

Reinventing Flood Control

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*The excuse we have heard from some government officials throughout this investigation, that Katrina was an unforeseeable ultra-catastrophe, has not only been demonstrated to have been mistaken, but also misses the point that we need to be ready for the worst that nature or evil men can throw at us. Powerful though it was, the most extraordinary thing about Katrina was our lack of preparedness for a disaster so long predicted. . . . Our purpose and our obligation now is to move forward to create a structure that brings immediate improvement and guarantees continual progress.*⁶

I. Introduction

What do the following pairs of accidents have in common?

- Torrey Canyon tanker (1967) and the Exxon Valdez tanker (1989).
- The U.S.S. Greenville (2002) and the U.S.S. San Francisco (2005).
- The Challenger Space Shuttle (1986) and the Columbia Space Shuttle (2003).
- The Piper Alpha Platform (1988) and the Petrobras P36 Platform (2001).
- Hurricane Betsy (1965) and Hurricane Katrina (2005).

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⁶ *Hurricane Katrina: Recommendations for Reform: Hearing Before the Comm. on Homeland Security and Gov't Affairs*, 109th Cong. (2006) (statement of Sen. Susan M. Collins, Chairman, Comm. on Homeland Security and Gov't Affairs).

The answer is simple: In each of these cases someone, somewhere, understood that organizational and system processes were as much the cause of an initial disaster as were engineering design, construction and maintenance errors.⁷ In each case, this knowledge failed to prevent a *second* disaster from happening in the same industry.

This record suggests that we are doomed to a future in which increasingly complex organizations fail, causing unnecessary death and injury, large scale economic disruption, political haggling, and years of rebuilding. Hurricane Katrina exemplified this failure to learn from the past, and the odds are good that the future will provide yet more tragic examples of this syndrome. We may be doomed to repeat these failures, even though preventing disasters is cheaper than recovery. We *may* be doomed to this future -- despite the fact that we know that technological failures virtually always occur within the context of management failures, and despite the growing body of literature that describes management concepts that could reduce large scale failure.⁸ But planning for disaster seems to challenge our organizational capacities.⁹

We are doomed – unless. This article deals with “unless.” The investigation of the New Orleans levee failure in which all of us participated revealed that the destruction of New Orleans was a manmade disaster, caused by the organizational structures that designed, built, and maintained the New Orleans flood control system. Levees failed, not because of the unavailability of the information needed to build them properly, but because of organizational inability to act on that information. Our focus here, however, is not on what went wrong: it is on how to make things go better in the future.

Part II lays the groundwork for understanding the relationship among human error,

⁷ See, for example, Vaughan, D. (19) The Challenger Launch Decision: Risky Technology, Culture, and Deviance at NASA., Roberts, K.H., and W.H. Moore. (1993) "Bligh Reef Dead Ahead: The Grounding of the Exxon Valdez." In K. H. Roberts (Ed.), *New Challenges to Understanding Organizations*. New York: Macmillan, 157-167.

⁸ E.g., Karlene H. Roberts & Robert G. Bea, *Must Accidents Happen: Lessons from High Reliability Organizations*, 15 ACAD. MGMT. EXEC. 70 (2001); Karlene H. Roberts & Robert G. Bea, *When Systems Fail*, 29.3 ORGANIZATIONAL DYNAMICS 179 (2001); SIDNEY DEKKER, THE FIELD GUIDE TO HUMAN ERROR INVESTIGATIONS (2002); KARL E. WEICK & KATHLEEN M. SUTCLIFFE, MANAGING THE UNEXPECTED: ASSURING HIGH PERFORMANCE IN AN AGE OF COMPLEXITY (Univ. of Cal., Berkeley 2001).

⁹ As an example of what *doesn't* happen, the National Incident Management System (NIMS) Integration Center issued this alert:

All federal, state, local, tribal, private sector and non-governmental personnel with a direct role in emergency management and response must be NIMS and ICS trained. This includes all emergency services related disciplines such as EMS, hospitals, public health, fire service, law enforcement, public works/utilities, skilled support personnel, and other emergency management response, support and volunteer personnel....

Fed. Emergency Mgmt. Agency (FEMA), *Our Top Five Most Frequently Asked Questions*, NIMS Alert No. 04-006 (2006), http://www.fema.gov/pdf/emergency/nims/5_common_faqs.pdf.

Another example of the phenomenon discussed in the text: In mid March, 2005, Donald Hiett, Jr, Principal, Organizational Strategic Solutions Group, was asked by Louisiana State University (LSU) to develop a NIMS training program directed to the senior executive leadership in New Orleans to take place before June, 2006. On March 28, 2005 he was informed there was no interest by these officials in taking this training program. Donald Hiett, Jr. to Karlene H. Roberts, April 13, 2005.

technology, natural events—and the risk created by the intersection of all three. Part III examines the failure of political agencies and actors to operate coherently and interdependently, asking the reader to adopt a new perspective on the U.S. Army Corps of Engineers. Part IV assesses the prospects for preventing another Katrina. Part V makes a list of specific recommendations.

Where disasters are involved, failing to learn from the past does lead to repeating it. But we think quite a bit can be learned from the failures that lead to the New Orleans disaster. Some key lessons concern the Army Corps of Engineers. The Corps needs better funding, an institutional culture that is open to new data and new engineering practices, peer review of its flood control projects, and better oversight from Congress and the White House. It also needs to be networked with state agencies, outside stakeholders such as environmental groups, and other federal agencies.

II. Risk, Technology, and Human Errors

The first step in disaster prevention is understanding the role of human and organizational error in creating and ameliorating risk. People tend to think of risk as a physical phenomenon stemming from natural events or complex engineering projects such as a nuclear reactor. Such physical phenomena are a necessary component of risk, but they are only the starting point in addressing safety concerns. Whether a risk materializes and the extent of the harm it causes are almost always mediated by human actions. Those actions, in turn, take place inside organizations with their own histories and cultures. To understand risk, we need to see the human context as well as the physical events that cause harm. Only then can we begin to determine the appropriate response to risk.¹⁰ This section lays the groundwork for understanding the relationship among human errors, technology, natural events—and the risk created by the intersection of all three.

A. *Risks and Technological Delivery Systems*

The New Orleans flood offers a good illustration of this relationship. It represented the technological failure of inadequate flood control measures against a predictable, risky and potentially lethal event.¹¹ The collapse of the New Orleans Flood Defense System (NOFDS), and the resulting death and destruction occurred not simply because of the extreme forces of nature, but because of human and organizational errors (HOE). Indeed, precisely because the engineering parameters of flood control are so well understood, experts can increasingly focus on the role of HOE failures in causing disasters. A number of studies of Katrina have concluded that HOE failures far outnumbered engineering ones as the primary cause of the Katrina disaster.¹²

Understanding HOE failures involves an assessment of risk. Risk can be defined as a condition in which either an action or its absence poses threats of socially adverse and sometimes extreme consequences. Risk derives from acts of nature, from weaknesses of human nature, and from side effects of technology, all situations that mix complex technical parameters with the

¹⁰ For general discussions of risk standards, see Clayton P. Gillette and James E. Krier, *Risk, Courts, and Agencies*, 138 U. Pa. L. Rev. 1027 (1980); Cass Sunstein, *Which Risks First?*, 1997 U. Chi. L. F. 101 (1997).

¹¹ For an overview of the failures in planning the levee system, see JOHN MCQUAID AND MARK SCHLEIFSTEIN, *PATH OF DESTRUCTION: THE DEVASTATION OF NEW ORLEANS AND THE COMING AGE OF SUPERSTORMS* 70-86 (2006). For a summary of the storm's impact, see DANIEL FARBER AND JIM CHEN, *DISASTERS AND THE LAW: KATRINA AND BEYOND* 17 (2006).

¹² For the results of our study, see Ray Seed, et al., *supra* note 1.

variables of social behavior. Although each risk event is unique, all display commonalities that permit systemic analysis and management. These recurring properties lead to certain principles.

To begin, the acceptability of a given level of risk cannot be derived from science or mathematics; it is a social judgment. The spectrum of risk thus includes both the physical world defined by natural laws, and the human world loaded with beliefs, values, ambiguities and uncertainties. The physical world follows predictable principles of cause-and-effect. The human world, by contrast, performs more like an organism, following no set pattern, deeply intertwined with other actors, and altered by outside events and elements.

Technology mediates the relationship between the social and physical forces that gives rise to risk. In this context, it is helpful to think of technology as more than hardware; rather, it is a social system comprising many organizations, synchronized by a web of communications for a common purpose. It is energized by forces of free market demand, of popular demand for security and quality of life, and by forces of scientific discovery and innovation. We need to think in terms of a *Technological Delivery System* (TDS), a system that applies scientific knowledge to achieve society's needs and wants.¹³ A TDS consists of three primary parts: the affected public, the governments that represent the public, and the associated industry or technological enterprise. Inputs to the TDS consist of values, beliefs, technology, and other resources. Outputs consist of those that are desirable (such as flood protection) and those that are undesirable (such as floods). Thus, the provision and use of technology mediates risk. In the case of Katrina, there were critical breakdowns in all parts and levels of the TDS that determined disaster preparedness.

Put another way, technology acts like an amplifier of human performance. With the water wheel, the steam engine and the bomb, it amplifies human muscle. With the computer, it amplifies the human mind and memory. Technology also amplifies social activity, mobility, quality and length of life. It may also spawn unexpected side-effects which can lead to complexity, conflict and even chaos. Such effects produce a paradox of risk: technologies are introduced to defend against the violence of nature, or against human and organizational error, but often produce unintended and possibly dangerous consequences.

Understanding such risks, and of measures to contain them within safe limits, requires both hindsight and foresight. The past can illuminate failures and teach lessons for engaging new issues and threats. The future commands the exercise of foresight, an imaginative preparation of scenarios stirred by such questions as, "what might happen, if?" or "what might happen, unless?" Such inquiries should focus on when disasters might happen, what events will trigger them, who will suffer, and who is responsible for ameliorating the risk. Modeling becomes essential to represent all stakeholders and their inter-relationships, including both the private and the public sectors. The concept of a technology delivery system (TDS) is simply an attempt to model how the real world works.

B. The Relationship Between Technology Delivery Systems and Political Actors

Federal, state, and local governments are heavily involved in all of the technologies previously discussed and many more. With waterways, for example, the Army Corps of Engineers has predominant statutory responsibility. That accords with federal stewardship of national infrastructure, from roads, shipping channels, harbors, and canals to airplane routes and

¹³ See Edward Wenk, *Making Waves: Engineering, Politics, and the Social Management of Technology* (1995).

the Internet. The federal budget is constantly challenged to meet a spectrum of different fiscal demands, the total of which always exceeds Congressional appropriations. Reconciling this mismatch (often through tradeoffs) becomes the charge of policy-makers at the highest level, including the President of the United States and the Congress.

Often, focusing on government officials misses a major premise of democratic governance, the need for transparency and public accountability. This notion is reflected in such regulatory legislation as the National Environmental Policy Act (NEPA). Section 102(2)(C) of NEPA¹⁴ requires the government to estimate the harm that could result from technological initiatives, and also to consider the alternatives to accomplish the same goals with less harm. These environmental impact statements (EIS) are made available for public comment and possible amendment. This process makes every citizen a part of the governing process, ensuring they have a say in negotiating the question of “How safe is safe enough?”, and giving them a stake in the levels of safety and security they desire.

Those who are put in harm’s way must have a voice in what would otherwise be their involuntary exposure to risk. It is up to the federal agencies to implement this policy, but those agencies will disregard citizen input unless forced to consider it. Political actors must demand such accountability. The media can play a role in this principle too. Despite a tendency to highlight the sensational, the media can enrich popular understandings of risk by proving a backstory, describing the full cast of stakeholders and explaining the role of each in increasing or decreasing the risk to life and property of a potential disaster.

Contemporary society demands better protection against threats to life, peace, justice, health, liberty, lifestyle, private property, and the natural environment. These challenges are not new, but two things have changed—the increased potency of technology and increased media coverage. Technology amplifies both human performance and human failures, increasing the speed in which disasters can happen and their potential harm. At the same time, the media has sped up too, instantaneously covering worldwide events live, twenty-four hours a day. These two factors interact after a disaster to pressure political actors for better governance protection and better governance.

That citizens have higher expectations for disaster preparedness is legitimate, because so many modern threats are due to human and organizational errors, either in adapting technologies to meet market demand or in guarding against hazards. If human error is the potential cause of disasters, then human actors should be able to fix it. The NSF study of New Orleans levee failure the shows that the Katrina event fits that pattern. Government at all levels failed to provide security to citizens before and during the catastrophic flooding. Victims are justified in asking how this pathology of mundane levee failure developed, who is responsible, and how that knowledge can be applied to prevent a reoccurrence.

C. The Engineering Response to “How Safe is Safe Enough?”

The engineering profession has long understood the need to respond to, and prepare for, human and organizational errors. Their techniques can illuminate aspects of safety preparedness and point the way toward designing human organizations capable of minimizing risk.

Engineers have traditionally safeguarded their projects through the technique of overdesign, a practice of compensating for uncertainties in loading, in materials, in quality of

¹⁴42 U.S.C. 4321 et seq.

construction and maintenance, etc. This may be accomplished by adopting some multiple of loading as a margin of safety ranging from 1.4 to 5.0 and even greater. How these margins are set is of critical importance, especially when tradeoffs with cost, deadlines, or other compelling factors may compromise the intended reduction of risk.¹⁵

This method of safety assurance is more readily applicable to design of mechanisms not subject to human and organizational errors. The term “errors,” incidentally, is shorthand for a broad spectrum of individual and societal weaknesses that include ignorance, blunder, folly, mischief, pride, lack of competence, greed, and hubris. Protecting structures against violence of nature such as earthquakes, volcanic eruptions, tsunamis, floods, landslides, hurricanes, pestilence, droughts, and disease may utilize the concept of over-design, based on meteorological, hydrological, seismic and geophysical data of past extreme events.

Today, two basic aspects of Risk Assessment and Management (RAM) are addressed by engineers. The first and most prevalent addresses natural (inherent) and technical (modeling, parametric, state) uncertainties. These factors of safety are derived from two fundamental approaches: history and explicit evaluations of uncertainties.

The second aspect of risk, not traditionally included explicitly in RAM, is associated with HOE and frequently termed the “non-technical” aspect. Quality assurance and quality control are two examples of management processes used to help assure that errors and defects are held to acceptable levels throughout the life-cycle of the system. But experience developed during the past two decades clearly shows that many more important approaches and strategies must be used to successfully address HOE. Reducing HOE is a key goal of our proposals. One important source of HOE, of course, is failure to properly evaluate the technical risks of a project – something that was key to the Corps’ failure in New Orleans.

Thus, modern RAM consist of two primary approaches to achieve acceptable safety: factors of safety, and human and organizational measures. The flooding of New Orleans clearly shows why both aspects are important. Investigations of the flood control failures show that the vast majority of water that inundated the city washed through unanticipated breaches in the flood protection system. These failures, in turn, were firmly rooted in HOE. A “factor of safety” is generally a design feature that compensates from uncertainties about the potential loading and also potential errors in construction and maintenance. But the factor of design is meaningless unless (a) the design takes into account available knowledge, and (b) construction and maintenance is professionally competent and hence involves a manageable level of risk.

An important example of the irrelevance of numerical factors of safety in the absence of these conditions is the failure of the 17th Street drainage canal flood wall in New Orleans. Based on video recordings, reports by residents, and tests of the evolution of the failure, the NSF team was able to reconstruct what happened early in the morning of August 29th. Winds blew over the large oak trees growing near the top of the levees that should never have been allowed to grow there. The trees’ root balls ripped out significant parts of the levee toe connected with underground seepage, a defect which also should have been corrected earlier. A vertical joint opened up at the joint between two sections; the joint should not have been weaker than the segments it connected. At this point, a deep breach opened. As the water continued to rise, the

¹⁵ For a good introduction to margins of safety and how they are set, see Henry Petroski, *To Engineer is Human: The Role of Failure in Successful Design* 98-106 (1982).

walls leaned, opening more breaches. In the end, the levee, floodwall and supporting sheet pile were displaced laterally toward nearby homes by more than forty-five feet.

The fundamental flaw was that the levee was built on unstable soil. Examination of early maps of the area revealed that bayou tributaries had crossed the canal at the point of failure. These tributaries were filled with very soft soil that was buried by landfill before the levee was built. The Corps did not use sufficient boring samples to detect the variations in soil stability. Further, the Corps built the levee to a very minimum standard of safety (1.3) on experience with rural rather than urban topography – that is, use of a design strength 1.3 times greater than the maximum expected loading. This margin of safety was too small given the high human and economic costs of a levee failure in New Orleans. And there were other flaws. Field tests performed in 1965 should have warned the Corps that the levee itself was having a dangerous effect on underlying soil strengths. Even earlier, geologic tests performed by the Corps indicated the treacherous nature of the soil conditions. And the tops of the floodwalls were almost two feet lower than projected because of subsidence. Even when surveys in 2004 clearly showed that the floodwalls were not high enough, no corrective action was taken. Thus, the design was not based on best available information.

So, the conditions that led to the failure were clearly foreseeable. But they had not been foreseen. As one engineer in charge of one of the investigations put it, “We did not connect the dots.” The question, is why not? In our efforts to answer this question, the HOE aspects of the levee failure became clear to our team. The compounding effects of flawed decisions were evident. Ignoring early warning signs was pervasive. Breakdowns in communication, rejection of information, diffusion of responsibility, and in some cases, neglect, were evident. Other important HOE included failures of foresight, organization, funding, management, and risk assessment. These were the root causes of the failure of the 17th St. canal floodwall. It might have helped if the Corps had used a higher numerical margin of safety, but the key problem was the failure to anticipate and correct human error inside the Corps as well as elsewhere.

Learning from documented failures is a powerful method for reducing risks of repeated losses. Another method is to learn from close shaves. Many dangerous events fortunately culminate in only an incident rather than an accident, but the repetition of similar incidents can serve as early warnings of potential catastrophic failure. Indeed, the practice of systematically logging and analyzing such “near misses” on the nation’s airways partially accounts for commercial aviation’s impressive safety record. A system for reporting close encounters of aircraft was installed decades ago. Anticipating the possibility that airlines might be reluctant to blow the whistle on themselves, many years ago the Federal Aviation Administration arranged for NASA to collect incident data and to redact it to protect the privacy of the incident reporter. NASA also screened reports to identify patterns that could provide early warnings of dangerous conditions.¹⁶ Similar systems are in place for reporting nuclear power plant incidents. Learning from mistakes allows us to improve designs so as to maintain the desired level of safety.

Giving the growing recognition of human factors in accidents, the NSF team decided to examine a class of situations where uncommonly high risks were met with startlingly good safety records. In the Navy, for example, high risks are a part of the daily operations of submarines and aircraft carriers. Yet accident rates are paradoxically low.¹⁷ Careful analysis of these situations

¹⁶ [cite]

¹⁷ [cite]

shows that certain qualities of leadership and organizational culture foster the means to prevent accidents: integrity, a sense of responsibility among all participants, a tolerance by authority figures for dissent, and consensus on common goals of safe performance. High safety performance springs from an institutional culture that is bred from the top of the management pyramid. The most critical element of that culture is mutual trust among all parties.¹⁸ Such institutions are known as High Reliability Organizations (HROs).

HROs are extremely careful in developing and sustaining a culture that rewards all of those organizational processes that result in extreme reliability and safety. Some of these processes have to do with training to insure the proper cultural configuration. Some have to do with communication and decision-making. Decisions often have to be made in a fast-changing environment. Thus, all contingencies must be considered beforehand to reduce surprises “in the moment.”

Long experience with military and paramilitary organizations such as first responders proves the value of rehearsals to reduce risks and control damage. Satisfactory communication is an essential element of such operation—and rehearsal operations often shown that communication is the weak link in disaster response. So too do post-accident analyses of real events, where delays or missteps in the communication of warnings and rescue operations cost lives.¹⁹

Often, catastrophic accidents involve interfaces between groups or organizations. Shift changes are a notorious example: serious accidents can occur when an outgoing shift fails to communicate effectively to the next shift about anomalous behavior or emerging problems. Breakdowns in horizontal communications between organizational units can also serve as breeding grounds for disaster. Some researchers refer to these interstitial sources of disaster as the ‘space between’ organizations in which danger lurks.²⁰

As Katrina revealed, the flood control system has been nearly the opposite of a High Reliability Organization. Instead, it has been plagued by weak leadership, troubled integrity, group think, inattention to safety, and an inability to learn from experience. Much of the finger-pointing has been at the Corps itself, but as we will see, the organizational flaws are broader.

D. Observations on Risk Management

The most compelling imperative of life is survival. Yet the experience of living teaches that there is no such thing as zero risk. Some exposures must be tolerated as “normal,” whether in rush hour traffic or when coping with nature, human fallibility, or the unintended consequences of technology. To sum up, the context for analyzing the levee failures from Hurricane Katrina illustrates two simple but important lessons.

First, the design of precautionary measures requires inspired foresight to imagine alternative futures. All human support systems entail technology, and all technologies project unintended consequences. Analysis of risk and its control extracts lessons from past failures, although the most catastrophic events are so rare as to often frustrate projections.

¹⁸ Karlene H. Roberts, Some Characteristics of One Type of High Reliability Organization, 1 *ORG. SCI.* 160 (1990).

¹⁹ *Id.*

²⁰ See, for example, Cooper, C. and Block, R. (2006) *Disaster: Hurricane Katrina and the Failure of Homeland Security*, New York: Times Books Henry Holt.

Organizational learning is a critical component of disaster prevention. To prevent devastating accidents, organizations need to make learning a high priority; they must be alert for minor unexpected events that may be harbingers of larger risks; and they must react decisively when mistakes occur to reform the systems which made the mistakes possible. None of this comes very naturally to organizations, which often find it easier to perfect routines, optimizing their behavior under “normal” conditions but creating little capacity to detect or respond to the abnormal. Research on organizational learning finds that practices and routines in organizations develop incrementally through feedback from the organization’s environment. Organizations generally tend to be inert, adapting less than perfectly to, and falling in and out of alignment with, their environments.²¹

This stagnation is especially dangerous for organizations that deal with major emergencies such as floods, fires, and other natural and manmade disasters. Organizations that await major failures before adapting tend to enter crisis mode and find learning and response even more difficult.²² For example, following the demise of the space shuttle Challenger, NASA faced political pressures, inertia, and resource constraints that expedited some organizational changes but made other structural and cultural adjustments more difficult.²³ Furthermore, in the absence of a significant environmental change or destabilizing event, lessons learned in organizations often tend to be forgotten or misapplied.²⁴

Even worse, because of the infrequency with which major disasters occur, trial and error organizational learning processes may lead organizational members to forget lessons from past disasters. Levitt and March argue that in the case of disaster preparedness, trial and error processes lead to “pernicious learning” – organizational leaders conclude that resources designated for disaster preparedness are idle and should be applied elsewhere.²⁵ Disaster preparation calls for a different form of learning in which organizations draw on not only their own experiences, but also those of other organizations. Such network effects exist for a variety of learning processes.²⁶

²¹ RICHARD R. NELSON & SIDNEY G. WINTER, AN EVOLUTIONARY THEORY OF ECONOMIC CHANGE (1982). See also Bradbury, H., and B.M.B. Lichtenstein (2000) Relationality in organizational research: Exploring the space between. *Organization Science*, 11, 551-564. Heath C. and N. Staudenmayer (2000) Coordination neglect: How lay theories of organizing complicate coordination in organizations. In B.M. Staw and R.I Sutton (Eds), Research in Organizational Behavior, 22, 153-191. Elsevier Science.

²² Roberts, K.H., Madsen, P., and Desai, V. (2005) “The Space Between in Space Transportation: A Relational Analysis of the Failure of STS 107,” In M. Farjoun and W. Starbuck (Eds). Organization at the Limit: Lessons from the Columbia Disaster, Malden, MA: Blackwell, 81- 98

²³ HOWARD E. MCCURDY, INSIDE NASA: HIGH TECHNOLOGY AND ORGANIZATIONAL CHANGE IN THE U.S. SPACE PROGRAM (1993).

²⁴ Pabli Martin De Holan & Nelson Phillips, *Remembrance of Things Past? The Dynamics of Organizational Forgetting*, 50 MGMT SCI. 1603 (2004); James G. March et al., *Learning from Samples of One or Fewer*, 2.1 ORG. SCI. 1 (1991).

²⁵ Barbara Levitt & James G. March, *Organizational Learning*, 14 ANN. REV. SOCIOLOGICAL SCI. 319 (1988).

²⁶ See, e.g., Linda Argote et al., *The Persistence and Transfer of Learning in Industrial Settings*, 36.2 MGMT SCI. 140 (1990); Joel A.C. Baum & Paul Ingram, *Survival-Enhancing Learning in the Manhattan Hotel Industry*, 1898-1980. 44.7 MGMT. SCI., 996 (1998); Christine M. Beckman & Pamela R. Haunschild, *Network Learning: The Effects of Partners’ Heterogeneity of Experience on Corporate Acquisitions*, 47.1 ADMIN. SCI. Q. 92 (2002).

Over the past few decades, scholars from many disciplines have advocated relational or systems approaches, as opposed to reductionist approaches that study particular events and entities in isolation.²⁷ Taking a relational approach will help us identify and examine learning processes as they affect and are influenced by organizations responding to major catastrophes. The issues we discuss may occur at several different levels in organizations – the interpersonal level, the sub-unit level, or the inter-organizational level. Fortunately, we have learned a great deal about how to overcome these organizational barriers. What is needed is to instill “mindfulness” toward risks.

Second, risk management is inherently political, in the sense that it involves society’s judgments about the acceptability of risk. Different cultures have different risk tolerances, including attitudes distinguishing voluntary from involuntary risk. In a democratic society, the decision of how much risk is enough must ultimately be made through the political process.

Tradeoffs are inevitable between short- and long-range events and consequences, between safety and cost, between special interests and social interests, between who wins and who loses, and who decides. Society embraces a spectrum of values that often conflict, as with the goals of efficiency in the private sector and of sustainability and social justice in the public. Key decisions regarding citizen safety and security are made by government through public policies to manage risk. These policies dominate the legislative agenda. This mandate imposes a heavy burden on the President and on Congress, both bodies requiring access to authentic and immediate information. In our democracy, this authority should flow from citizens following the principle that those who govern do so at the informed consent of the governed. Making decisions and implementing them necessarily draws political capital, meaning the decisions ultimately come down to political power and political will.

These issues illustrate the anatomy of risk and the complexity of its management. They sound a wake-up call for those responsible for risk management to pursue a deeper understanding of risk—and for those attentive but exposed citizens to seek a voice in the decision-making process.

III. Organizational Failures and the Katrina Disaster

The risk awareness and management strategies described in Part II must ultimately be enacted by political agencies and actors who are, after all, charged with protecting the country. Yet the magnitude of organizational failures during Katrina suggests the state and federal governments are unprepared for this task. A major part of the problem is that first responder organizations, do not operate in a vacuum, but are nestled within a large number of organizations that should be interdependent with one another. This friction leads to failures. Indeed, the relationships among political actors and the Corps, among the Corps and other federal agencies, and within the Corps itself can all serve to preclude or frustrate the types of risk management strategies described in Part II.

²⁷ JAMES GRIER MILLER, *LIVING SYSTEMS* (McGraw Hill 1972); FRED A. WOLF, *TAKING THE QUANTUM LEAP: THE NEW PHYSICS FOR NONSCIENTISTS* (1980); William E. Kastenberg et al., *Shifting the Paradigm of Risk Analysis, Proceedings of the International Seminar on Nuclear War and Planetary Emergencies*, 29th Session, Erice, Italy, May 10-15.

The social science literature addresses this problem by using such concepts as *interstices*,²⁸ “interdependencies”²⁹ or the “space between.”³⁰ Failure to consider the processes that operate both within any one unit and across multiple units is failure to be ready for the next large scale catastrophe. This discussion focuses on that context, and asks the reader to take a new perspective on the Corps of Engineers.

Failure of the New Orleans Flood Defense System (NOFDS) was not caused by an overwhelming extreme natural event (hurricane wind, waves, currents, surge, etc.). While portions of the NOFDS were overtopped by Hurricane Katrina's surge and waves, our studies indicate that the vast majority of the flooding came from unanticipated and unintended breaches in the levees (many adjacent to other structures), failures in the floodwalls, and water entering through gaps (floodgates not in place) or low spots (due to subsidence and incomplete sections) in the NOFDS. The roots of these unanticipated and unintended developments were firmly embedded in Technology Delivery System flaws and malfunctions; failures of organizations and institutions; and their resource allocation processes.

We identified eight categories of TDS malfunctions that played primary roles in the failure of the NOFDS:

1) Failures of foresight: Catastrophic flooding of the greater New Orleans area due to surge from an intense hurricane was predicted for several decades. The consequences observed in the wake of hurricane Katrina were also predicted. The hazards associated with the NOFDS were not recognized, defensive measures identified and prioritized, and effective action was not mobilized to effectively deal with the hazards.

2) Failures of organization: The roots of the failure of the NOFDS are firmly embedded in flawed organizational systems. The organizations lacked centralized and focused responsibility and authority for providing adequate flood protection. There were dramatic and pervasive failures in management represented in ineffective and inefficient planning, organizing, leading, and controlling to achieve desirable quality and reliability in the NOFDS. There were extensive and persistent failures to demonstrate initiative, imagination, leadership, cooperation, and management.

3) Failures of funding: The failure of the NOFDS resulted from inadequate provision of resources based primarily on recommendations provided by the Corps followed by failure of the federal and state governments to fund badly needed improvements once limitations were recognized. In several instances, State agencies pressured for 'lower cost' solutions not realizing that these solutions would result in lowering the quality and reliability of the NOFDS. There were important deficiencies in the cost-benefit analyses used to justify the levels of protection and their continued improvement as knowledge and technology advanced.

²⁸ Martha Grabowski & Karlene H. Roberts, *Risk Mitigation in Virtual Organizations*, 10 ORG. SCI. 704 (1999).

²⁹ Chip Heath & Nancy Staudenmayer, *Coordination Neglect: How Lay Theories of Organizing Complicate Coordination in Organizations*, in 22 RESEARCH IN ORGANIZATIONAL BEHAVIOR 153 (Barry M. Staw & Robert I. Sutton eds., Elsevier 2000).

³⁰ Hilary Bradbury & Benyamin M. Bergman Lichtenstein, *Relationality in Organizational Research: Exploring the Space Between*, 11 ORG. SCI. 551 (2000); MARTIN BUBER, I AND THOU (Walter Kaufman trans., Scribner's Sons 1970).

4) Failures of diligence: Forty years after the devastating flooding caused by Hurricane Betsy, the flood protection system authorized in 1965 and founded on the Standard Project Hurricane (SPH) was not completed. The concept and application of the SPH was recognized to be seriously flawed, yet there were no adjustments made to the system before Katrina struck. Early warning signs of deficiencies and flaws persisted throughout development of the different components that comprised the NOFDS and these signs were not adequately evaluated and acted upon.

5) Failures of trade-offs: The history of this system was marked by a series of flawed decisions and trade-offs that proved to be fatal to the ability of the system to perform adequately. Compromises in the ability of this system to perform adequately started with the decisions regarding the fundamental design criteria for the development of the system, then were propagated through time as alternatives for the system were evaluated and engineered. Design, construction, operation, and maintenance of the system in a piecemeal fashion allowed the introduction of additional flaws and defects. Efficiency was traded for quality, reliability, and effectiveness. Superiority in provision of an adequate NOFDS was traded for mediocrity and getting along.

6) Failures of management: Requirements imposed on the Corps of Engineers by Congress, the White House, State and local agencies, and the general public have changed dramatically during the past three decades. Defense, re-construction, maintenance, waste disposal, recreational, emergency response, ecological restoration have served to divert attention from flood control. Public and Congressional pressures to reduce backlogs of approved projects, improve project and organizational efficiency (down-sizing, out-sourcing), address environmental impacts and develop appropriations for projects have served to divert attention from engineering quality and reliability of flood control. Engineering technology leadership, competency, expertise, research, and development capabilities appear to have been sacrificed for improvements in project planning and controlling.

7) Failures of synthesis: While individual parts of a complex system can be adequate, when these parts are joined together to form an interactive-interdependent- adaptive system, unforeseen failure modes can be expected to develop. These unforeseen, but foreseeable, failure modes did develop in the NOFDS during hurricane Katrina. It is evident that insufficient attention was given to creation of an integrated series of components to provide a reliable NOFDS. Synthesis was subverted to decomposition. As a result, many failures developed at interfaces in the NOFDS.

8) Failures of risk assessment and management: The risks (likelihoods and consequences) associated with hurricane surge and wave induced flooding were seriously underestimated. There was inadequate recognition of the primary contributors to the likelihoods and consequences of catastrophic flooding. Sufficient defensive measures to counteract and mitigate these uncertainties were not deployed. Factors of safety used in design of the primary elements in the NOFDS were insufficient. Quality assurance and control measures invoked during the life of the system failed to disclose critical flaws in the system. Inappropriate use was made of existing engineering technology available to design, construct, operate, and maintain a NOFDS that would have acceptable quality and reliability. Deficient risk management methods were used to allocate resources and impel action to properly manage risks. Risk management

failed to employ continuing improvement, monitoring, assessment, and modifications in means and methods which were discovered to be ineffective.

As Houck observes:

So What Do We Do? Here is what we know. It is not just the tire, it's the car. And it's not just the car, it's the driver. Nothing in the system has made a numero uno priority either of protecting New Orleans from hurricanes or to restoring or even hanging onto -- the Louisiana coast. We have a flood control program, a navigation program, a permitting program, a coastal management program, a flood insurance program, a coastal restoration program - just for openers - and they do not talk to each other. They are riddled with conflicts, basically headless, basically goal-less, weakened by compromises and refuse outright to deal with first causes and first needs.³¹

The key phrases here are “and they do not talk to each other” and “[t]hey are riddled with conflicts, headless, basically goal-less...and refuse outright to deal with first causes....”

In reaction to the organizational liquefaction that developed during Hurricane Katrina, the Senate Committee on Homeland Security and Governmental Affairs recommended:

The Corps and local levee sponsors should immediately clarify and memorialize responsibilities and procedures for the turn-over of projects to local sponsors, and for operations and maintenance, including, but not limited to procedures for the repair or correction of levee conditions that reduce the level of protection below the original design level (due to subsidence or other factors) and also emergency response. It must always be clear - to all parties involved - which entity is ultimately in charge of each state of each project. The Corps should also provide real-time information to the public on the level of protection afforded by the levee system. A mechanism should be included for the public to report potential problems and provide general feedback to the Corps.³²

A. The Office of the President, the Congress, and the Corps

Other things happen at interstices. The interfaces between the Corps and its political masters, Congress and the President, are particularly troublesome. The primary interactions between these entities involve funding. During the preparation of the NSF Report, we gathered information about funding requests from the President and ultimate Congressional budgeting. Figure 1 shows the Presidential and Congressional budget requests and Congressional recommendations for Corps of Engineer funding for 1975 through 2005 for the hurricane flood defense projects of Lake Pontchartrain and the vicinity.

³¹ Oliver A. Houck, *Can We Save New Orleans?*, 19 TUL. ENVTL L.J. 1 (2006).

³² Senate Comm. on Homeland Security and Governmental Affairs, U.S. Senate, *Hurricane Katrina: A Nation Still Unprepared* (2006).

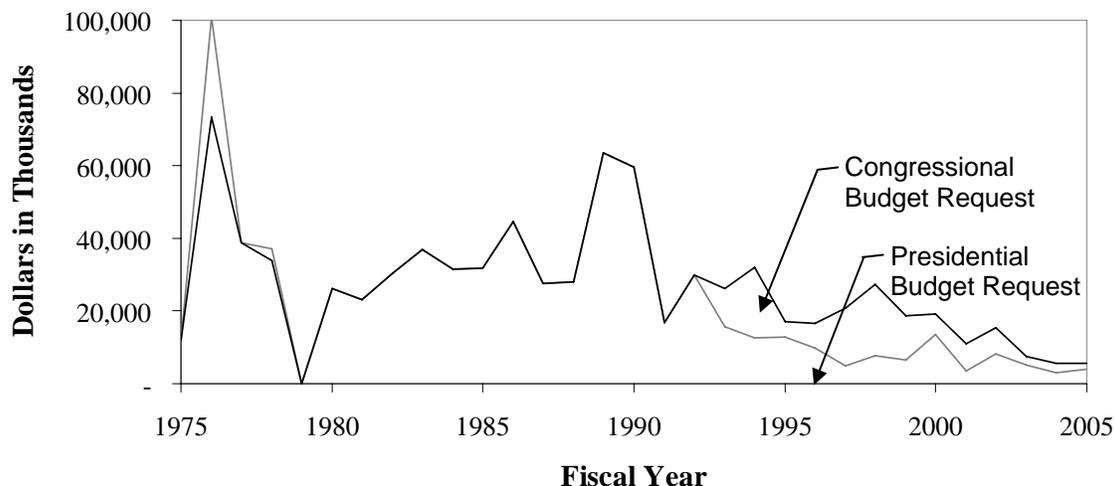


Figure 13.1: Lake Pontchartrain and Vicinity Project Construction Appropriations Over the Past 30 years [2005 dollars]; President’s Budget Request (grey) and the Amount Recommended by Congress (black).

Several inferences can be gleaned from this information. First, it appears that while the president was trying to reduce Corps funding, Congress was trying to protect it. With only 60% of the Lake Pontchartrain projects complete as of 2005 (40 years after authorization), it may be that Congress, in its wisdom, decided to fund only what it thought needed to be completed. The graph shows other interesting issues about interdependencies. The Corps of Engineers is interdependent with both the Office of the President of the United States and Congress. But because Congress has funded the Corps at higher levels than those recommended by the President for the last decade, Congress wields enormous power over the Corps, often pressuring it to fund new large projects in legislators’ districts. As a result, two things happen: First, the Corps defers needed maintenance projects and instead focuses on the new projects demanded by Congress. Second, to preserve its budget, the Corps has to devote time to currying favor with Congress. Currying favor with Congress is not supposed to be a main task of the Corps.

Yet another interesting hypothesis can be derived from these data. When multi-year projects are funded annually, an interesting dilemma is created for the funded organizations. The funding oscillation level is at one level, but organizations struggling under that oscillation oscillate at a higher frequency. It is hypothesized that this is because the funded organization operates under a considerable amount of ambiguity and uncertainty. This suggests that the unpredictability of the Congressional process creates unintended and negative consequences for its funded agencies. The processes and responses to them are both schizophrenic.

This is almost surely the same as the case for NASA. The Columbia Accident Investigation Board (CAIB) report said:

The White House and Congress must recognize the role of their decisions in this accident and take responsibility for safety in the future.... Leaders create culture. It is their responsibility to change it.... The past decisions of national leaders – the White House, Congress, and NASA Headquarters – set the Columbia accident in

motion by creating resource and schedule strains that compromised the principles of a high risk technology organization.³³

Diane Vaughan reports that both economic strain and schedule pressure still exist at NASA. She notes that it is unclear how the conflict between NASA's goals and the constraints upon achieving them will be resolved, but that one lesson from Challenger and Columbia is that system effects tend to reproduce.³⁴ This also happens to military installations every time a Base Reallocation and Closing (BRAC) list is formed. From the day of its publication until the day of decisions, the installations on this list spend considerable time trying to get off the list, distracting them from their principle tasks.

In the Katrina case, will Congress and the Office of the President take a sweeping look at their own behaviors in concert with those of the Corps of Engineers? They probably will not because there is not yet a strong incentive for them to do so. One incentive might be that the cost of cleanup is always more than the cost of prevention. Money is not limitless. But since we've observed many costly past disasters that were not prevented, and many instances in which they could have been mitigated or prevented, the reality is they probably will do nothing. Thus, the challenge is to find incentives that will encourage disaster-prevention and emergency-response organizations and actors, from the President on down, to examine their own organizational skeletons, muscle, and flesh, as well as to look at the "spaces between."

B. Other External Interstices for the Corps

Three additional sorts of interfaces between the Corps and its constituents are important. The first are the interfaces between the Corps and other federal agencies that occur during and after an emergency, and that are mandated by Emergency Support Function # 3 of the National Response Plan, a federal-government-wide master plan for emergencies designed and administered by the Department of Homeland Security".³⁵

ESF #3 is structured to provide public works and engineering-related support for the changing requirement of domestic incident management to include preparedness, prevention, response, recovery and mitigation actions. Activities within the scope of this function include conducting pre- and post-incident assessments of the public works and infrastructure; executing emergency contract support for life-saving and life-sustaining services; providing technical assistance to include engineering expertise, construction management, and contracting and real estate services; providing emergency repair of damaged infrastructure and critical facilities; and implementing and managing the DHS/Emergency Preparedness and Response/Federal Emergency Management Agency (DHS/EPR/FEMA) Public Assistance Program and other recovery programs.³⁶

³³ COLUMBIA ACCIDENT INVESTIGATION BD., NAT'L. AERONAUTICS AND SPACE ADMIN. (NASA), COLUMBIA ACCIDENT INVESTIGATION REPORT (2003).

³⁴ Diane Vaughan, *Systems Effects: On Slippery Slopes, Repeating Negative Patterns and Learning from Mistakes*, in ORGANIZATION AT THE LIMIT: LESSONS FROM THE COLUMBIA DISASTER 41 (William H. Starbuck & Moshe Farjoun eds., Blackwell 2005).

³⁵ For further information about the NRP, see Farber & Chen, *supra* note x, at 53-108.

³⁶ DEP'T OF HOMELAND SEC., NATIONAL RESPONSE PLAN (2004).

In responding to an emergency, the Corps can draw on the resources of 15 federal government agencies to accomplish these goals. In addition, state, local and tribal governments are “fully and consistently integrated into EFS #3 activities.”³⁷ All of this occurs, of course, when an incident or potential incident overwhelms state, local, and tribal capabilities.

The NRP concept of operations states that the DOD/USACE is the primary agency for providing ESF #3 technical assistance. It further states that close coordination is to be maintained with federal, state, local, and tribal officials to determine the potential support needs. In addition, it spells out the organizational structures for providing support, naming the Interagency Incident Management Group (IIMG) as the resource for providing on-call subject-matter experts to support IIMG activities.

Regional and field level mechanisms of support are clearly defined. ESF #3 activities are also spelled out and include such processes as:

[C]oordination and support of infrastructure risk and vulnerability assessments, participation in pre-incident activities, such as pre-positioning assessment teams,... participation in post-incident assessments of public works and infrastructures to help determine critical needs and potential workloads, implementation of structural; and non structural mitigation measures, including deploying protective measures to minimize adverse effects or fully protect resources, prior to an incident.³⁸

In the wake of Hurricane Katrina, neither the Corps nor any other agency was fully successful in rolling out the NRP. If the integration required by this plan is too difficult for agencies to implement, then it is the duty of the agencies and their oversight agencies (e.g., DOD, DHS, HHS, etc.) to indicate this and to develop strategies to revise the NRP to create a workable plan and document. Lee Clarke discusses at length “fantasy plans” that look a lot like the NRP.³⁹ Thus, a last word on integration across agencies:

From the vantage of preparedness, the failed response to Hurricane Katrina did not undercut the utility of “all-hazards” planning. Rather, it pointed to problems of implementation and coordination. This suggests that in the aftermath of the event, we are likely see the redirection and intensification of already-developed preparedness techniques rather than a broad rethinking of the security question.⁴⁰

Given our experiences with accident response, it is this team’s conclusion that, without substantial leadership and reorganization, neither comprehensive technical nor social reforms will likely soon be developed to address future natural or man-made catastrophes.

The second set of interfaces that need to be considered are those created by the Corps’ need to “outsource” many functions (e.g., the hiring of outside, private firms and/or individuals to perform work, including engineering design and construction.) The federal government has imposed this requirement on the Corps through the White House Office of Management and Budget and through Congressional actions. In reviewing this mandate with current Corps of

³⁷ Id.

³⁸ Id.

³⁹ LEE CLARKE, MISSION IMPROBABLE: USING FANTASY DOCUMENTS TO TAME DISASTER (Univ. of Chicago 1999).

⁴⁰ Andrew Lakoff, *From Disaster to Catastrophe: The Limits of Preparedness*, Understanding Katrina: Perspectives from the Social Sciences, <http://understandingkatrina.ssrc.org/Lakoff> (last visited May 15, 2006).

Engineers personnel in multiple settings and in private briefings, our team has concluded that outsourcing and partnership efforts have threatened the Corps' key engineering competencies (practicing, research, development). These competencies were sacrificed under pressures to outsource, to improve project management, and to develop environmental restoration and mitigation capabilities, all within a finite overall budget and resources.

This is not to say that such partnering holds only disadvantages. On the contrary, crucial operational benefits can accrue from partnering. An agency can learn new concepts from partners, perhaps through access to best-of-class processes. Partnered competitors perhaps can learn technology secrets from one another. When industry benchmarks aren't well known, partnering with a competitor can offer insights on an organization's productivity, quality, and efficiency.

But there are also obvious disadvantages to partnering. Lack of control is a critical disadvantage. The demise of ValuJet, for example, happened because the company outsourced cargo handling to a company it had no control over in terms of quality standards. In another form of outsourcing, competitors learn from each others' operations, which may be detrimental to one or more partners. Mutual trust is a chronic problem. A new company board for one of the partners may not approve of the other partner. The strategic aims of partners may change mid-stream, causing failure. These are just some of the reasons for outsourcing failures.⁴¹ The Corps needs to examine its partner relationships, asking if it has lost too much.

One of the Corps' sister agencies in times of chaos, FEMA, has also created problems by outsourcing its disaster response efforts.

For example, when the Nisqually earthquake struck the Puget Sound area in 2001, homes that had been retrofitted for earthquakes and schools with FEMA funds were protected from high-impact structural hazards. The day of that quake was also the day that the new president, G. W. Bush, chose to announce that Project Impact would be discontinued. Funds for mitigation were cut in half, and those for Louisiana were rejected. Disaster management was being privatized, with the person who was to be promoted to head the agency, Michael Brown, saying at a conference in 2001, "The general idea—that the business of government is not to provide services, but to make sure that they are provided—seems self-evident to me." The administration tried to cut federal contribution for large-scale natural disaster expenditures from 75 percent to 50 percent.⁴²

D. The Corps' Internal Interstices

Two other organizational processes also result in lost institutional memory and loss of control. They are downsizing and retirements. Figure 2 shows that the Corps is also losing employees through retirements.

⁴¹ Karlene H. Roberts & Daniel Wong, *Outsourcing and Temporary Workers*, in *ENCYCLOPEDIA OF INDUSTRIAL/ORGANIZATIONAL PSYCHOLOGY* (Steven Rogelberg ed., Sage 2006).

⁴² Charles Perrow, *Using Organizations: The Case of FEMA*, Social Science Research Council Forum, <http://understandingkartina.ssrc.org> (last visited Apr. 21, 2006)(internal references omitted).

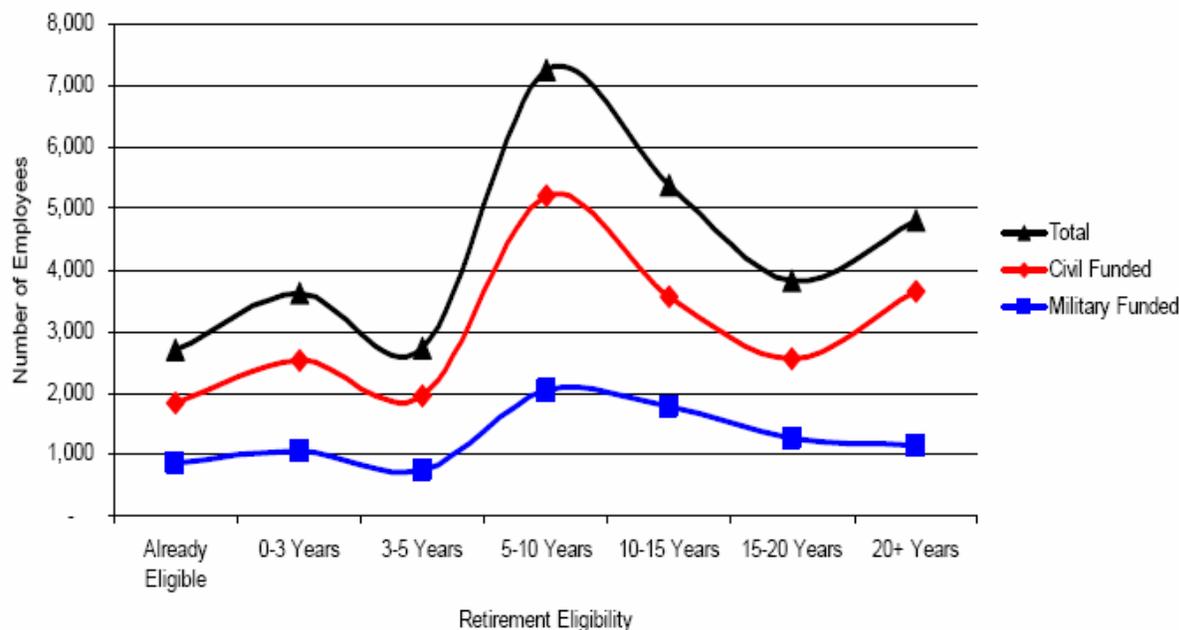


Figure 2: Human Capital Planning Projected Retirement (the Corps 2002).

In 2002, between 35 and 40 percent of architecture and engineering work was outsourced to private firms, while all construction projects were outsourced.⁴³ The simultaneous operation of the three processes (outsourcing, downsizing and retirement) has been and will be disasters for the Corps. Retirements, downsizing, and outsourcing are interdependent in terms of the problems they cause for organizations. Again, the causes are probably buried in not only the Corps activities, but in the Corps' relationships with its external constituencies.

New approaches to organizational failure examine the degree to which organizations are internally stove-piped. Figure 3 shows that the Corps' organizational structure might lend itself to this. It appears that regions and districts act autonomously to a large extent.

⁴³ United States Army Corps of Engineers, USACE Strategic Workforce Planning, *USACE Command Brief*, <<http://www7.nationalacademies.org/ffc/usace.pdf>> (Mar. 30, 2006).

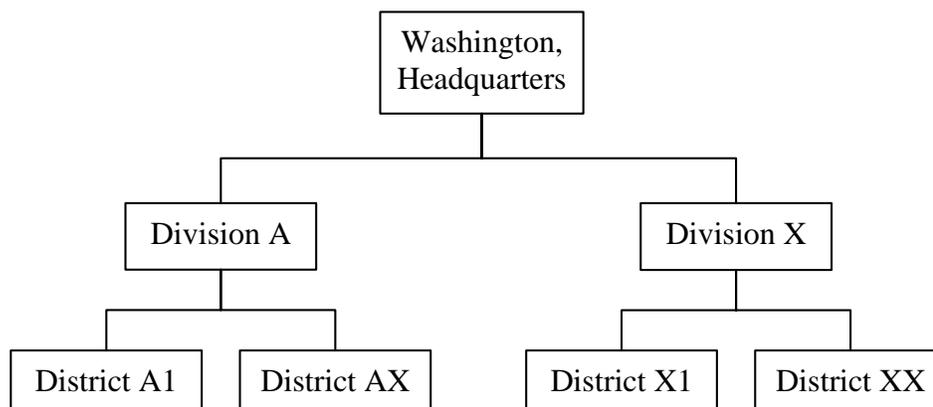


Figure 3: Conceptual Organizational Chart of the U.S. Army Corps of Engineers Civil Works Program.⁴⁴

In addition Houck observes:

...restoring coastal Louisiana is a national issue and will require remedies beyond this state. We lie at the receiving end of a large watershed, and some of what we need has been turned off and other stuff that is hurting us has been turned on. The Corps districts need to talk to each other. The EPA has to step up to the plate, upstream states have to change some habits too. If the nation's taxpayers are going to be asked to spend more money than America spent on the Marshall Plan to fix all of post-war Europe, then they have a right to expect a national effort.⁴⁵

McCurdy discusses how stove-piping existed when NASA was created. Today, the adverse results of NASA's stove-piping are excessive unit independence, specialization, and neglect of mutual coordination in a situation that should be characterized by just the opposite.⁴⁶

All in all, the Corps' ability to do its job has been organizationally handicapped. It has lost engineering and research and development capabilities; it has lost its ability to maintain old projects; it fails to be appropriately interdependent with various constituencies; and it fails to act effectively on issues of internal interdependence. And, it cannot get well on its own.

⁴⁴ The Corps Civil Works Program is composed of 8 Divisions and 38 subordinate districts. Prime Power, ERDC, Centers, and FOAs are not shown for clarity. In addition, a 9th provisional division with four districts was activated January 25, 2004, to oversee operations in Iraq and Afghanistan. A more complete organizational chart is available in *USACE 2012 – Appendix G, Resource Analysis*, page 1.

⁴⁵ Houck, *supra* note 32.

⁴⁶ Karlene H. Roberts, et al., *The Space Between in Space Transportation: A Relational Analysis of the Failure of STS 107*, in *ORGANIZATION AT THE LIMIT: LESSONS FROM THE COLUMBIA DISASTER 81* (William H. Starbuck and Moshe Farjoun eds., Blackwell 2005).

IV. Preventing the Next Katrina

In virtually all human affairs, risk is normal. But the consequences of neglect may be grave. As we indicated in the beginning of this article, we are skeptical that those with the power and resources to prevent the next Katrina will take the steps necessary to do so.

Nonetheless, from our larger discussion about defining risk and safety in the context of human actors and organizations, three recommendations emerged. First, decision-making responsibility at the top of the authority structure should be clarified and strengthened to enhance vigilance and the management of all modes of risk. Second, Congress should hire additional technical staff to ensure federal agencies have enough resources, to manage risk, and to monitor the performance of the Executive Branch in its duties of care. Third, state and local governments should authorize new processes that would foster informed consent and dissent, provide early warnings in disaster-prone areas, and ensure that citizens at risk have access to information regarding their exposure and opportunities to participate in governance.

One central purpose should animate all the entities involved, separately and in tandem. They should address the question, “How Safe is Safe Enough?” That investigation demands foresight in the spirit of the injunction, “Without vision, the people perish.”

In addition to this larger purview, specific attention needs to be given to the Corps and the organizations with which it is interdependent. We know a great deal about how to fix problems of this nature, and there are growing bodies of engineering, legal, public policy, organizational, and other literatures that address such issues. There is also a growing pool of experts from different areas who know how to talk about such issues. The problem is that stakeholders have huge incentives not to pay any attention to such expertise. They are no more likely to address these issue than they were likely to prevent the Challenger problem from becoming the Columbia problem, or the Betsy problem from becoming the Katrina problem.

Fixing these problems – preventing HOE by bridging interstices -- will require a set of processes that affected stakeholders do not want to engage in, despite their interdependencies:

- They must come together to fashion clear and consistent goals in a politically complex and charged world.
- They must be willing to spend many years addressing such problems even as shifting political incentives lead to policy attention spans best measured in weeks or hours.
- Agencies must work together and trust one another.
- They must recognize their interdependencies as well as the interdisciplinary nature of their problems.
- They must be willing to spend money and make recipients of that money accountable for their spending.
- They must develop oversight programs and agencies with real teeth.

All of this is easier said than done. We offer some suggestions about initial steps to revitalizing the federal flood control program.

A. Re-Engineering the Corps

Fixing the Corps's technical problems will have only limited impact unless we also fix the organizational problems. The Corps must strive to become a High Reliability Organization. We have four recommendations that would go a long way toward repairing the Corp's ability to design and build effective flood control projects: (1) rebuild the Corps's engineering and R&D capability, (2) restructure the federal/state relationship in flood control, (3) develop a National Flood Defense Authority, and (4) create effective disaster planning. These recommendations are designed to break down the gaps to the flow of expertise and information within the Corps itself and between the Corps and outside experts and constituencies.

Three years before Katrina, the National Research Council concluded that the "Corps' more complex planning studies should be subjected to independent review by objective, expert panels."⁴⁷ This is an obvious point – which makes it all the more urgent to implement. In theory, independent viewpoints and expertise could be brought to bear within an internal Corps review process, and that would probably happen in an HRO. But the Corps lacks sufficient technical expertise as well as the institutional culture of constant internal criticism and learning needed for such an internal review process to be effective. The prospect of facing independent outside review can actually help an organization improve its own internal culture in this regard. Although the need for independent project review has been apparent for years, none of the past proposals have yet been implemented.⁴⁸ There is, however, some hope that congressional action on this issue will be forthcoming.

The major effort to reform the Army Corps of Engineers currently resides in the Senate version of the Water Resources Development Act (S. 728).⁴⁹ Congress normally passes a WRDA every two years to authorize new flood control and water management projects. However, Congress has not updated the WRDA since 2000. In July of 2005, the House passed its version of the WRDA update (H.R. 2864), well before Hurricane Katrina.⁵⁰ The original House version authorized \$10-12 billion in spending on new water projects, including environmental restoration on the Great Lakes, the Florida Everglades, and coastal wetlands in Louisiana.

The Senate took up the House bill on July 19, 2006, preserving most of the projects but emphasizing some critical reforms. Senators McCain and Feingold successfully added an amendment (S.Amdt. 4681) to create an independent peer review office for evaluating flood control, navigation and environmental restoration projects costing \$40 million or more.⁵¹ The peer-review panels would address all elements of the projects, including cost, engineering and design requirements, and environmental impact. They would include scientific and economic experts responsible for making formal recommendations to the Corps. A decision to ignore the panel's advice could be used against the Corps in legal proceedings.

⁴⁷ Nat'l. Research Council, *Review Procedures for Water Resources Project Planning* (2002).

⁴⁸ See also David Hosansky, *Reforming the Corps*, 13 CQ RESEARCHER (May 30, 2003).

⁴⁹ Available at <http://thomas.loc.gov/cgi-bin/bdquery/z?d109:S.728:>.

⁵⁰ Available at <http://thomas.loc.gov/cgi-bin/bdquery/z?d109:H.R.2864:>.

⁵¹ Available at <http://thomas.loc.gov/cgi-bin/bdquery/z?d109:SP04681:>. For discussion of the proposed legislation, see Felicity Barringer, *Senate Backs New Controls For Projects By Engineers*, New York Times, July 20, 2006. Brian Friel, *Lawmakers Weighing Controversial Army Corps Reforms*, National Journal, September 11, 2006

Debate over the amendment explicitly centered on the Katrina disaster, the complicity of the Corps, and the need for reform and independent oversight. Environmental groups, good government organizations, and Katrina victims advocates all endorsed the changes. However, several Senators in farm states with numerous Corps projects objected to the amendment, arguing that it would lead to costly delays in approving projects. Led by Senators James Inhofe (R-OK) and Kit Bond (R-MO), they offered their own amendment to water down the independent review and preserve most of the House's language on the issue (S.Amdt. 4682⁵²). Ultimately, the Senate approved the McCain-Feingold amendment 54-46 and rejected the Inhofe-Bond amendment 49-51

On September 19, the bill went before a joint House-Senate Conference Committee to work out differences between the two chambers' versions. The committee hopes to conclude work by October 1. However, the Republican leadership named Senator Inhofe and Representative Don Young (R-AK) as chairs of the Committee; both have been sharply critical of efforts to increase oversight of the Corps. On the other hand, the White House supports the Senate reforms. Therefore, chances are mixed whether the final bill will preserve the reforms. Congress adjourned for the fall recess without reaching agreement on S.728/H.R. 2484, the Water Resources Development Act that contained reforms of the Corps. Officials announced that the conference committee would take up the bill again when Congress reconvened after the midterms on November 13, but at this writing congressional inaction seems unlikely before the end of the session. Given the change in control of Congress in the November 2006 elections, the fate of the bill is even less predictable.

B. Rebuilding the Corps' Technical/Engineering Capacity

The Corps' engineering and R&D capabilities were degraded over the past twenty years as a result of streamlining and budget cuts (downsizing and outsourcing). As a nation, we cannot afford the loss of this expertise. Although outsourcing can be efficient in some instances, it cannot be allowed to deplete the Corps' own core expertise. The result of the outsourcing is to separate the technical experts from the individuals making the ultimate decisions, creating a gaping interstice where none needs to exist. As the National Research Council concluded, "Shifting analytical tasks to the private sector, however, has its limits, as core, "in-house" competence is necessary for the Corps to commission, manage, and comprehend the advice of external experts."⁵³

The Army Corps of Engineers must be, first and foremost, the nation's premiere expert in flood control engineering. Through no fault of its own, the Corps has been stripped of much of what it needs to perform this role. Congress must adopt a plan and allocate the necessary funds to "put the 'engineers' back into the Corps of Engineers." It must remake the Corps into the organization that new, "wet behind the ears" civil engineers will want to join to sink their teeth into their new profession. It must retain and perform sufficiently challenging engineering work to encourage these engineers to develop their careers within the Corps. It must define and perform sufficient R&D work to help support the activities of these engineers. And it must pay them adequate salaries to be suitably competitive with private industry. An agency lacking in critical technical expertise cannot be expected to engage in the kind of organizational learning so critical to HROs.

⁵² Available at <http://thomas.loc.gov/cgi-bin/bdquery/z?d109:SP04682>:

⁵³ NRC, *supra* note 46.

The Working Group for Post-Hurricane Planning for the Louisiana Coast has advanced some complementary recommendations for Corps staffing in their report, *A New Framework for Planning the Future of Coastal Louisiana after the Hurricanes of 2005*:

An essential element in enhancing the credibility and soundness of planning and implementation is an agency's internal staff capabilities. The Corps of Engineers is facing a significant loss of staff numbers and capability through retirement, just at the time that the demands for its skills are increasing. Indeed, the integrated planning process will demand a wider array of skills from the engineering, hydrologic, geological, biological and social sciences than is currently available in the agency or in federal or state agencies generally. Also, the effectiveness of the long-term program requires the institutional memory that develops within a permanent and professional staff.⁵⁴

C. Restructuring the Federal/State Relationship in Flood Defense

The Corps' relationship with local flood control entities in Louisiana is dysfunctional. Some of the issues relate to the fragmentation of the local entities, which the state has begun to address. However, a number of the issues are broader.

Often, water planning activities involve not only multiple federal agencies, but also state and local governments. In the blunt words of one observer, "The first consequence is that flood defense has no head Whatever the merits of this diffusion of authority, it does not produce coherent flood control."⁵⁵ The result is an organizational structure that goes beyond having "interstices" to having gaping chasms. Curing this problem is far from easy. One useful model may be what has been called "modularity" -- a concept which involves provisional and functional rearrangement of units in terms of alternative configurations of tools, structures and relationships.⁵⁶

The state of Louisiana has taken several useful steps to reduce administrative fragmentation. On September 30, 2006, the voters overwhelmingly approved a measure to consolidate the system of local levee boards. The amendment also requires levee boards to focus on flood control rather than other distractions, and requires appointees to have relevant expertise.⁵⁷ This effort comes on top of Louisiana Governor Kathleen Blanco's successful push in November of 2005 to create a new interagency statewide flood control authority, the Coastal Protection and Restoration Authority.⁵⁸ The CPRA is charged with drawing up a master plan to combine coastal restoration, hurricane protection, and flood control efforts at the state level, as well as to provide oversight of local levee districts. Previously, statewide flood control programs were scattered across different Cabinet positions and agencies. The CPRA also serves as the single statewide "voice" of Louisiana when dealing with the Army Corps of Engineers and other federal agencies.

⁵⁴ WORKING GROUP FOR POST-HURRICANE PLANNING FOR THE LOUISIANA COAST, UNIV. OF MARYLAND CTR. FOR ENVTL. SCI., *A NEW FRAMEWORK FOR PLANNING THE FUTURE OF COASTAL LOUISIANA AFTER THE HURRICANES OF 2005* (2006), <http://www.umces.edu/la-restore>.

⁵⁵ Houck, *supra* note 14.

⁵⁶ Jody Freeman & Daniel A Farber, *Modular Environmental Regulation*, 54 DUKE L.J. 795 (2005).

⁵⁷ Frank Donze, *Voters Merge Levee Boards*, Times Picayune (Oct. 1, 2006).

⁵⁸ Louisiana Coastal Protection, Conservation, Restoration, and Management Act, Act No. 8, 2005 La. Acts 1st Extraordinary Sess. (codified at La. Rev. Stat. 49:213.1 et. seq.).

Comprised of a 16-member panel that includes Cabinet secretaries, statewide officials, and local levee officers, the CPRA will develop a comprehensive approach to protection that includes central authority to plan, design, build, inspect, and audit new flood control measures.⁵⁹ Governor Blanco has also directed the CPRA to design a formal state policy regarding the Mississippi River Gulf Outlet, which overflowed during Katrina; create a levee district inspection program and set minimum maintenance standards; and create a memorandum of understanding that the state authority will sign with the Corps of Engineers that recognizes that the CPRA will be the lead state entity to work with the Corps on hurricane protection and coastal restoration.

Congress has directed the Army Corps' New Orleans District to initiate a 24-month endeavor, the Louisiana Coastal Protection and Restoration Project (LCPRA).⁶⁰ The project will identify, describe and propose a full range of flood control, coastal restoration, and hurricane protection measures for South Louisiana. The LCPRA is currently in the midst of drafting its first major reports. However, the LCPRA is advisory and shouldn't be considered a new "authority" in Louisiana. In the meantime, various federal authorities involved in the reconstruction of New Orleans infrastructure (including the flood control system) lack any organizational coherence.

D.. Developing a National Flood Defense Authority

A National Flood Defense Authority (NFDA) should be established and charged with oversight of the construction and maintenance of flood control systems. Following Louisiana's lead, each state would have an equivalent organization that could foster cooperation and development between and within the states. The Corps of Engineers, state flood control authorities, and technical advisory boards would work with the NFDA to foster application of the best available technology and help coordinate development and maintenance efforts and planning. Federal and state governments would provide reliable and sustainable funding for the life-cycle (design, construction, operation, maintenance) of specific flood defense systems. To facilitate coherent funding, Congressional authorization and financing would be separated from the traditional Water Resources Development Act process. Rather, the NFDA would be funded through a separate appropriations process.

The Corps of Engineers, in cooperation with other qualified agencies and industrial partners, would have the responsibility to design and construct, and if directed and authorized, operate and maintain flood defense systems. The NFDA would be based on a continuous and integrated process of flood risk assessment and management for specified flood defense systems, with each of these systems being integrated with other allied flood defense systems. Flood risk assessment and management processes would include proactive, reactive, and interactive (adaptive) approaches based on the best available proven technology. Flood defense system planning and development would engage public and industrial stakeholders and responsible federal and state agencies in a cooperative and vigilant Technology Delivery System.

⁵⁹Governor Kathleen Blanco, Speech to the Coastal Protection and Restoration Authority, January 18, 2006, available at <http://www.gov.state.la.us/index.cfm?md=newsroom&tmp=detail&catID=4&articleID=1597>.

⁶⁰ Energy and Water Development Appropriations Act of 2006, Pub. L. No. 109-103, § 1003.

Following the disastrous 1993 Midwest flooding, the federal Interagency Floodplain Management Review Committee suggested similar reforms after evaluating the performance of existing floodplain management programs. The Working Group for Post-Hurricane Planning for the Louisiana Coast has advanced similar recommendations for organization and funding in their report *A New Framework for Planning the Future of Coastal Louisiana after the Hurricanes of 2005*. This group observed:

Organizational and funding barriers that have inhibited the adoption of an integrated planning and adaptive decision making process persist. Both new organization and funding reforms are needed to support coastal planning and project implementation by the Corps and the State.⁶¹

This group proposed a model that involves better federal intragovernmental coordination with the new Louisiana Coastal Protection and Restoration Authority, and the development of a Coastal Assessment Group and a Coastal Engineering and Science Program. This model includes recommendations for programmatic authorization and funding including formation of a new Louisiana Coastal Investment Corporation and major revisions in the Water Resources Development Act appropriations process.

At the highest levels, we must also recognize that no one in the White House has the job of disaster response. Yet federal disaster response requires action by many agencies – not just FEMA but also the Defense Department, the Center for Disease Control, the Environmental Protection Agency and others. White House coordination of these executive branch activities is crucial. Just as the White House has a Council of Economic Advisors, it needs to have an official or board charged with national disaster oversight – not necessarily day-to-day management during disasters (which is FEMA’s responsibility), but rather a budgetary and policy supervision role. This official would also be in charge of monitoring organizational problems in the agencies charged with disaster prevention and response. Moreover, a natural part of the official’s portfolio would be disaster prevention efforts, where the aim should be to avoid ever again being caught unprepared for a “predictable surprise” like Katrina.

Such an integrated approach to catastrophic risk is lacking. One lesson from Katrina is that disasters are not just engineering failures, they are social system failures and failures of government. Societal infrastructures can collapse just as surely as physical ones can. Consequently, disaster prevention cannot be considered in isolation from disaster response plans, mechanisms for compensation and risk spreading, and reconstruction planning. All of these issues are tightly coupled, yet the linkages receive little attention.

Under the Constitution, Congress bears the primary responsibility for developing national policy and setting national priorities. Congress authorizes and controls FEMA, the Army Corps, flood control projects, the flood insurance program, and other aspects of our nation’s response to catastrophic risks. Yet Congress lacks the expertise needed to accomplish these tasks in a systematic way. As a result, members of Congress operate as lone wolves, seeking to maximize the benefits of individual projects for their districts, while Congress as a whole has no mechanism for evaluating risk levels and project needs.

⁶¹ WORKING GROUP FOR POST-HURRICANE PLANNING FOR THE LOUISIANA COAST, *supra* note 30.

In the Post-Katrina Emergency Management Reform Act of 2006,⁶² Congress took a step toward ensuring that it would be provided with better risk information. Section 649 calls upon the Administrator of FEMA to assess on an on-going basis the country's prevention capabilities. But this mandate has two faults. First, the primary emphasis of sections 649-652 is on response readiness, not on prevention. And of course, FEMA's primary mission is to respond to emergencies, not to assess the strength of levees or other preventative measures. Second, since FEMA is an executive agency, it will necessarily have lower credibility within Congress than an agency controlled by Congress itself. Thus, a Congressional Risk Office would be a significant improvement.

V. Recommendations – Organizing for Success

Mobilizing the political will to build an adequate New Orleans Flood Defense System (NOFDS) is the primary challenge for policy-makers. If the United States decides that Katrina's catastrophic effects must not be repeated, the necessary leadership, organization, management, resources, and public support must be marshaled. One of the primary challenges is time; the clock is ticking for this area of the United States to again confront a severe hurricane.

Our overall vision flood control is diagramed in the Appendix. We do not advocate a completely centralized bureaucracy to manage flood control. Flood control must involve the political input of both state and federal actors, because the ultimate decisions about tradeoffs must be made in a politically accountable process. Moreover, flood control issues may require multiple sources of expertise, not just the informed judgments of a single bureaucratic hierarchy. What we have in mind, then, has some resemblance to what has been called “modular regulation.”⁶³

In its ideal, modularity supposes that both the tools and governance structures for environmental regulation and resource management can be built, un-built and rebuilt—an optimistic but, we hope, compelling normative view. Thinking in this way has both a theoretical and practical payoff. From a theoretical perspective, modularity captures a moment of maturation in both administrative law and environmental law, which has yet to be named and fully described. In this moment, traditional forms of action and institutional structures give way to a “problem-focus” that calls for new arrangements. We are trying to articulate what that moment looks like, even as it is happening. From a practical perspective, we think modularity offers the potential for real, measurable improvements in environmental policy-making. We believe it can generate better-informed, more adaptive, and sufficiently accountable decisions that wind up satisfying more stakeholders more of the time.

In essence, modularity is a recognition of organizational interdependencies and of the need to insure effective information flow and learning across organizational interstices. Because different problems require different alignments of expertise and involve different stakeholders, modular structures are flexible and capable of being reassembled in new configurations.

To summarize, our specific recommendations are as follows:

Recommendation 1: *Seriously consider defining risk within the framework of federal, state, and local government responsibilities to protect citizens.* For a technological delivery system to enjoy legitimacy in a modern democracy, the risk levels that the system tolerates (and

⁶² Title VI of P.L. 109-295.

⁶³ Jody Freeman & Daniel A. Farber, *Modular Environmental Regulation*, 54 Duke L.J. 795 (2005).

the corresponding margins of safety) must be set transparently. Environmental law provides a number of models for making government decisions about acceptable levels of risk. One possibility would be cost-benefit analysis; another would be to set (at least as an aspirational goal) a fixed level of natural disaster risk considered acceptable.

Recommendation 2: *Exploit the major and unprecedented role that exists for citizens to shape this discourse.* Citizen participation is a necessary part of governance because those who govern do so at the informed consent of the governed. This includes the population exposed to catastrophic risks, and the people that will be protected by the NOFDS. Authorities for catastrophic risk management should ensure that those vulnerable have sufficient and timely information regarding their condition and a reciprocal ability to respond to requests for their informed consent especially regarding tradeoffs of safety for cost. The public protected by the NOFDS need to be encouraged to actively and intelligently interact with its development.

Recommendation 3: *Upgrade the Corps' technical capacity.* Congress must intensify, focus, and fund Corps of Engineers modernization efforts; increase in-house engineering capabilities and project performance; increase in-house research and development capabilities; increase in-house engineering performance of technically challenging projects; develop an organizational culture of high reliability founded on existing cultural values of duty, honor, and country; develop a leadership role and responsibility for technical and management oversight of all phases of development of a NOFDS. The Corps must re-establish technical superiority. Outsourcing must be balanced with in-sourcing to encourage development and maintenance of superior technical leadership and capabilities. This will require close and continuous collaboration of federal legislative, executive, and judicial agencies. This will require that the Corps of Engineers re-conceptualize itself as a pivotal part of a modular organization developing partnerships with other federal agencies, state and local governments, enterprise interests, and private stakeholders.

Recommendation 4: *Restructure federal/state relationships in flood control.* Enhance cooperation and collaboration, reducing confusion as to overlapping areas of operation and responsibility. Advance mutually supportive cross-checks and communication. In short, recognize interdependency and work to ensure information flow across interstices.

Recommendation 5: *Develop a National Flood Defense Authority (NFDA) charged with oversight of the design, construction, operation and maintenance of flood control systems.* Each state would have an equivalent organization that could foster cooperation and developments between and within the states. The Corps of Engineers, state flood control authorities, and technical advisory boards would work with the NFDA to foster application of the best available technology and help coordinate development and maintenance efforts and planning. In cooperative developments, federal and state governments would provide reliable and sustainable funding for the life-cycle of specific flood defense systems. This development should be accompanied by development of an integrated and coherent Louisiana Flood Defense Authority representing state, regional, local, city, and public stakeholders that can focus and prioritize stakeholder interests and requirements and collaborate with the Corps of Engineers in development of a NOFDS.

Recommendation 6: *A new Council for Catastrophic Risk Management should be appointed within the White House and given policy and budgetary oversight of disaster preparation and response efforts.* A similar body should be appointed within Congress, analogous to the Congressional Budget Office. Incentives must be created to encourage all levels

of government to deal proactively and effectively with potential national, regional, and local catastrophe.

Beyond these specifics, there is a larger lesson. In retrospect, while the New Orleans disaster was triggered by a natural event, but that natural event caused unprecedented catastrophe only because the institutional structures for designing and managing the flood control system were grossly inadequate. Without these institutional failures, Hurricane Katrina would have caused serious damage on the Gulf Coast and in New Orleans, but it would not have virtually destroyed a major American city. The failures were found not only within the Army Corps of Engineers, but in its relationships with outside institutions such as the White House and Congress. Moving around boxes on an organizational chart has limited utility unless we fully assimilate the import of the historical record: Do not be misled by years of quiet, “normal” behavior. Disaster is always lurking, just around the corner. Natural disaster cannot be prevented, but we can take appropriate precautions if our leaders and our organizations keep their wits about them. Sloppy, stagnant organizations are merely wasteful in the short run; in the long run, they can be catastrophic.

Appendix: Proposed Flood Control Organization

