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We use the case of the now-dead Shoreham Nuclear Power Station to pose some questions, and a few answers, about organizational failure. The analysis centers on the symbolism of organizational plans, specifically how organizations use plans to justify increasingly complex systems to themselves and to others. That such plans are based on sparse or nonexistent experience, and that they are often wildly unrealistic, suggests some reasons why high-technology, high-risk systems do not foster organizational learning.

Organizations fail often and they fail in important ways. Police departments become corrupt. Banks invest unwisely. Schools do not educate. Investment houses make bad bets. But large or powerful organizations rarely disappear, though one would think that failure would mean extinction. Only one work deals with this phenomenon in any systematic way, the sociological study by Marshall Meyer and Lynne Zucker with its evocative title, *Permanently Failing Organizations* (1989). Even that remarkable work, though, is equivocal in that organizations may permanently fail in their official goals but not in their unofficial ones. Other than Meyer and Zucker's work, the social sciences offer little in the way of explaining either the sources of organizational failure or the meaning of organizational plans for responses to potential failure.

In what follows we use a case study to suggest a theory of organizational failure that emphasizes the symbolism of organizational planning. The empirical material comes from the case of the Shoreham Nuclear Power Station on Long Island. Under pressure from regulatory agencies, in our case (or investment bankers, or even unsatisfied customers or rambunctious competitors in other cases), the Long Island Lighting Company (LILCO) formulated the plans required for evacuating Long Island in the event of a nuclear accident and were in the process of obtaining approval for them.

There are two mainstays of our analysis: (1) organizations come to believe their own representations, and, as a consequence, (2) they ignore the bulk of

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their experience that shows that these representations may be inaccurate. Clarke (forthcoming) calls these plans "fantasy documents," and they are neither wholly believed nor disbelieved; certainty is impossible because fantasy documents cover extremely improbable events. They are tested against reality only rarely, in that, for example, none of the following disasters were believed to be credible events by the organizations involved: Three Mile Island, Chernobyl, Bhopal, the *Challenger*, and *Exxon Valdez*. In addition to being untested, the accident mitigation and/or evacuation plans—the "fantasy documents"—are likely to draw from a quite unrealistic view or model of organizations. The fantasy is that everything will work right the first time, that every contingency is known and prepared for. Thus LILCO designed an emergency organization, the Local Emergency Response Organization, LERO, that was even more complex and bureaucratic than its own organization, and expected it to work. The plans, buttressed by many experts, including the Federal Emergency Management Agency and the Department of Energy, allowed leaders to make bold promises that their organizations could control a mass evacuation.

THE SHOREHAM NUCLEAR POWER STATION

The Shoreham Nuclear Power Station used to live on the north shore of Long Island.[1] By the end of Shoreham's life, many people thought it utterly ridiculous to put a nuclear power plant on Long Island in the first place. But it was not always so. In fact it was not until the late 1970s that the notion arose that it might be dangerous to put a nuclear power station on Long Island. The "danger" people focused on, the conception of hazard that animated people to oppose the plant, was not the risk of meltdown or radiation release. The key danger, that is to say the key definition of unacceptable risk, was the risk of not being able to evacuate a large part of Long Island in the event of catastrophe.

LILCO promised that it could evacuate a 10-mile radius around Shoreham (known as the EPZ, or emergency planning zone). Some uncalculated but substantial reason for the decline and fall of Shoreham was LILCO's failure to demonstrate to others that its promise could be kept. Shoreham's fate depended on the evacuation plan because part of the fallout from Three Mile Island was that utilities were (and are) required to have such a plan; that plan, furthermore, must be approved by the Federal Emergency Management Agency (FEMA), the Nuclear Regulatory Commission (NRC), and local and state governments. These new requirements gave states and localities a warrant to insert themselves into decision processes that previously had been the exclusive province of federal agencies. It was this warrant that produced the documents we review here. If LILCO could not present a highly credible case that its evacuation plan would actually work, then Shoreham, and possibly even LILCO itself, would be at risk.

The main argument from Shoreham's proponents was that there was nothing special about nuclear accidents. A good deal of research on nonnuclear disasters,

largely by sociologists at disaster research centers, which LILCO cited, tells us that people do *not* panic in emergencies and that most of the time emergency workers at least try to fulfill their responsibilities. To illustrate the reasoning, let us quote some testimony from LILCO consultants:

> The record is clear that emergency workers do their jobs when they understand that they have an emergency job to do, when they understand what that job requires of them, and when they have a sense of the importance of their job for overall community safety and to their work group. These understandings can be produced in different ways. For example, people who hold jobs that are in the routine of everyday life comparable to their emergency roles—for example, firemen—bring these understandings to the emergency setting. (Nuclear Regulatory Commission, 1983, p. 100)

Were a nuclear catastrophe akin to a flash flood, an earthquake, or commuting—all allusions asserted by LILCO—it would mean that large-scale evacuation was merely a big project, not an insurmountable obstacle. More, it would mean that an organization could overcome the considerable uncertainties that would attend a very serious worst-case event.

For their part, Shoreham's opponents argued that the station was such an exceptional case that there were good reasons to think that officials and organizations would not be able to control an evacuation. They pointed out that denizens of Long Island evinced considerable distrust of LILCO and so wouldn't believe expert proclamations or follow official orders in an emergency. Worse, the same research that shows that most emergency workers in most disasters do what they are supposed to do also shows that when disaster comes, what is highest on people's priority list is their families. Not only would people fail to follow the plan in the event of a severe radiological emergency, Shoreham's opponents reasoned, but those asked to function as evacuation workers would likely try to protect their families first. If the whistle blew and people did not take their posts, massive unpredictability—not controlled evacuation—would ensue. Were that the case, then Shoreham would not pass a pivotal test for ensuring public safety. LILCO, in other words, needed people, and the courts and federal agencies, to believe their promises. The fantasy documents were crucial representations of those promises.

AN EVACUATION EXERCISE

LILCO's credibility problem was large indeed. Surveys consistently showed that people did not even trust LILCO executives' explanations for high electricity rates, so it would be hard to persuade them that those same executives would have the public interest in mind when making decisions about a multibillion-dollar nuclear investment. LILCO used several devices to remedy the credibility gap. Those devices were designed to convince the public and other organizations that they had planned well for catastrophe at Shoreham. Computer simulations, which are used throughout industry, were one such device:

> LILCO's analysis . . . shows a normal evacuation time of 4 hours and 55 minutes for the entire EPZ in normal weather and with traffic guides. These times compare favorably to other plants located in and supported by New York State. . . . A comprehensive 1982 [NRC] study evaluating 52 nuclear plant sites on a consistent basis showed that half the plants studied had evacuation times in excess of that expected for Shoreham (quoted in McCaffrey, 1991, p. 134).

But the value of simulations would be mainly internal, useful to nuclear experts and technical decision makers for bringing problems to the fore that they may not have conceived or for ratifying presumably resolved dilemmas. Simulations would do nothing for the public relations and credibility problems because they were too technical and too unreal.

So LILCO conducted a series of real-time exercises. Important parts of the evacuation plan would not, for various reasons, be tested. The sirens would not actually cry out, and the public would not actually be moved. The radio and television stations would only pretend to announce disaster. The plant would not be SCRAMMED, as it was not even on line. One of the most significant parts of the plan that could not be tested concerned state and local governments. New York State, Nassau and Suffolk counties, and most local governments (including the police, who we gather were skeptical if not incredulous) had proclaimed their opposition to the Shoreham plant, in accordance with the preferences of most Long Islanders (who, incidentally, were unaware the exercises were going on), and refused to participate in any of the planning process. That was a problem because the federal licensing rules required just that sort of participation. LILCO's short-term solution to this problem was to convince federal regulators to act *as if* state and local governments participated. Even with these limitations, however, there was considerable realism to the exercises.

A methodological note: We have searched far and wide for training simulations of similar magnitude, to no avail. There *do* exist cases of emergency exercises involving local police and fire departments in other states simulating events such as airplane crashes and propane explosions at local airports and the like. Although interesting, the emergency organizations in those cases had considerable prior and even relatively frequent experience with the routines they would activate in an emergency. Thus the relevance of those cases for Shoreham is extremely limited. Another source of comparative data is the military where such exercises are commonplace, but detailed documents on those exercises are not available.

There were a series of LILCO exercises, but we focus here on one that took place on February 13, 1986. The exercise involved, among other things, sending evacuation workers on their missions, setting up media centers with pretend reporters, arranging command posts, telephone calling, and sending emergency vehicles to mock emergencies (Federal Emergency Management Agency, 1986). LILCO's main agent for organizing emergency planning ws LERO. LERO's plan used utility employees, contractors, private organizations, and the Department of Energy in both its plan and the exercises. Thirty-eight evaluators from federal agencies (e.g., FEMA, Department of Energy [DOE], NRC) were on

hand to judge 17 key pieces of the plan, including emergency operations, emergency staging areas, medical drills, decontamination facilities, traffic control, bus evacuation routes, and radiological monitoring, among others. The main point, said FEMA, was that:

> LERO was to be responsible for ensuring that its resources actually deployed in adequate numbers to reasonably test its notification, mobilization, command, coordination, and communications capabilities (Federal Emergency Management Agency, 1986, p. 19).

Following is a skeletal chronology that frames our subsequent discussion (all page numbers to the end of this section refer to Nuclear Regulatory Commission, 1986):

6:52 a.m. Emergency Broadcast System (EBS) announcement that schools would close because of problems then developing at Shoreham. In LILCO's estimation this would not be sufficiently alarming to people that they would begin to evacuate, so no provision was made, in either the exercise or the actual plan, for such potential evacuees.

8:19 a.m. Site Area Emergency. The Shoreham Nuclear Power Station suffers a break in the High Pressure Coolant Injection steam line. Core melt becomes highly probable.

8:41 a.m. Starting here, and continuing for every 15 minutes, the plan calls for the issuance of messages that there was a radiation release at 8:19 a.m. An advisory is issued that dairy animals should eat only stored feed.

9:39 a.m. General Emergency declared. There has been a total loss of the Emergency Core Cooling System and two of the three fission product barriers have failed. In other words, Shoreham is melting down and the radiation is going to be released to the environment. Forty percent of LERO traffic guides have been contacted; none are at their field posts to perform their duties (p. 112). Traffic guides were dispatched only *after* the evacuation recommendation in the General Emergency EBS message.

10:24 a.m. Several EBS messages recommend that evacuations begin.

10:30 a.m. A request is issued for a bus to be dispatched to Ridge Elementary School, which is not far from Shoreham; bus arrives 3 hours later at 1:23 p.m. The bus driver was not dispatched to pick up a bus for 40 minutes and then, apparently, got lost (p. 140). The bus still had not arrived at the Nassau County Coliseum, the terminus of the evacuation efforts, with its pretend 40 children, by 4:23 p.m. The implication is the bus and the children never made it out of the EPZ.

10:40 a.m. Gravel truck freeplay impediment is injected; discussed below.

11:00 a.m. Fuel truck accident injected (p. 120); discussed below.

11:46 a.m. EBS message recommending that entire EPZ evacuate.

Overall, FEMA judged the exercise a success. LERO demonstrated "that it has adequate access control and that security can be maintained" (p. 29), that it "can establish appropriate communications links" (p. 29), that the operations centers worked well. FEMA would reckon that communications were acceptable at the emergency operations center and note that "evacuation personnel were well trained" (p. xii). FEMA did, however, admit "a need for greater communication and more efficient sharing of information" (p. xii) and admitted that in one of the two surprise events, to which we return below, "all pertinent information was not transferred from the freeplay impediment message forms introduced by the exercise controller to the LERO message forms" (p. 3). The missing information was, incidentally, critical. For the other surprise event, FEMA pointed out that the "message concerning the 'visual check' of the fuel truck impediment from the Bus Dispatcher at the Patchogue Staging Area to the Transportation Support Coordinator was partially illegible and was not written on a standard LERO message form" (p. 30). According to FEMA, though, most communications, for instance, involving radio and telephones, "were established rapidly and maintained throughout the exercise" (p. 32). By FEMA's lights, nearly all the objectives of the exercises were met, including the most demanding, about which FEMA (1986) concluded:

> The LERO [Emergency Operations Center] met the exercise objective of demonstrating the organizational ability to manage an orderly evacuation of all or part of the 10-mile EPZ including the water portion. (p. 34)

One might conclude, judging only from FEMA's assessment, that there were but minor problems in the exercise and that the problem of planning for a meltdown of a nuclear power plant in the middle of Long Island had been solved. The discussion of the surprise events, from which we quote above, sounds as if the most important failures in the exercise were simply a partially illegible message and another message not being written on the standard form. Were that true, were the only failures in fact writing problems, opening Shoreham should proceed directly.

A FEW PROBLEMS

Natural and technological disasters, and those who write about them, provide plenty of data on organizational breakdown.[2] Organizations lose their mandates, personnel sabotage procedures, internal politics compromises vigilance, production pressures foster myopia in leaders, small failures cascade into catastrophe, systems are overwhelmed, and so on. Although that research has been invaluable for many purposes, it is limited to systems that were operating under difficult—sometimes impossible—conditions.[3] In such cases we often must attribute failure to the overwhelming influence of external factors.

But on Long Island we had an instance of organizations working under nearly *best-case conditions*: It was a sunny day and traffic was innocently and uncon-

cernedly moving well. It was not rush hour; the precise time and sequence of events was set weeks before. There had also been previous exercises. Reading through the volumes of description available on the Shoreham case, it is clear that much of the behavior in the exercise was highly scripted. Like the acts in a high school play, little was left to chance. We might have expected that even the responses to the two surprise ("freeplay") messages would have been scripted. Accidents resembling the freeplay ones are not rare on busy Long Island roads.

There were other reasons to expect that success, not failure, would characterize the exercise. Significant amounts of organizational, political, economic, and even individuals' energy were spent on LILCO's exercise. Evacuation workers had 3 to 5 years of training, they took classes, received instruction, engaged in tabletop exercises and drills, and even participated in full-scale exercises. Federal regulators, especially FEMA and DOE, as well as private consultants, worked closely with LILCO to develop the plan for the exercise as well as the plan for the exercise's evaluation. Workers spent untold hours in classes, learning about dosimeters, the EPZ, and radioactivity. Executives spent untold hours working with the press and leaders in the business community. Let us not forget that much of the planning was quite public, LILCO's actions open to outside scrutiny. The exercise, too, would become very public as extensive litigation was in process with much more to come. A great deal was at stake.

In spite of all the oversight, in spite of all the incentive and opportunity to make the exercise work well, there was instead massive organizational failure. A good deal more went wrong than the failure to fill out a form correctly. Many of the personnel at the staging areas were new and, without previous training, had to have their responsibilities explained *during the exercise* (Nuclear Regulatory Commission, 1987a, p. 50). Recall from the chronology that the "Site Area Emergency" was declared at 8:19 a.m., yet none of the road crews—who were on official notice that they would be called—arrived at the three staging areas until after 10:00 a.m. A few never reported at all. By 9:39 a.m. when a "General Emergency" had to be declared because all the plant's safety systems had failed, only 11% of the road crew—again, aware that they would be used—deemed essential by LILCO's plan were available.

Neither the Long Island Railroad (LIRR) nor the Federal Aviation Administration were notified of the emergency because no procedures were in place for it (Federal Emergency Management Agency, 1986, p. 29); apparently no one thought of that. Note that the LIRR runs many trains through and around the EPZ and there is a large airport in the middle of Long Island (Islip); nearby is the site of the major traffic control center in the region, and planes bound for LaGuardia and Kennedy routinely fly over the area.

A large part of LILCO's evacuation plan depended on bus drivers. Those drivers would be especially important for people who needed extra help getting out of harm's way, chiefly children and the mentally and physically incapacitated. The children were perhaps the linchpin in the machine, for both symbolic and practical reasons. If the problem of evacuating the children could not be resolved, the exercise would likely be seen as absurd. Symbolically, children are

the pure, the pristine, the most innocent of victims. They could have had no say in whether Shoreham would be built, and it would be difficult for anyone to argue any fine points about risk/benefit trade-offs in the face of cancer-ridden innocence. Practically, if the buses could not be counted on to evacuate the children, and if people did not believe the buses could be counted on to evacuate their children, the plan could never succeed. Instead of everyone moving toward the presumed safety of the Nassau County Coliseum, some nonnegligible proportion of Long Island would be moving in the direction of nuclear danger to get their children. LILCO needed the buses to work.

Although the bus drivers, as one might expect, were drilled extensively before the exercises, the buses in large measure did not work. Bus drivers did not take time to read dosimeters (some apparently did not know how to; it had been a problem on previous exercises and the same happened with some ambulance crews), a task required by the plan. One driver, asked by a FEMA evaluator to participate in the exercise, responded that he did not "wish to drive as he had trouble reading signs. This driver even threatened to quit LERO" (Federal Emergency Management Agency, 1986, p. 105). Postexercise assessment made clear that many bus drivers did not know the boundaries of the EPZ, which meant they did not know when they were or were not "safe" (Federal Emergency Management Agency, 1986, p. 111). Nearly one third of the bus drivers failed to follow preassigned routes (Nuclear Regulatory Commission, 1989, p. 101), which means they either went their own way or they got lost; many did not contact the people they were supposed to contact. They were not alone, however, as some of LILCO's official "Traffic Guides" did not know the proper routes the buses were supposed to travel, nor did they know the organizational structure of LERO, or the plan's procedures (Federal Emergency Management Agency, 1986, p. 116).

Another important part of the plan, and the exercise of course, concerned the procedures for communicating with the public. Here, we might have predicted, would be an area ripe for organizational perfection. Knowing well ahead of time just what the emergency would be, the announcements would be carefully prepared, and we might reasonably have expected the responses to those messages, with minor variations perhaps, to be carefully crafted and accurate. Such was not the case. EBS messages were sometimes four single spaced pages long (Federal Emergency Management Agency, 1986, p. 136), which, read over television and radio, would surely have been too long for people to follow carefully, even if they had been constructed in a crystal clear fashion. In fact, the EBS messages were crafted poorly. Sometimes there was conflicting information in the same message. One such message advised people outside the 10-mile EPZ that "no protective action was necessary," immediately followed by a paragraph advising that they take blankets, pillows, and medications as they "could be away for days" (Federal Emergency Management Agency, 1986, p. 139). Sometimes *new* information was presented at the end of the message, which would likely raise questions just at the time people would be expecting answers. As but one example, in a series of three Emergency Broadcast

messages, the first two told people that children from a local school district would be taken to the Nassau Coliseum; in the last they were told the children were not in fact at the Coliseum but a different place (Hicksville) "for monitoring and decontamination" (Federal Emergency Management Agency, 1986, p. 138). Such a sequence of messages could have produced only anxiety and possibly panic among worried parents, parents likely to stop at nearly nothing to ensure the safety of their loved ones.

This obvious anxiety was consistently downplayed by LILCO, which had every confidence that its instructions would be obeyed. Yet even this conceit was not scripted. LILCO retained a world expert on radiation hazards from nearby Brookhaven National Laboratories—a government organization that took public positions supporting LILCO and its nuclear plant. He was to be the expert on hand in the Emergency Broadcast Station, available to answer questions by FEMA workers posing as reporters. The reporters exhibited none of the ruthless questioning that might be expected under the circumstances, but one of them asked Dr. Brill, the expert, if he expected the population would evacuate the EPZ when they were asked to. Dr. Brill replied that they would but that he would not! He explained, certainly to everyone's surprise, that although he lived within 2 miles of the plant, he would probably be one of the "diehards" who would not leave his home. This was at a time when LILCO had suggested the complete evacuation of the 10-mile EPZ and when the reactor core was two-thirds uncovered. Alarmed by this violation of the order, the FEMA workers asked "why?" Dr. Brill's view was that the traffic jam would be so enormous that people evacuating would be exposed to more radiation in their autos than if they hid in their basements. LILCO's expert would thus have made matters much worse. A key argument of those who opposed the plant and doubted LILCO's ability to evacuate Long Island in a few hours was that the traffic jam would be so enormous that only a minority would escape (On Dr. Brill, see Nuclear Regulatory Commission, 1989, pp. 161-169).

Rumor response and press conferences evinced other failures. One prevalent failure in rumor response was a long lag between the time of a request and a response to the request. Examples included "people"—FEMA workers calling in pretending to be citizens—hearing fire trucks and calling the command center to ask about them. They usually received a very late response or no response at all. Others, preparing to evacuate and calling to ask what ought to be done with their pets, also received delayed responses, or no response at all. Sometimes "residents" asking the experts for advice were told both to evacuate and take shelter. A pretend woman who was 4.5 months pregnant was allowed to drive through the EPZ without being reminded of the risk to her fetus. The simulated press conferences were full of evasive-sounding answers and dismissals of people's worries.

Although FEMA judged the behavior of the traffic guides at the three staging areas—in Patchogue, Port Jefferson, and Riverhead—largely a success, in fact the earliest that any traffic guides were dispatched was 10:25 a.m. and the latest completion was at 12:49 p.m. (Nuclear Regulatory Commission, 1986, p. 113),

which were, respectively, 3.5 hours and 6 hours after local schools had been closed. Yet LILCO's plan held that emergency information would be disseminated to the public every 15 minutes telling people that LILCO personnel would be guiding traffic. Thus the exercise would leave people with the impression that LILCO could not be counted on to help people evacuate should the need arise.

Much of this would be standard in a real worst case. Had Shoreham turned itself into a molten radiating mass, we certainly would have seen—we invariably do—confusion in rumor control, conflicting advice, contradictory statements, and evasion or even dissembling at press conferences. But when we see these kinds of failures in an important exercise with prior planning and training, and plenty of warning, we must begin to wonder, What are the possibilities and limits of organizational learning? Or, more specifically, What could make organizations fail so? Truthfully, social science is at a loss to answer these fundamental questions.

A TALE OF TWO TRUCKS

Some parts of the exercise were not entirely known in advance and so could not have been fully scripted even had the participants tried. FEMA called these "freeplay messages," and the idea was to introduce surprise problems to which LERO personnel could respond. If LERO were organized properly and its personnel trained well, as LILCO believed, the responses would be prompt and appropriate. Of course, emergencies are by definition not routine events and will contain surprises. No one ever expects such responses to be perfect—it is probably sheer accident when responses in times of crisis are perfect—but it was entirely reasonable to expect they would be sufficiently appropriate to permit the conclusion that LERO was more or less prepared. That, indeed, had been LILCO's promise.

The first freeplay involved a gravel truck turned sideways in the road with a broken driveshaft, and the second an overturned fuel truck (both "accidents" were simulated). According to LILCO's plan, if a traffic impediment cropped up during the evacuation, a clear and set channel would route the information from the field, through various officers, to the road logistics coordinator at the Emergency Operations Center (EOC). During both the fuel truck and the gravel truck impediments, this channel was entirely subverted. Rather than field personnel routing the information through those channels, FEMA observers noticed the failure and on their own stepped in and informed the EOC directly that there were traffic impediments (Nuclear Regulatory Commission, 1987b). The messages that were given to the EOC were mostly clear and appropriate, portraying accurately the information necessary for a timely resolution of the problems. Not everything goes wrong that can, Mr. Murphy to the contrary.

But there was a failure to properly inform the chain of command. In practice this could easily have meant that key but lower-level personnel would not know

that roadways were blocked. Two hours after the gravel truck impediment, the Transportation Support Coordinator did not know that a bus evacuation route was potentially blocked (Nuclear Regulatory Commission, 1987b, p. 36), and there was no public dissemination of information about the impediments (e.g., an EBS) until 1:45 p.m. So it was more than a failure of a formal plan; it was also potentially a failure of organization. It turned out that for the gravel truck accident, which was "injected" into the exercise at 10:40 a.m., the FEMA observer informed the evacuation coordinator at about 12:13 p.m.; had that not been the case, it would have taken even longer for LERO to respond. Traffic was not then rerouted, nor had any equipment been dispatched to remove the gravel. Once LERO finally did send equipment to the gravel truck, it sent only one tow truck and no scraper or other equipment that could move a large pile of rock from the road. That one tow truck, even FEMA agreed, would not have been adequate to move a gravel-laden dump truck with a broken driveshaft and three disabled cars.

The FEMA fuel truck freeplay was introduced at 11:00 a.m. The notice read that the fuel tanker jackknifed and overturned on a busy, main evacuation route (Route 25a), blocking both east- and westbound traffic as well as both shoulders. The fuel was leaking from the ruptured tank, though there was no fire yet. The message gave the exact location of the accident and all the key conditions surrounding it. No equipment was dispatched to the scene for 2 hours and 48 minutes by the Road Logistics Coordinator (Nuclear Regulatory Commission, 1987b, p. 41). There were no efforts to inform the public, many of whom might be expected to use the road to flee the area, for 2 hours and 43 minutes. As with the gravel truck accident, LILCO finally sent one tow truck, but of a size (10,000 pounds) appropriate for passenger cars and small commercial vehicles. Some road crews were dispatched by 11:50 a.m. but did not get to the scene until about 2:00 p.m. Even the FEMA evaluator had left the scene by then.

In a better execution of the plan, the traffic would have been rerouted within 10 or 20 minutes of the freeplay injections and, in the opinion of local police officers, could have been done easily (Nuclear Regulatory Commission, 1987b, pp. 52-57). Instead, the reroutes were longer than necessary and in the case of the fuel truck, the reroute was to an area "among the most congested in the entire EPZ," according to local police officers (Nuclear Regulatory Commission, 1987b, p. 56). One of the reroutes for the fuel truck freeplay would have led people into a cul-de-sac and other dead-end roads. LILCO lives on Long Island but was unaware of the myriad roadway and traffic problems it would face should massive evacuation be necessary.

LILCO's response to criticism after the exercise was instructive. When LERO officials were asked about the deficiencies in planning alleged by Shoreham's opponents, they responded that there were no problems for two reasons. First, the information would have gotten to the necessary people "in a timely manner by other paths," although none of those paths were specified (Nuclear Regulatory Commission, 1987b, p. 4). Second, "following the Exer-

cise, steps have been taken to improve further both the Plan and Procedures and LILCO's training program as they relate to dealing with road impediments" (Nuclear Regulatory Commission, 1987b, p. 4). The steps are not detailed, but as we shall see, it would be quite predictable if they consisted primarily of adding more levels of authority, more units, and more personnel. The emergency organization, LERO, was a striking example of believing in the document that promises to surmount all problems. Believing the fantasy, LERO would then work from rational bureaucratic prescriptions that were likely never to work the first time and that could not have been modified by continued use. Belief in the evacuation of Long Island in a few hours time went hand in glove with belief in the faultless operation of endless bureaucratic layers and channels.

LILCO judged its response to the impediments a success. "It is apparent," LILCO officials said,

> that in large measure LERO demonstrated its ability to respond to roadway impediments during an evacuation of the Shoreham EPZ. This is true even though the LERO organization had never practiced responding to such *extremely severe* accidents that blocked entire roadways and thus required not only actions to remove the impediment but also actions to ensure that evacuating traffic was not unnecessarily impeded. (Nuclear Regulatory Commission, 1987b, p. 19, emphasis added).

Severe accidents of this sort, of course, are uncommon but far from rare on crowded Long Island roads even in such beautiful weather and low traffic volume as they enjoyed on the day of the exercise. (A summer day, with thousands of tourists near the beaches, or a winter storm day, would be something else.) Had there also been a nuclear accident and hundreds of thousands of vehicles on the roads, "extremely severe" accidents would possibly be commonplace.

Another, less ambitious, exercise was carried out in June of 1986, about 4 months later. We haven't the space to detail the problems and successes of that exercise, except to note that there were still substantial problems in responding to the road impediments. "Overall response," said one evaluating organization, "by the participants can be classified as poor; however, due to the nature of the drill and the participants, this was not totally unexpected" (Impell Corporation, 1986). What the evaluator means by "the nature of the drill and the participants" is that many of the personnel were new and so had not been involved in previous exercises. LERO's problems would never be solved and its fantastic promises would never be believed.

It is important to note that we have hardly exhausted the failures exhibited in the exercise. In fact there were many, many more failures and there were many, many more types of failures. It is also important to note that most of those failures could easily have made a huge difference in a real emergency. Our high technology systems, because of their highly interactive and tightly coupled nature, are fraught with potential for small failures to cascade into or combine with other failures and bring down the whole system (Perrow, 1984).

ORGANIZATIONAL FAILURE AND FANTASY DOCUMENTS

Although FEMA resolutely judged the exercise a success, a three-judge panel ruled otherwise and threw the quality of LERO's preparation into doubt. The question became moot when the plant was shut down and the reactor turned off. No one can be sure how much LILCO's poor performance in the exercise contributed to the final judgment, but we think it was considerable. The three judges in no way could be considered enemies of nuclear power, and their finding that the company was unprepared after years of preparation for a test that can only be called a very low hurdle must have counted for a lot. Why did LILCO fail when so much was at stake?

Opponents of Shoreham concluded that LILCO could not follow its own plan and that the reason it could not was that the organization itself, in myriad ways, was incompetent. It is tempting to come to a similar conclusion for there *is* evidence of poor training, thoughtless response, and ill-conceived procedure. Yet the "incompetent organization" theory rests, finally, on the premise that LILCO was exceptional, that it was singularly without good leaders, smart workers, and acceptable procedures for learning from its mistakes. We do not think LILCO was a particularly incompetent organization, off our organizational theory and performance map, so to speak. Our research and experience (we both lived on Long Island for some time) confirm that LILCO has made its share of mistakes, even disregarding the Shoreham station. But those mistakes were not extraordinary in either their frequency or severity. Nor can lack of preparation or expertise explain LILCO's failure. Indeed, quite the opposite. The question is how could it have failed given its preparation and expertise? The utility had been involved in the Shoreham project for more than 20 years, which is certainly sufficient time to learn some technical lessons about nuclear design and disaster preparation, to learn some political lessons about risk communication, and to learn some coordination lessons about organization. And, as noted, the exercise we spent the most time analyzing was only one in a series of exercises, albeit an important one, so that there were opportunities for organizational learning. In addition, FEMA, the DOE, and the NRC were highly committed to seeing Shoreham open (keep in mind that *no* nuclear plant had been blocked by local opposition) and so lent their own extensive expertise to the project. Not only was LILCO itself a competent organization but it was surrounded by competent organizations that supported the opening of Shoreham.

Nor can we attribute the failures to lack of commitment. Although we concede the possibility that LILCO failed because the exercise was not "the real thing," we think there is overwhelming reason to think otherwise. The plant cost $5.5 billion to construct, and though it is certainly true that the utility could, indeed did, pass that cost on to consumers, utility executives were not so powerful that they could simply ignore such a huge investment. Moreover, LILCO decision makers, like everyone else, knew that Shoreham's opening would be much more likely if the exercises were a big success. Were the exercises to fail, as we have seen they did in important ways, Shoreham's

opponents would argue that LILCO could not control a large evacuation and if that could not be demonstrated, then it would be very difficult to grant the plant a full-power license. Perhaps the best reason to think that LILCO took the exercises seriously was the simple fact that everyone was watching: courts, lawyers, social protest groups, the media, local governments, banks, and the general public. It was not only in LILCO's best interest to do well under such conditions, it was LILCO's *only* interest.

We think that the repeated failures in all areas of the exercise were due to a logic that is required of our risky systems. It runs as follows: We increasingly depend on systems that have catastrophic potential. A few actively oppose those systems, and a common response to that opposition is to produce plans that promise personnel, equipment, and organization that will respond effectively to severe emergencies. The plans are "fantasy documents" and they have some interesting characteristics. They emanate from systems that are either new (such as nuclear power) or newly scaled up (oil shipments from the Alaskan slope), and thus the historical record is absent or unrepresentative. This absence removes what might otherwise function as a reality check, because we do not know how such a system will behave under stress. Moreover, even if we had some experience with the behavior of comparably risky systems, the plans must be designed to cover a wide range of particular accidents, and each accident may be different enough to be off the plan's map. This leads to the absence of a second reality check: Each accident is unique, and plans cannot cover everything.

Next, fantasy documents are designed to be maximally persuasive, because regulators, lawmakers, and the opponents of the system must be assuaged as much as possible. Thus do the plans make the most benign assumptions about the environment. Fantasy documents such as the exercise plan for evacuating Long Island specify relevant actors and the story lines those actors are supposed to pursue. Fantasy documents describe the scenery, necessarily neglecting much as they construct the organizational stage upon which the fantasy will presumably work itself out. Fantasy documents detail the timing of assault, of reaction, and of recovery: when the disaster will strike, and how, and when—never if—the all clear will sound.

One important consequence of fantasy documents is that they license persuasion of employees. The employees, of course, want to believe that it is impossible for their Russian reactor to explode, for the booster rocket joints to fail, and so on. The organization encourages them to believe so with the fantasy documents. Thus the people with the most experience with the organization they give their lives over to are not encouraged to bring that experience to bear upon the credibility of the fantasy document.

One of the best pieces of evidence for the self-deceiving character of fantasy documents was the organizational structure of LERO. In the organizations literature, "span of control" refers to the number of subordinates that a superior is responsible for and encompasses the variety of functions those subordinates must fulfill. There is no optimal span of control, chiefly because whether an organization functions well or poorly with a certain span depends on the nature

of the task. If the jobs of subordinates are routine, easily monitored, of a similar function, and not interdependent, a fairly large span of control, between 10 and 30 even, can be quite acceptable. But when the tasks are nonroutine, when performance checks are difficult to execute, when there is variation in the tasks, and most especially if there is a high degree of interdependence between the tasks, then a very small span of control, between 2 and 5 perhaps, is appropriate. The Director of Local Response, the head position in LERO, had only two positions directly reporting. But the Lead Communicator, which was an important node of information coordination, was responsible for 13 people in five separate departments. There was substantial variation in the tasks of the departments. The span of control in that case was clearly inappropriate and helps explain why there was a delay of 4½ hours before the state of Connecticut was notified of the "disaster." Similarly, the Ambulance Coordinator would have been responsible for 256 emergency response personnel; the Radiation Health Coordinator had responsibility for 200 positions with a variety of functions attached to them (Nuclear Regulatory Commission, 1987a, pp. 192-198).

LERO's organizational structure was that of a conventional, centralized bureaucracy, which we know is appropriate only when operations are continuous, when tasks are routine, when social environments are stable, and when technologies are clear. Bureaucratic organizations such as LILCO are structured to accomplish some tasks efficiently and effectively but not others. Routine, predictable demands provide organizations opportunities to learn because they happen in similar ways over time. Because the tasks and even problems with the tasks recur, organizations can write procedures, even manuals, for how best to respond. Recall LILCO's demurral that it had not prepared for an accident involving a truck that completely blocked traffic. Such an accident was "extremely severe" to LILCO, yet it was not to fire and police departments or to a wrecker service with large tow trucks. To create highly successful plans, organizations require that the problems for which they are planning recur on a more or less regular basis. Absent such recurrence, they cannot build the structural mechanisms that permit successful response. It is easy to see that LERO, and the problems LERO would face, bore no resemblance to such conditions. It would operate rarely (indeed probably only once), the emergencies to which it would respond would be anything but routine, the social environment would be like nothing LERO had known, and the technologies for responding to a nuclear meltdown, while intelligible in the abstract and beforehand, would likely become confusing and ambiguous as a nuclear disaster proceeded (Erikson, 1994).

It is unlikely that an organization with the experience of the Long Island Lighting Company would establish a profit-making subsidiary with anything like this unwieldy structure. What the long lines of communication and the gigantic spans of control and the unspecified terms of interactions between groups represent is a pledge, a promise, a paper demonstration that every effort is being made to ensure proper communication, rapid response, traffic route awareness, dosimetry skills, and more.

When fantasies are proffered as accurate representations of organizational capabilities, then we have the recipe not only for organizational failure but also for massive failure of the publics those organizations are supposed to serve. Fantasy documents normalize danger by allowing organizations and experts to claim that the problems are under control. Complex, highly interactive systems increasingly insinuate themselves into society. The justifications that attend those systems often mask the failures we need to see more clearly.

NOTES

1. Actually, it is still dying. The Nuclear Regulatory Commission allowed the Long Island Lighting Company to powerup the plant to 5% of its capacity, contaminating the core and creating a huge amount of radioactive waste.

2. On natural disasters, see Kreps (1984), and Quarantelli and Dynes (1977). On technological disasters, see Perrow (1984), and Sagan (1993).

3. It also often suffers from the problem of sampling on the dependent variable, a methodological problem that has not received the attention it deserves.

REFERENCES

Clarke, L. (forthcoming). *Controlling the uncontrollable.*

Erikson, K. (1994). *A new species of trouble.* New York: Norton.

Federal Emergency Management Agency. (1986). *Post exercise assessment: February 13, 1986.* Exercise of the Local Emergency Response Organization (LERO), as specified in the LILCO Transition Plan for the Shoreham Nuclear Power Station, Shoreham, NY, April 17.

Impell Corporation. (1986). Drill report for June 6, 1986 for LERO facilities, ECO, ENC, and Riverhead staging area. Attachment 7 in USA, NRC, Docket No. 50-322-OL-5, March 20, 1987, Regarding Contention EX 50, Training of off-site emergency response personnel, October 31.

Kreps, G. A. (1984). Sociological inquiry and disaster research. *Annual Review of Sociology, 10,* 309-330.

McCaffrey, D. (1991). *The politics of nuclear power.* Boston: Kluwer.

Meyer, M., & Zucker, L. (1989). *Permanently failing organizations.* Newbury Park, CA: Sage.

Nuclear Regulatory Commission. (1983). *Before the Atomic Safety and Licensing Board, in the matter of Long Island Lighting Company, Shoreham Nuclear Power Station* (Unit 1, Docket No. 50-322-OL-3). Emergency Planning Proceeding, Testimony of Matthew C. Cordaro, Russell R. Dynes, William G. Johnson, Dennis S. Mileti, John H. Sorensen, and John A. Weismantle on behalf of The Long Island Lighting Company on Phase II Emergency Planning, Contention 25 (Role Conflict), November 18.

Nuclear Regulatory Commission. (1986). *Emergency planning contentions relating to the February 13, 1986 exercise* (Docket No. 50-322-OL-5). In the matter of Long Island Lighting Company, Shoreham Nuclear Power Station, Unit 1, United States of American Nuclear Regulatory Commission, Before the Atomic Safety and Licensing Board, August 1, 1986.

Nuclear Regulatory Commission. (1987a). *Before the Atomic Safety and Licensing Board* (Docket No. 50-322-OL-5). Regarding Contention EX 50—Training of Offsite Emergency Response Personnel, March 20.

Nuclear Regulatory Commission. (1987b). *Before the Atomic Safety and Licensing Board, In the matter of Long Island Lighting Company* (Docket No. 50-322-0L-5) (EP Exercise). Direct testimony of Assistant Chief Inspector Richard C. Roberts, Inspector Richard Dormer, Inspector

Philip McGuire, and Deputy Inspector Edwin J. Michel on behalf of Suffolk County regarding Contention EX 41—Mobilization and dispatch of road crew and removal of impediments from the roadways during the February 13, 1986 Shoreham Exercise.

Nuclear Regulatory Commission. (1989). *Nuclear Regulatory Commission, Before the Atomic Safety and Licensing Board, In the Matter of the Long Island Lighting Company* (Docket No. 50-322-OL-5R). Regarding Contention 20, Fundamental Flaws in LILCO's Training Program, 2 February.

Perrow, C. (1984). *Normal accidents*. New York: Basic Books.

Quarantelli, E. L., & Dynes, R. R. (1977). Response to social crisis and disaster. *Annual Review of Sociology*, *3*, 23-49.

Sagan, S. (1993). *The limits of safety*. Princeton: Princeton University Press.