant operators on duty suffered from the problems of unhelpful information and inadequate understanding of events. The operators were getting too much information on matters irrelevant or peripheral to the main causes of the accident. Within minutes, over 100 alarms showed on the control room panel. One operator, ironically named Craig Faust, said later: "I would have liked to have thrown away the alarm panel; it wasn't giving us any useful information." It was telling them too much. Eight minutes into the accident, for instance, they discovered—from the alarm lights on the control panel—that certain emergency feedwater pumps were ineffective because valves on their pipelines were closed; so the operators opened the valves. As the Kemeny Report asserts, "the loss of the feedwater had no significant effect on the outcome of the accident. But it did add to the confusion that distracted the operators as they sought to understand the cause of their primary problem," a distraction that is readily understandable since the feedwater system "could be crucial in preventing core melt from entirely different kinds of hypothesized accidents" and since the valves were meant never to be closed when the plant was operating. In other words, as the operators struggled to comprehend what was happening, they were bombarded with so much information that it was difficult to discern which alarms were essential to the smooth termination of the incident and which were irrelevant.

Concurrently, they were *not* getting some essential information. One problem occurred, as noted above, thirteen seconds into the accident: the light that, when on, indicates that the PORV is receiving electrical current to keep it open, went off. This signals that the PORV is closed, though in fact all it indicates is that electrical current is not keeping the PORV open. The PORV was stuck open; the operators, following their training and their control panel, thought it was closed, as did all the technical experts on the scene for the next two hours. The lights and gauges worked as designed, the operators read them as trained. But the necessary information was not available, and the information obtained from the control panel was misleading.

A similar difficulty arose seconds later. With the PORV open and reactor coolant draining out, the High Pressure Injection Pumps (HPI), a crucial part of the Emergency Core Cooling System, started as they should have and poured 1000 gallons per minute onto the core, effectively replacing the coolant lost through the PORV. At the same time, however, the water level in the pressurizer continued to rise, indicating (according to all training and procedures) a rising level of reactor coolant. As an operator said later, "the rapidly increasing pressurizer level at the onset of the accident led me to believe that the HPI was excessive, and that we were going to have a solid system." A "solid system"—where the entire cooling system is filled with water—is very vulnerable to serious damage or rupture from excessive pressure or a sudden "pressure spike." In their five years in the nuclear navy and in their training at TMI, the operators had been drilled that they should never let the pressurizer "go solid"—and TMI operating procedure 2103.1.3 lists no exceptions to the dictate.[2] So, two and a half minutes into the accident, the operators shut down one HPI pump and throttled the other back to a mere 100 gallons per minute. But the effect, of course, of the operators' action was to cut off the inflow of water needed to replace the coolant water escaping through the PORV that was still open—even though the light on the control panel still signaled it was shut.

The operators misunderstood what was actually happening: while the pressurizer water level was going up (and indeed "went solid" six minutes into the accident), the rise occurred not because the water level in the reactor coolant system was secure and rising, but because the reactor coolant was so hot that as soon as it touched the reactor core it flashed to steam, leaving the core uncovered and driving some remaining water into the pressurizer (and eventually out the open PORV).

The operators failed to interpret accurately what was occurring because the plant's system in its entirety had not been presented coherently and understandably to them. Even if they had focused on the relevant information, they had never before seen the same concatenation of events, either in training simulations or in operating the plant. Nor had their boss. Forty-five minutes into the acci-

2 To try to eliminate human error by automation is no solution; an automated system is only as good as its instrument readings and its operating procedures (following TMI operating procedure 2103.1.3, an automated system would have turned off the HPI too), and in practice it needs operator intervention. At Crystal River in 1980, the plant literally took off and "did its own thing" when a short-circuit confused a computer, and only operator action ended the accident; at Browns Ferry in 1975 operator improvisation kept the reactor core covered after the electrical cables for the HPI and other pumps were burned out.

dent, George Kunder, superintendent of technical support at TMI, arrived and examined the situation. He said: "I felt we were experiencing a very unusual situation, because I had never seen pressurizer level go high and peg in the high range, and, at the same time, pressure being so low. They have always performed consistently."

That the situation was "very unusual" for the TMI technicians is not surprising. As the Kemeny Report states, "the simulator at B&W [Babcock and Wilcox] was a key tool in the training of operators. Simulator training did not include preparation of the operators for multiple-failure accidents. Indeed, the B&W simulator was not ... programmed to reproduce the conditions that confronted the operators during the accident. It was unable to simulate increasing pressurizer level at the same time that reactor coolant pressure was dropping." Lacking experience with the specific problem, the operators and their bosses also lacked essential conceptual understanding of TMI; they even "demonstrated a lack of understanding of one of the most basic concepts of a pressurized water reactor: that system pressure must be kept above the boiling point for the existing temperature of the reactor coolant," as the Rogovin Report asserts. For the technical staff, TMI had not been made understandable.

The technical experts at Met Ed, B&W, and the NRC had the same difficulties as the plant operators and their boss; as a result, the sequence of events, dangers, and damage to TMI were not accurately grasped until days after the PORV stuck open. In trying to interpret events, these technical experts could not obtain some important information: there was no direct way to measure the amount of coolant in the reactor core, the temperatures at crucial places throughout the reactor, or the composition of gasses in the containment building.

But enough information for accurate interpretation and action did exist, somewhere—buried in the NRC's files, at B&W's headquarters, with Met Ed. For instance, the utilities are required to report all abnormal occurrences to the NRC; but the NRC's inadequately differentiated collection of reports of all problems —major or minor, 3,500 per year—from all commercial nuclear power plants would overwhelm anyone trying to learn from similar past occurrences or attempting to predict future problems. While the NRC had always been concerned with "large-break" LOCAs, the controversial Rasmussen Report commissioned by the NRC itself showed that small-break LOCAs (like that at TMI) were likely, but the NRC did not attend to that portion of the report. The stuck PORV and the misleading indications (of high pressurizer and therefore coolant levels) to operators had occurred twice before: in 1974 at a Westinghouse reactor in Beznau, Switzerland; and in 1977 at Davis-Besse, in Ohio, a B&W reactor. Information about these problems was passed on to the NRC and, in the case of

Davis-Besse, to B&W, where the danger was recognized; but it did not get to TMI, nor was the information effectively available to any person on the scene.

The hydrogen bubble scare of the weekend illustrated strikingly the experts' inability to understand and control their own information gathering and dissemination. On Thursday, the second day of the accident, B&W informed the NRC that no excess oxygen was being generated inside the containment building and therefore no fire or explosion was possible; on the fourth day, B&W reiterated the information. But it never reached the NRC experts, who then produced and publicized erroneous calculations showing that the hydrogen bubble in the TMI containment building might explode with a potentially catastrophic radiation release. Information was not effectively discovered and transmitted among the crucial actors.

TMI makes clear the necessity for and the problems of the effective—accurate and fast—transmission of information in nuclear power plants. Some of the problems of information transmission are primarily technical: the information must be accurate (and not crippled by the misleading indirect gauges, malfunctioning equipment, or lack of electrical power that usually attend accidents at nuclear power plants); and the vast quantities of sometimes unrelated data must be correlated accurately and very quickly. It is not clear if these technical constraints can be overcome within a reasonable cost factor. Certainly TMI had inadequate capabilities, from the missing information to a computer printer registering alarms so slowly that it fell two and one half hours behind on the morning of the accident. But even well-funded computerized information-gathering may have recurrent (and highly dangerous) technical problems, as indicated by the recent snafus with the U.S. early warning system for nuclear attacks, which signaled Russian missile attacks once in 1979 and twice in June 1980.

Effective information transmission, however, cannot be considered as merely a technical problem amenable to a technical solution. In the first place, all information requires interpretation. If the NRC is to differentiate significant from trivial information into a form helpful in preventing accidents, it must first interpret the nuclear power plant as a whole to determine what is significant to safety (a task in which the NRC and others have failed badly—as the nearly exclusive concern with large-break LOCAs suggests). Then it must interpret and categorize reports on near-accidents, a task made more difficult because, in the words of the Rogovin Report, "reports often do not clearly identify the real cause of a particular incident." In fact, the report to the NRC about Davis-Besse omitted the key parallel between Davis-Besse and TMI: when the PORV stuck at Davis-Besse and high pressurizer readings followed, the operators, like those at TMI, turned off the HPI. (Davis-Besse avoided a serious accident because it was operating at 9 percent full power; TMI was at 97 percent.)

After the information is interpreted, new, safe, and effective procedures to handle the problem must be introduced—and this bedevilled B&W when its safety division did propose new procedures for handling the Davis-Besse (and TMI) problem; a B&W engineer suggested the proposed new procedures might have some dangerous side effects, and so B&W dropped the whole matter.

Additionally, the information must be interpreted in and transmitted through large-scale and complex bureaucracies in the NRC, the reactor vendors, their subcontractors, and utilities in this country and abroad. Research on bureaucracies strongly suggests insuperable structural problems that hinder smooth and efficent operation. "Information pathologies" are endemic in large-scale organizations; communication and "intelligence failures are rooted in structural problems that cannot be fully solved; they express universal dilemmas of organizational life."[3] Faced with its own complexity as well as the complexity of what it administers, a large organization has difficulty understanding its situation; moreover, such complexity seems to lead to loss of agency.[4] Once an organization is identified with a policy, it may opt for symbolic solutions rather than substantive ones, or may use doctoring or repression of information to prove its case. Then too, organizations are not monoliths: the plurality of divisions, interests, and persons in a large organization leads to diversity, differences, and disagreement, through which information cannot travel smoothly. For instance, at TMI memos from the operators about recurring problems with the control panel and valves were not acted on by the management of Met Ed.

Disagreements also frequently exist between organizations; the NRC, reactor vendors, and utilities have divergent goals and interests, and information often supports one party at the expense of another. It cannot be expected that information and interpretation can pass unhindered and unbiased between the interests of such competing groups. Indeed, during and after the accident at TMI, different organizations put forth conflicting interpretations of the events and damage.

Finally, all improvements in information will cost money and time. To the extent that the vendors and utilities pay for them, the visible costs of nuclear power will increase—at a time when the current costs of nuclear power and coal, and the projected costs of nuclear and solar energy, are competitive. To the extent that the government (i.e., taxpayers) pays as well, the cost to society as a whole for nuclear power increases—an increase in social costs that should be questioned.

3 Harold L. Wilensky, *Organizational Intelligence: Knowledge and Policy in Government and Industry* (New York: Basic Books, 1967), p. 42.

4 Langdon Winner, "Complexity and Human Understanding," in Todd R. LaPorte, ed., *Organized Social Complexity* (Princeton.: Princeton University Press, 1975), pp. 40–76.

Compounding the experts' problems with information was the other factor that also troubled the operators on duty: the experts themselves did not understand the nuclear power plant "system" that they had created or regulated. The reactor vendor (B&W), the utility, and the NRC all were unprepared both before and during the accident for what in fact occurred. Most telling is that the actual combination of events at TMI was seen as so unlikely to occur (or, more probably, was not considered at all) that B&W's training simulators could not reproduce the combination. Other examples of misunderstanding abound. The stuck PORV so crucial in the accident was not labelled "safety-related" on the grounds that it had a block valve behind it; likewise, the block valve was not "safety-related" because it had a PORV in front of it. The indirect indicator of the position of the PORV (the light indicating whether electrical current is keeping the PORV open) was accepted partly because the PORV was not "safety-related" and also because plant operators supposedly had two independent indicators if the PORV stuck open: the temperature reading on the drain pipe behind the PORV would rise (as the hot coolant escaped), and a gauge would indicate whether drained coolant was filling the overflow tank. But these design features were inadequate in the event. Because the PORV leaked continually in normal operation (despite requests to management by operators that it be fixed), temperature readings on the drain pipe were normally higher than allowed by the plant's operating procedures; so operators disregarded the high temperatures caused by coolant escaping through the open PORV, and the overflow tank gauge was placed on a part of the control panel that faced away from the operators, who ignored it during the crucial first day since the part of the control panel facing them presented enough problems.[5]

In a commendable concern for safety and "defense in depth," the NRC has required numerous back-up mechanisms throughout the plants; but these can have the opposite effects on the safety of the system as a whole. To increase the number of important mechanisms is to increase the possibility of malfunction or human error. As the number of important mechanisms increases, the number of gauges and lights on the control panel increases, making it more difficult for operators to get relevant information from the control panel. Moreover, while the increase of important mechanisms probably reduces the chance of a serious acci-

5 Nuclear power plant accidents and incidents frequently are caused by unanticipated events. At Browns Ferry in 1975, some technicians looked for an air leak with a candle and started a very bad fire. At Indian Point in October 1980, 100,000 gallons of cold Hudson River water leaked into the hot reactor core. In late 1981, the NRC discovered the premature embrittlement and weakening of the steel shells surrounding the reactors of at least thirteen nuclear plants. Then the NRC discovered a large number of design errors at earthquake-vulnerable Diablo Canyon, where the blueprints for the two separate reactors had been confused.

dent because of the failure of a single part, it increases almost exponentially the number of possible combinations of problems where there are multiple-part failures; it therefore increases the number of combinations that must be anticipated, understood, solved, put into the simulator for training, and, since the time allowed decision making is so brief, become part of the operator's repertoire of immediate responses. In other words, each additional safety device leads to less chance for mechanical failure at a single point, and greater chance of complex failure, since it is progressively more difficult to take all contingencies into account.[6]

Having misunderstood the system's potential accidents when they designed and regulated it, the experts then misunderstood the course of the accident itself. Throughout the accident, they perceived the actual combination of events as novel. On the fourth day of the accident, Dr. Roger Mattson, director of the NRC's division of system safety, commented in NRC meetings: "It is a failure mode that has never been studied. It is just unbelievable. No plant has ever been tested in this condition, no plant has ever been analyzed in this condition in the history of this program."[7]

Outside the fences bounding TMI, obtaining relevant information and comprehending events were equally difficult, with severe political consequences for the NRC, politicians, and citizens. One striking example is that governmental experts, frequently unsure themselves about what was occurring, managed the news. During the accident, two methods of informing the public were attempted. At the beginning, the NRC, utilities, and anyone in a position of responsibility was giving out information. Not surprisingly, much of this expert opinion was contradictory. On the fourth day of the accident, according to the Kemeny Report, "Jack Watson, a senior White House aide," expressed "his concern that the many conflicting statements about TMI-2 reported by the news media were increasing public anxiety" and that a single spokesperson was desirable. That single person—a high NRC official, Harold Denton—presented the news. He also managed it. On the sixth day, Denton (with Mattson) held a press conference about the hydrogen bubble, which was by then known to have effectively disappeared and never to have been near detonation: "throughout the press conference, Denton continued to refer to NRC's estimates about hydrogen and oxygen as too conservative; he never stated outright that the NRC had erred in

6 Even one additional safety item can add risks, "as in the 1966 accident at the Detroit Fermi reactor, where a partial meltdown was caused by the breaking loose of a flow-deflecting zirconium plate that had been especially installed to reduce the likelihood of a core meltdown" (Report of the Nuclear Energy Policy Study Group, *Nuclear Power: Issues and Choices* [Cambridge, Mass: Ballinger, 1977], p. 233).

7 *New York Times*, April 14, 1979, p. 9.

its conclusion that the bubble was near the dangerous point." It is possible to speculate why he withheld his knowledge. One reason may have been that it is difficult to maintain credibility as an expert by saying in effect that "we were wrong two days ago, and all the fear of the hydrogen bubble, fear generated by our error, was groundless; but we are correct now." Another reason was the conscious decision by the NRC about future credibility: as Mattson later said, "we wanted to go slow on saying it was good news.... We did not want to firmly and finally conclude that there was no problem. We had to save some wiggle room in order to preserve credibility. That was our judgment." An accident such as TMI always raises the spectre that, "to minimize public anxiety" and "not to show up experts as disagreeing," a single spokesperson will be imposed; and that person, acting out of motives beneficent or malignant, can and probably will manage and manipulate the information being presented. With a nuclear power plant accident, as with war and espionage, truth is the first casualty.

With the absence and management of the news, political and public decision making becomes very difficult. Governor Thornburgh of Pennsylvania knew from the start that he would have to make important decisions. Yet at 7:50 A.M. of the first day, he lamented that "I can't make much sense out of what Met Ed is reporting. You can't make decisions about people's lives without solid facts."[8] Two days later he had to determine whether to order an evacuation. The costs of a mistaken judgment were high: failing to order a necessary evacuation would have meant a high death toll; ordering an unnecessary evacuation would have resulted in much inconvenience, economic loss, looting of empty towns, and accidental deaths. Thornburgh, the political leader, called Hendrie, the technical leader at the NRC, to get advice. But, as Hendrie had just said of himself and the governor, "we are operating almost totally in the blind. His information is ambiguous, mine is non-existent and—I don't know, it's like a couple of blind men staggering around making decisions."[9] When Thornburgh asked whether anyone "in the country" had experience with the health consequences of a possible imminent radiation release, Hendrie replied, "Ah—not in the sense that it's been studied and understood in any real way."[10] Local leaders

8 *New York Times*, April 16, 1979, p. B10.

9 *New York Times*, April 14, 1979, p. 9.

10 Nuclear Regulatory Commission, "Three Mile Island Nuclear Station, Unit 2: Transcript of 1979 March 30 Meeting in Washington, D.C., and Bethesda, Md.," microfiche (Washington, D.C.: Nuclear Regulatory Commission, 1979).

and individual citizens were given even less information on which to base a decision. For a political leader or citizen to make a reasonable, responsible decision is impossible when information is lacking and the news is heavily managed.

The management of news is one aspect of the antidemocratic tendencies inherent in nuclear power production. While some technologies may be fairly neutral in themselves and influence society only because of the ways that they are used, other technologies require a certain type of political and social structure and value system, and carry with them certain social practices and values which become embedded in society as a "second nature." While solar power, for instance, can be centralized in a power tower or decentralized, and while conservation is compatible with a wide range of social organization, nuclear power has rigid requisites and results. It requires centralization of resources and control into a few (public or private) utilities, organized on a large scale, held together by a complex hierarchical structure, directed or advised by a priesthood of technical experts, in a political context of pervasive and long-term social peace and order. At the same time, it carries with it the social and political practices and values of control and order, standardization and routinization, technical expertise and domination, specialization and separation. Energy production by nuclear power is inimical to democracy and prerequisites of democracy such as equality, an open society, and the free flow of information.

After chairing the Presidential Commission, Kemeny discerned the lesson of TMI, he thought: "Jeffersonian democracy cannot work in the year 1980—the world has become too complex.... The only way to save American democracy is to change the fundamental decision making process, at the federal level, so that it can come to grips with the enormous and complex issues that face this nation."[11] Faced with a tension between democracy and nuclear power technology, Kemeny accepts nuclear power technology as it is and insists that democracy be transformed. According to Kemeny, we can longer muddle through with popular democracy—we need the specialized experts in Washington to make decisions and determine policy for us. Kemeny does not consider that specific technologies of energy production ought to be judged in part in terms of their political implications: do they enhance or undermine democratic decision making? do they facilitate or restrict democratic activities and values?

Furthermore, the accident at TMI strongly suggests that reliance on governmental planning and regulatory expertise is unwise and misplaced. The manifold problems at TMI raise questions about the competence and legitimacy of

11 John G. Kemeny, "Saving American Democracy," *Technology Review* 83, no. 7 (June–July 1980): 74–75.

technical experts and governmental agencies. The world of nuclear power requires the technical expert; but the dearth of necessary technical information in an accident makes it difficult for the expert to make correct decisions.

Equally, the legitimacy of the political system may be called into question. One important function of the modern state is to plan for society at many different levels—from an energy policy determined by Congress and the president in Washington, to the safe operation of nuclear power plants by the NRC. But, as the accident showed, the NRC had done very little effective planning. For instance, there was no serious plan for evacuation except for those within a five-mile radius of TMI, even though the effects of the accident could have been much wider; so ten- and twenty-mile radius evacuation plans had to be drawn up on the spot. There were no plans to meet a protracted crisis at a power plant. There were no plans for communications between the personnel on the site and Harrisburg, Washington, Bethesda, the utility, B&W, outside technical experts, etc. Clearly, TMI was an example of crisis management, not planning.

Is it possible for the NRC to plan for future accidents in light of the experience at TMI? Can the NRC require and establish the necessary plans and keep them up to date? Does it have the financial and technical resources to put together full and workable plans for handling a severe accident at each operating plant? Lines of information must be established and updated; evacuation plans must be drawn and updated; particular problems, such as hospitals with immobile patients, must be considered; radiation-blocking agents must be stockpiled and distribution plans developed and updated; and all this must be done by a commission that has numerous other regulatory responsibilities and limited staff and budget. Certainly the events since TMI suggest that the NRC is not equal to this task of planning. Yet, without it, the response to the next accident will be crisis management again. A regulatory commission (and the state of which it is an agent) does not gain or maintain legitimacy when its claims to planning are belied by its obvious reliance on crisis management in emergencies.

A pinnacle of modern scientific and technical virtuosity, a complex manipulation of nature that tampers with Democritus's atom to effect results far beyond those imagined by medieval alchemists or nineteenth-century industrialists, nuclear power plants must be comprehensible or at least predictable if they are to be run safely, and their operators and technical experts must have the capacity to discern, obtain, process, communicate, and act on relevant information. At the same time, the society's planners also require information and comprehension in order effectively and smoothly to plan for abnormal events; this claim to effective planning is presented as the justification for the anti-democratic tendencies of nuclear technology. Those who direct the technical and social aspects of nuclear power, in other words, assume that they have the comprehension and information to keep the power plant running safely. But the accident at TMI shows that experts and planners both inside and outside the plant misunderstood crucial events and could not marshall relevant information; the accident at TMI shows the failed promise and the flawed politics of nuclear power.

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