6-2010

Achieving Successful Long-Term Recovery and Safety from a Catastrophe: Recommendations for Systems for Catastrophic Safety

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RECOMMENDATIONS FOR SYSTEMS FOR CATASTROPHIC SAFETY

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Research support from the Ford Foundation, Government Performance and Accountability in the Governance and Civil Society Unit

Systems for Catastrophic Safety

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Destination and Path of a Modern Systems Approach to Catastrophic Hazard Risk Mitigation

Introduction: For every participant the Katrina experience was a nightmare. It was not only a nightmare in physical safety but in social survival. The Katrina nightmare visited individual victims as well as virtually all the institutional players. The scale and devastation redefined what it meant to experience a catastrophe. Not only did Katrina visit while the storm was raging, but its effects continued and continue for more than half a decade.

The other chapters of this report look at opportunities for improving individual programmatic parts of the federal government's approach to catastrophe preparation, response and recovery. They also offer responsible recommendations for changes without in most cases altering the existing framework for disaster management. This chapter seeks to investigate deeply rooted issues and causes that would suggest solutions requiring more comprehensive changes and disruptions.

Readers need to be prepared to see a significantly more radical yet comprehensive path to dealing with the broader issues uncovered by the catastrophic Katrina experience. Compared to the recommendations in other chapters, this alternative would entail a transformative paradigm shift. Each issue discussed herein corresponds to patterns that have been observed in other fields, and each recommendation is based on proven, world class practices. In many respects this approach applies to both structural and non-structural mitigation and conjectures that a single integrated system to address prevention, response and recovery is indicated by the consistent patterns of dysfunctionality and poor performance we found in the current, non-integrated approach. The author argues that the appropriate integrating focus should be on serving the individual resident and his or her community to make them safe from future catastrophes and to respond and recover so that people and communities survive and prosper.

Over the course of our investigation we began to note some patterns appearing across programs, agencies and jurisdictions. Other critiques of the Katrina experience pointed to similar issues and suggested solutions. In reviewing successful disaster management experiences around the world we encountered efforts that had come to adopt some of these radical changes. This chapter reiterates the data that was available and associates it with our own experience and interviews. The name we give our analysis and recommended radical approach is: a comprehensive systems approach (see Figure 1).

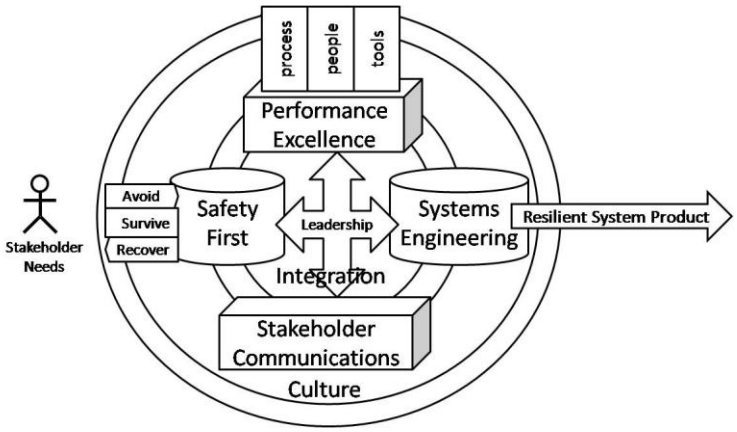

Figure 1: Ingredients of a Successful Systems Approach

Supporting this overall systems view we include some focus areas that are meaningful and consistent with any systems approach and that were not much in evidence in the collective institutional services that constituted Katrina's disaster management actors. These supporting elements are: safety first, performance excellence and stakeholder focus, and a systems (engineering) approach itself.

1. Flood Protection, Response and Recovery Were Not Systems

Nobody knew that the flood defenses would be so easily overwhelmed and be so brittle. No one anticipated weeks of being under water. No one thought of or planned for extended displacement or the struggle of masses of residents trying to repair or rebuild in a region that had already been built out.

The clearest assessment that there was, in fact, a "systems problem" was provided by the Corps of Engineers who's Interagency Performance Evaluation Team (IPET) June 23, 2009 Final Report found:

1. "The system did not perform as a system"
2. "The lack of resilience … significantly increased flooding and resultant losses"
3. "Planning and design methods need to be system-based"
4. Hurricane protection structures need to be designed as a part of a complete system-based approach …"
5. "Designs need to be conservative …"
6. "Resilience needs to be factored in to all designs to prevent catastrophic failure …"
7. "The system in place before Katrina was compromised by a long series of decisions driven by competing priorities, incremental decision making and funding, inadequate consideration of change and *de-facto* standards far too low to deal with the realities of modern natural hazards
8. "Designs need to better consider unknowns"
9. "New Orleans remains vulnerable to large storms"

Recommendation #1a : Adopt resilience systems engineering practices to create flood management as a true system which is appropriately organized, empowered, and integrated all-hazard safety team.

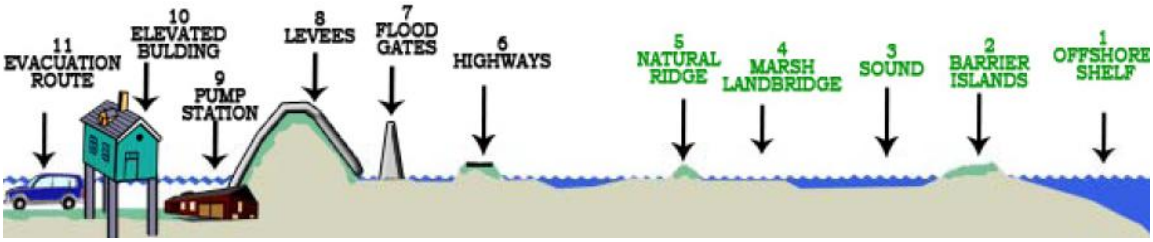

Figure 2: Multiple Lines of Defense System Framework
(Source: Lake Pontchartrain Basin Foundation)

Discussion: While people believe they work rationally and systematically and may even use the word system in describing their efforts, the systems approach this chapter is referring to is one which embraces the internationally standardized best practices of systems engineers to produce solutions that deliver results of value to their intended stakeholders across all related disciplines (civil engineering, individual assistance, public assistance, mitigation, etc.) and resources.

While those disciplines contribute and are still focused on everything from physical structures to environmental restoration to responding to incidents to recovering safely, their collective effort does not yield an integrated, coordinated, non-duplicative and responsive system unless it has been forged by systems engineers to pull out desirable and safety-essential emergent properties such as integration and system-wide resiliency.

What would such a catastrophe management system look like? The best way to look at a system is to look through the eyes of professionals who commonly define large problems and solutions in both holistic and analytic terms (systems architects). In a holistic view from the top, you would see the key elements of the systems, the stakeholders who are impacted by its results and the interactions or interfaces between components and stakeholders. You would expect to

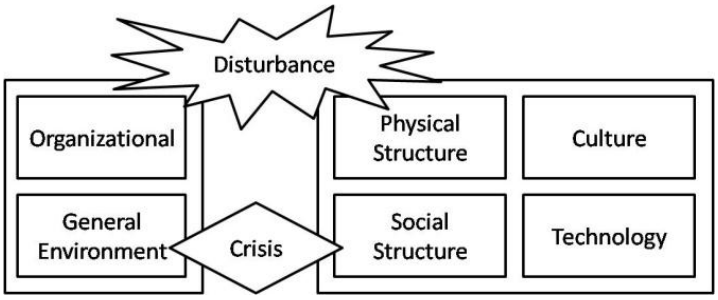

Figure 3: Context for Catastrophes
(Source: Jackson, Scott: Architecting Resilient Systems, Wiley 2010)

see a view that represented "flat water" and another that depicted say, storm surge or the disturbed condition in order to establish the range of resilience needed. You would want to see

an organizational picture of how all resource providers had formed an integrated, empowered and resourced team to ensure elements and element providers were working together. You would expect to see a simple statement of their shared vision that ensures they are all working towards the understanding of the same goal. An example of such a vision could be as simple as "safety first" which is at the core of the Dutch flood defenses. A very important view of the system would be all the key risks that have to be overcome or mitigated for the end system products to perform up to expectations. Water's ability to seek out weaknesses regardless of political or administrative boundaries is a law of physics that cannot be nullified by legislation or Federalism.

Proceeding concurrently, systems engineers would be considering the disruptions and stresses under which the system must deliver or recover delivering protection. System risk analysts would quantify and allocate risk and risk response to components with those risks that can't be allocated to elements of the solution system identified and clearly and actionably communicated as residual risks to stakeholders.

The end system "product" would consist of physical and social structures, processes, information all ready to address disruptions with adequate notice. The operational system would be under constant review and assessment to continuously improve its performance and responsiveness while tightly controlling costs. In the case of a catastrophe management system, elements of the system would be continuously working with stakeholder decision makers to promote safety through better decision making at the regional, community and individual level. In preparation for an incident, key stakeholders should decide on actions to relocate and avoid risks or to install mitigation measures to reduce impact. These are the same decision-makers who must decide to evacuate as well as decide to return and rebuild safer. If measures, such as realistic flood elevations or probabilities expressed in meaningful terms (life of a mortgage) are not visible, understood and accessible to decision makers, catastrophe will sooner or later result. Those stakeholders, such as home owners, businesses, renters, infrastructure managers, etc. are shaped and enabled by their culture and the ways in which that culture communicates and reinforces messages about risks. This is not new.

Systems Engineering Mechanisms

Systems engineers employ a broad array of practices all aimed at insuring performance, integrity and resilience. Some of the most critical omissions in the "systems in name only" that characterized all elements of the Katrina experience include:

Requirements:

The central practice of requirements engineering is to elicit requirements from stakeholders where those stakeholders and their expected results of value (e.g. protection from flood damage) become the ultimate measure of the system's success. One of the

key elements of requirements engineering is to frame and model requirements as results of value to stakeholders. Requirements are then traced to the evolving design and implementation throughout its life cycle to facilitate the impact of change.

The requirements engineering process is the root of forming a shared vision among all stakeholders. This vision was not shared prior to Katrina. It was pointedly unshared during the delayed response of Federal troops. It was evidently unshared between state recovery authorities when the Housing and Urban Development (HUD) Community Development Block Grant (CDBG) focus wrenchingly switched from recovery to victim compensation years after the event. The lack of a shared vision has led to a program that promises up to $100,000 FEMA grants to mitigate hazards that results in only a few hundred of the approximately 35,000 residents expressing interest. To avoid this from happening again, clashes between stakeholder results of value need to be sought out and, when found, resolved to a negotiated win-win condition. Capacity to select among alternative solutions depends on this being accomplished.

This inability of our federal system of government to form shared visions and agreed upon goals between the central government, state governments, municipal governments, economic growth interests and individuals when it comes to personal, institutional and property safety is a major stumbling block. We have actually been able to do just this in aviation and rail safety. We seem to accept a central air transportation solution. We don't seem to be able to do this effectively for mine safety or flood safety. The Dutch seem to have achieved a continuously informed and shared vision about putting safety first in its water policy. Progress, in the form of the National Disaster Recovery Framework, seems to include flood safety as a peer goal among a long list of non-safety goals. Failure to put safety in a politics free zone under the care of competent and ethical engineers will ensure that losses will continue to mount and lives will continue to be lost.

Architecting:

Architecture and architecting are unique and distinctive traits of systems. Systems have architecture which is reflected in holistic and analytic "views" of the entire system from a number of essential perspectives including operational, supportability, developmental and resiliency. Architecting not only relies on the traditional reductionist tools and rules of systems analysis but employs holistic or "up" rules to ensure there is a whole and that it delivers emergent properties not attributable to any one component such as integrity and resilience.

Systems architects not only designate the key components and their supporting disciplines but define and control how these parts interact with each other and with the supporting actors, culture and infrastructure. Interface Control Working Groups are designated to establish and maintain formal, agreed upon specifications for each interface which is controlled throughout the life cycle. As has been observed by the US Army

Corps of Engineers (USACE) Interagency Performance (IPET) and experienced in the fragmented recovery efforts, interfaces became the weak points where structures failed and programs were unsynchronized to the total frustration of victims. This was particularly evident in elevation programs where failures to recover safely (several hundred awards out of 35,000 expressions of interest were, to a large extent, due to conflicting rules and schedules among non-cooperating elevation programs rather than intentional defrauding by homeowners who took elevation funds but have not yet elevated.)

2. Safety Is Not a Shared Goal for Life-Critical National Flood Protection Programs

As indicated in Figure 1, safety first is the shared vision that a safety system needs to be based on. Safety first and a systems approach are the twin pillars of the Netherlands' successful national water policy. One of the primary motivators for adopting a systems approach is in fact complex systems where human safety is critical to success and avoids potentially catastrophic surprises. As we have seen in New Orleans and Haiti, safety was not an important consideration while in the Netherlands and Chile-- with its strict and systematically applied earthquake proof building codes-- have been able to withstand tight stress conditions. It is inconceivable that future catastrophes can be avoided without a national consensus that safety should come first and be articulated in an overarching nation policy.

Recommendation #2a: Create a national hazard safety policy that places safety first.

Discussion: As seen in the behavior of Louisiana residents, leadership, government officials and commercial interests, there is an ongoing conflict among convenience, growth and hazard safety with long term safety often taking a back seat. When specific decisions are made regarding adopting conservative safety measures (i.e., base flood elevations), leadership is consistent in erring on the side of inappropriate optimism. Land development interests appear to be gaining the upper hand in ensuring new and revitalized levees that maximize the amount of land available rather than emphasizing more resilient security for established, more defensible, communities.

The fact that recovery in devastated New Orleans is primarily at grade with few elevations above the Katrina high water mark is more evidence that safety was not put first but put behind social and economic recovery. With the proportion of safe to unsafe houses being as low as it is, one could assess that New Orleans lost an opportunity to come back safely and survive inevitable future storms and engineering failures. Many returning residents voice their perception as follows: "If it happens again, the government will buy me out and I'm out of here." For a community whose culture is defined in terms of multigenerational interactions, this might very well have a detrimental effect.

3. Unacceptable Performance under Catastrophic Stress

Process performance by most Katrina-related public sector activities failed to deliver results of value to stakeholder residents.

Recommendation #3a: Direct that institutions engaged in hazard safety achieve performance excellence against established and objective criteria.

Discussion: The third element of a comprehensive systems approach is the evident need to cope with the stress of a catastrophe and the catastrophic scale of recovery efforts by achieving the highest levels and continuously improving them for all processes performed. The Louisiana Road Home Program established once and for all the idiocy of expecting ad hoc policies and processes to accommodate hundreds of thousands of displaced persons and destroyed homes, infrastructures and businesses. In the height of activity in December 2006 applicants to the Road Home Program were told by staff that the Program was in "chaos." Error rates and rework were extremely high. The actual extent of administrative rework was unknown because there were no published metrics for the quality of application processing. When members of the LRA Housing Task Force suggested that the LRA consider adopting proven quality management practices, the staff admitted they were too busy.

Another sign of performance deficiency was the instability of the processes. As of March 28, 2009, rules governing payment of Individual Mitigation Measures had not been stabilized and were in direct conflict with what the original 2006 LRA plan had committed to recovering residents.

In the last half of the 20th century, Americans were discovering that the Japanese were using continuous processes improvement to build better, cheaper automobiles that people wanted. Even more humiliating was that the Japanese were being taught by Americans such as W. Edwards Deming, and Joseph Juran. The concepts adopted by the Japanese are now the norm at virtually all world class manufacturing and service organizations.

The key areas of continuous processes improvement employed by the Malcolm Baldrige National Quality Award criteria include:

1. Leadership
2. Strategic Planning
3. Customer Focus
4. Measurement, Analysis, and Knowledge Management
5. Workforce Focus
6. Process Management
7. Results

The Software Engineering Institute at Carnegie Mellon has devised a framework or model to specifically address systems engineering capabilities – what processes are needed to engineer a system and maturity levels of an organization's ability to use those processes which range across the following five levels:

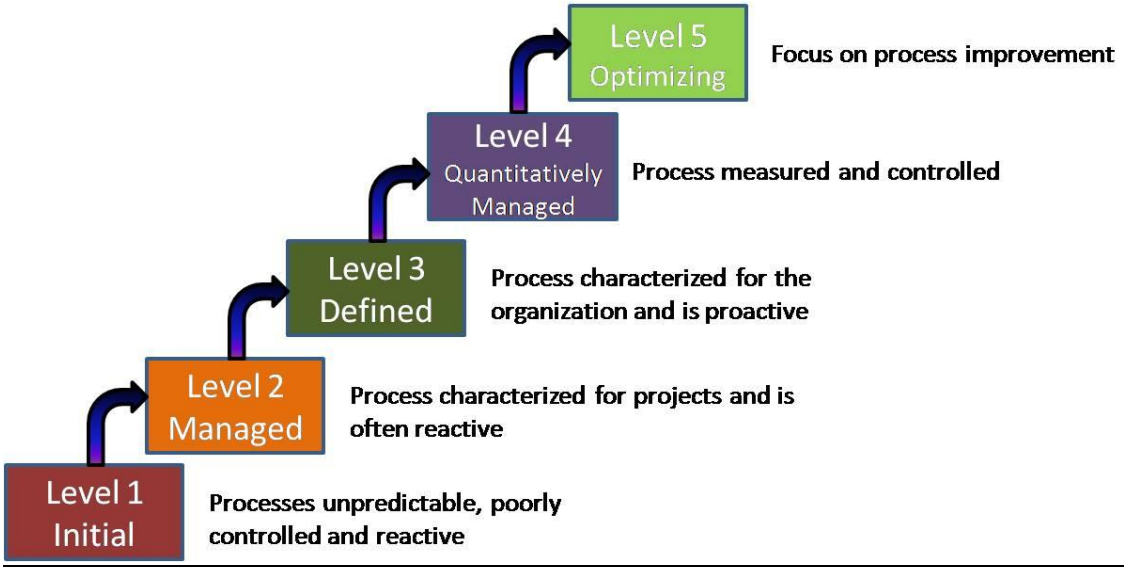

Figure 4: Five Levels of "Maturity" in CMMI
(Source: Software Engineering Institute, 2008)

The bottom line is that these practices address the following predictable faults, all experienced during the Katrina by virtually all agencies

Missed Commitments

- Spiraling costs
- Late delivery to the market
- Last-minute crunches

Inadequate Management Visibility

- Too many surprises

Quality Problems

- Customer complaints
- Too much rework
- Functions not working correctly

Poor Morale

- Burned-out people
- Inadequate control of project results

Institutionalizing continuous process improvement and avoiding the above conditions is best done in a methodical and iterative series of improvement cycles. Starting from scratch it typically takes more than 2 years to reach level 3 and another 2 years to reach level 5. This implies that it is unlikely that you will create a high performance organization after a catastrophe is experienced. Building the capability and exhibiting the maturity able to stand up to catastrophe must be in place before a catastrophe strikes.

4. No Focus on Key Stakeholders

All dimensions of Katrina hazard avoidance, survival and recovery shared a broad lack of focus on key stakeholders--those who are significantly impact by the results of a solution. These include not only officials and solution developers (contractors) but residents who expect to be protected and, when protection fails, assisted in surviving and recovering.

Recommendation #4a: Adopt international standard resilience systems engineering practices to ensure that stakeholders are identified and their legitimate expectations (protection, survival and recovery) delivered by all hazard safety institutions.

Discussion: Global advances in productivity have resulted in a large part from the innovations introduced by the total quality community such as the imperative of understanding that quality is measured by how stakeholders perceive the results they get. . In the case of flood protection, response and recovery, key stakeholders are those who suffer (or might suffer) extensive damage. Stakeholders also include taxpayers, as well as those who deliver any form of service, directly or indirectly to victims. These practices are strongly embedded in the Malcolm Baldridge National Quality Awards and pervade modern systems engineering as well as best commercial and government administrative activities. From Katrina forward, failure to adopt this simple concept is a guarantee of program failure.

The essential element of a comprehensive systems approach is engaging and communicating with stakeholders. This is truly the lynch pin of a successful systems approach. When you adopt the view that success is defined by the value you deliver to customers and clients you are on the road to discovering why systems engineering, performance excellence and safety first are imperative elements.

Stakeholder communications is also one of the pervasive complaints of and faults in everything to do with preparation response and recovery with respect to Katrina.

Before Katrina there was almost total complacency on the part of residents and their leadership with respect to risks from storms. This complacency was encouraged by optimistic and unrealistic assertions by Corps spokespersons regarding the increasing risks faced by residents.

In 2002 the Times Picayune reported that "The Army Corps of Engineers says the chance of New Orleans-area levees being topped is remote." That gap continues to this day where communications about recovering flood protection structures (levees and flood walls) is driven by National Environmental Policy Act (NEPA) requirements for public comment on environmental issues, not a commitment of the Corps to communicate safety. In its CAT5 study, the Corps-led Louisiana Coastal Protection and Restoration (LACPR) planning effort only acknowledges congressional investment interest and took no note of resident stakeholders' safety.

Complacency should also be used to characterize the attitude of not adopting building codes and base flood elevations that reflected the true risks. Despite adopting international building codes statewide after Katrina, at-risk houses are not required to install Dade County rated shutters. One can conjecture that this is the message being sent by FEMA when they deny individual mitigation measures (IMM) to new recovery construction.

During and well after the response phase, citizens used the web discussion groups to keep each other informed and warned of misleading or inconsistent information provided by authorities. Some maintain that without these neighborhood- based discussion groups many residents would not have returned; but also many made what, in retrospect, was the right decision not to return based on what they learned on these web sites.

Recovery program communications with all classes of stakeholders can only be characterized as reluctant at best and non-existent as the norm. It took citizen activists to pry out the rules for compensation grants and organizations like UNO-CHART to try to represent the process of acquiring elevation funds, the effort of determining eligibility and steps to apply. And such efforts were pro bono citizen activities or supported by private foundation funding rather than state resources. Statistical reports from the Road Home program dealt with work flow volumes and did not address the growing applicant waiting time (aging) and quality until activists pointed out this deficiency. Programs subsequent to the CDBG compensation had even less visibility, relevance and completeness. Press releases only announce good news and never seemed to communicate delays or uncertainties. This is not a framework where victims can rationally plan their recovery let alone attempt to do so safely.

In general, what few stakeholder communications events that were held appeared to be unfocused and not in line with best systems and process practices of identifying roles and results of value and reporting on achievement of those results throughout the recovery and concurrent preparation.

It should be noted that all of the "doctrine" cited for systems engineering, continuous process improvement and shared visions have the same stakeholder focus and provide methods to ensure that stakeholders' voices are heeded and acted on. It may be politically hard but should not be an

administratively complicated effort to insure that stakeholder results of value are integrated into legislative direction and guidance.

5. No One Was and Is In Charge

There is no experience of success in any safety critical arena when these conditions are not achieved. Catastrophes are serious stuff. They can permanently disable regions, impact the national economy and devastate people and their sanity far beyond the immediate relief efforts. One might go so far as to say that the primary constitutional function of the government is to protect our citizens from all enemies – including the blunders of our officials when linked with the uncertain nature of powerful natural disaster events.

We have also learned that preparing for, responding to and recovering from a catastrophe is no place for ill-prepared amateurs and ad hoc solutions. Only world class solutions and highly capable and mature institutions can act effectively and humanely under catastrophic stresses.

Recommendation #5a: Employ skilled, empowered, integrated product teams (IPT) under the direction of proven and committed leadership to deliver works and services that provide results valued by stakeholders.

We fully recognize that the family of complementary and consistent solution elements will be a "hard row to hoe." Resistance to changes in values and practices is itself a major challenge. To that we can say that the systems approach, coupled with proven team-based leadership and execution, has been successful and is being followed with predicted results by world class organizations. It has also been adopted in less mature institutions than the professional bureaucracy that must do it for storm safety. Although there are alternative paths to fixing specific problems, in the end a comprehensive systems approach is the only way to proactively avoid similar problems in future, inevitable catastrophes.