

Crisis Management in Hindsight: Cognition, Communication, Coordination, and Control

Part III—The Future: Hindsight, Foresight, and Rear-View Mirror Politics

This article argues that cognition is central to performance in emergency management. Cognition is defined as the capacity to recognize the degree of emerging risk to which a community is exposed and to act on that information. Using the case of Hurricane Katrina to illustrate the collapse of the standard model of emergency management without a clear focus on the role of cognition, the author reframes the concept of intergovernmental crisis management as a complex, adaptive system. That is, the system needs to adjust and adapt its performance to fit the demands of an ever-changing physical, engineered, and social environment. The terms of cognition, communication, coordination, and control are redefined in ways that fit the reality of practice in extreme events. A reframed intergovernmental crisis management system may be conceived as a dynamic interorganizational system that is characterized by four primary decision points: (1) detection of risk, (2) recognition and interpretation of risk for the immediate context, (3) communication of risk to multiple organizations in a wider region, and (4) self-organization and mobilization of a collective, community response system to reduce risk and respond to danger.

Reviewing the record of actions and consequences since Hurricane Katrina made landfall just east of New Orleans on August 29, 2005, we face a sobering task in assessing these events in a constructive, responsible way. This means setting aside the “hotwash” of anger, blame, frustration, and despair that has characterized so much of the public dialogue about this historic sequence of events.

Rather, it means analyzing the preparedness, response, and recovery operations as they actually occurred, in contrast to what had been expected or ignored. It means separating the reality of action from the myths of planning and learned ignorance and recognizing that the basis for building effective crisis management lies in the human ability to recognize and correct mistakes.

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In hindsight, a critical component of emergency response is cognition—that is, the capacity to recognize the degree of emerging risk to which a community is exposed and to act on that information. This capacity was not widely evident in the response to Hurricane Katrina. The questions are why and how can it be developed in communities that are vulnerable to risk.

The role of cognition substantially alters the interaction among the familiar three Cs of emergency management: communication, coordination, and control. Cognition is the triggering insight of emerging risk that initiates the emergency response process. Without cognition, the other components of emergency management remain static or disconnected and, as shown by the record of operations during Hurricane Katrina, often lead to cumulative failure. The relation between cognition and action transforms emergency management from a static, rule-bound set of procedures into a dynamic process, one that is based on the human capacity to learn, innovate, and adapt to changing conditions, informed by timely, valid data. The challenge is to build the capacity for cognition at multiple levels of organization and action in the assessment of risk to vulnerable communities. This essay examines the concept of cognition and its role in emergency management and proposes reframing this process to include four Cs: cognition, communication, coordination, and control.

Cognition enables experienced managers to lessen the contrast between planning and practice, a gap that theorists in emergency management have long sought to close. In the last decades, theorists in public policy and emergency management have increasingly recognized that the dynamic, complex environment of rapidly evolving emergency events requires a different approach than the traditional hierarchical administrative

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framework, which assumes stable operating conditions (Axelrod and Cohen 1999; Comfort 1994, 1999; Kettl 2006; Kiel 1994). Yet the extensive reorganization of the emergency management system following the terrorist attacks of September 11, 2001, reinforced the traditional model of command and control. The separation of the key functions of crisis management and consequence management and their allocation to separate federal departments in the Interagency Domestic Terrorism Concept of Operations Plan (U.S. Department of Justice et al. 2001) initiated the decline of mitigation as a primary focus of emergency management. This decline was accelerated by the establishment of the new Department of Homeland Security in 2003 (Executive Order No. 13284). Under this reorganization of emergency functions, the Federal Emergency Management Agency (FEMA) was formally subsumed under the authority of the new Department of Homeland Security as one of 22 federal agencies with responsibilities related to security. Formal plans to reorganize emergency management functions that were produced and introduced into practice under the authority of the Department of Homeland Security further widened the gap with actual practice. These plans specified a detailed, hierarchical structure of command and control in the National Response Plan (DHS 2004b) and the National Incident Management System (DHS 2004a) that largely ignored the complexity and uncertainty inherent in actual disaster environments.

The obvious collapse of the intergovernmental system in emergency management under the strain of the catastrophic events initiated by Hurricane Katrina provides an unquestioned demonstration of the failure of hierarchical control in the dynamic context of an actual disaster. The question becomes how to reframe the dynamic organizational issues endemic in emergency management practice in ways that policy makers can understand and implement. This task requires rethinking the terms of communication and coordination to dispel the myth of hierarchical control, identifying the mental models that emergency managers use in practice to assess and adjust their actions to rapidly changing conditions. It means redefining the terms of cognition, communication, coordination, and control in ways that fit the reality of practice in extreme events.

Science vs. Policy: A Continuing Tension in Emergency Management

“What worked?” and “What went wrong?” are classic questions asked in any after-action review. In the after-action assessments of Hurricane Katrina, these questions reveal the startling differences between

science and policy in building resilience for a community exposed to serious risk. They also reveal the discrepancies between information and action among the organizations responsible for protecting citizens exposed to extreme danger. In the events leading up to Hurricane Katrina, the scientists were acutely aware and remarkably accurate in their assessment of the size, direction, severity, and likely impact of the developing storm. Current Doppler radar systems had identified the formation of Tropical Depression 12 in the Caribbean on August 23, 2005. Meteorologists at the National Hurricane Center in Miami upgraded the depression to Tropical Storm Katrina on the morning of August 24, classified the storm as a Category 1 hurricane as it made landfall in south Florida on August 25, upgraded the hurricane to Category 2 as it moved into the Gulf of Mexico on August 26, and projected landfall as a Category 3 hurricane in Louisiana and Mississippi on August 27 (Comfort 2006). The scientists provided clear, timely, professional warnings regarding the severity, intensity, and direction of Hurricane Katrina to public information sources.

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The failure was not a lack of communication, as the information regarding the impending storm was transmitted to policy makers and public news agencies in time to mobilize action (U.S. House

2006). Rather, the issue was the cognition of the risk posed by the storm. Although key policy makers at the federal, state, parish/county, and municipal levels had received warnings by direct telephone calls from Max Mayfield, director of the National Weather Service, they failed to comprehend the risk and potential destruction of a Category 4 or 5 hurricane for the city of New Orleans and other vulnerable Gulf Coast communities. Without clear recognition of the severity of the threat and its likely consequences, decision makers at all four levels of jurisdictional responsibility in emergency management failed to communicate the urgency of the danger to their respective agencies. Without authoritative communication to activate appropriate response operations, the coordination of actions among the levels of jurisdiction in the emergency response system largely failed. Without timely coordination among city, state, and federal agencies, private and nonprofit organizations, response operations in key locations in New Orleans spiraled out of control.

In contrast, some organizations and groups did heed the storm warnings and take appropriate action to reduce risk. The clearest example is that approximately 80 percent of the population of New Orleans followed the voluntary evacuation order issued by Mayor Ray Nagin on Saturday evening, August 27, and left the city before the storm struck. The limits of this action

were painfully clear in the economic and racial differences among those who could leave and those who had no means to do so on their own. As the television monitors showed graphically, the approximately 100,000 people who remained in the city as the storm struck were largely poor and African American. Other examples of partial efforts include the decision of the airlines to suspend flights from Louis Armstrong International Airport in New Orleans on Sunday morning, August 27. In protecting their own operations, the airlines cancelled the possibility of others to leave the city before the storm. These examples illustrate the uneven results of separate actions taken without an overarching framework for collective action for the region at risk.

Innovative efforts to cope with the flood in New Orleans and the aftermath of the storm in other areas were documented in multiple ways by individuals, public, private, and nonprofit organizations. U.S. Coast Guard helicopter crews, operating on their recognition of severe risk to anyone remaining in the city, acted outside their formally defined role in emergency response and scanned the abandoned city of New Orleans for survivors. They airlifted injured persons to safety and medical care when there were no operable communications or transportation in the city. Local emergency personnel worked long hours to help others despite their own losses, demonstrating professional commitment and personal responsibility. Individual residents took their own power saws to clear roads of downed trees, clearing vital transportation routes in outlying areas. National business organizations sent assistance to their local affiliates in the storm-affected region, increasing local capacity to manage the damage and destruction to their business operations. Citizens across the nation responded with voluntary contributions totaling more than \$2.3 billion to assist families displaced by the storm. Nations from Canada to Sri Lanka to Venezuela offered assistance to the United States to cope with this severe event, acknowledging the common humanitarian bond of giving assistance to people in need. The United States, unaccustomed to receiving aid from the global community, initially refused aid from other nations but finally accepted limited assistance from trusted nations such as Canada.

There were extraordinary acts of courage and generosity by individuals and groups during this massive event, but the capacity to harness those individual actions into a coherent process of response and recovery was missing. In retrospect, the policy framework to facilitate self-organizing actions in response to valid scientific information was largely absent. Instead, individuals and organizations volunteering to provide assistance to people who suffered damage from the storm were turned away for lack of proper forms or until some distant authority could approve the action

under existing procedural controls (Alkan 2006). The challenge, in a disaster event this large, was to provide a framework for collective recognition of danger that could support communication and coordinated action across scales of jurisdiction, severity, and time.

Cognition, Communication, Coordination, and Control

Three critical terms in emergency management—communication, coordination, and control—imply an interdependent, evolving process of organizational management. The record of disaster operations both before and after Hurricane Katrina made landfall demonstrate the importance of a prior term—cognition—that is essential to activating the response process. Serious efforts to revise and strengthen a national capacity for emergency management begin with the recognition of the need to create a common knowledge base for collective action in extreme events. This need is well recognized by practicing emergency managers.

In the language of practice, building a “common operating picture” is essential for clear communication and coordination of actions among emergency response organizations. This means achieving a sufficient level of shared information among the different organizations and jurisdictions participating in disaster operations at different locations, so all actors readily understand the constraints on each and the possible combinations of collaboration and support among them under a given set of conditions. This task is usually accomplished through common training, years of shared experience, and professional interaction among individual emergency response personnel. The task becomes more difficult as the size, scope, and severity of an impending disaster increase. It becomes a major challenge when the requirements of disaster operations include a range of heterogeneous organizations from the nonprofit and private sectors, as well as individual households and neighborhood groups.

While the role of cognition has been recognized by theorists of decision making under conditions of uncertainty (Alberts and Papp 2001; Salas and Klein 2001; Weick and Roberts 1993) and is widely acknowledged in practice, it has not been formally included in the organizational framework of the National Response Plan. Recognition-primed decision making (Klein, Orasanu, and Calderwood 1993; Salas and Klein 2001) is now incorporated into many training programs for emergency personnel. Klein’s concept of recognition-primed decision making acknowledges that, under threat, the process of reasoning through a linear set of instructions or rules is far too slow for human managers to avoid danger. Rather, he observed that experienced leaders draw on a repertoire of previous actions in similar conditions and create workable strategies to fit the existing

context for action more appropriately. The limits of this approach lie in the maxim of Herbert Simon (1997), “we can only create what we already understand.” If actors under threat confront a situation that is so completely different from their experience, they will find little meaning that can serve as a basis for action. Essentially, it means that decision makers operating under conditions of urgent stress formulate strategies of action based on their prior experience or training.

The importance of cognition is critical to understanding the collapse of the intergovernmental emergency management system for disaster operations in response to Hurricane Katrina. Only the scientists had a clear understanding of the potential threat of this powerful storm, which crossed the jurisdictional boundaries of at least nine states, three federal regions, and international borders within the Caribbean and with Mexico and Canada. Without a clear understanding of the severity of this emerging threat, the policy makers did not engage effectively in the kinds of systemwide communication that would have led to stronger coordination of preparedness and response operations and improved control over the wide scale of activities required to mitigate, respond, and recover from the consequent destruction. The dependence of effective communication on cognition, and equally, the dependence of effective coordination on communication, illustrates the nonlinear structure of disaster management operations. Control in disaster operations cannot be achieved through hierarchical measures alone. Rather, it develops through a process of rapid assessment of risk, integration of information from multiple sources, the capacity to formulate strategic plans of action, identification and correction of error, and a continual monitoring and feedback process among key actors. This process cannot function effectively on a wide scale under the rigid constraints imposed by the current organizational design and procedural requirements of the National Response Plan and the National Incident Management System. Instead, adding cognition to the process acknowledges the need to include systematic means of adapting to dynamic, uncertain conditions as a crisis evolves and dissipates.

Reframing Intergovernmental Crisis Management

The challenge, of course, is to rethink the process of cognition, communication, coordination, and control to achieve a more effective operational system for the nation. Three major problems characterized the intergovernmental response in Hurricane Katrina. First, there was an extraordinarily high degree of heterogeneity in size, experience, knowledge, and capacity among the participating groups, organizations, and jurisdictions involved in disaster response operations for this event. Although government organizations

have legal responsibility for managing extreme events, the scale of operations required for Hurricane Katrina exceeded the capacity of the emergency response organizations at all four jurisdictional levels: city, parish/county, state, and federal. As the public emergency response organizations were overwhelmed, organizations from other regions and from the private and nonprofit sectors initiated their own activities in an effort to lend assistance. This situation led to an even greater diversity in knowledge, training, facilities, and capacity to act in seriously eroded conditions. The operating picture was anything but common, and errors, misjudgments, frustrations, and abuse characterized the disaster operations instead. The useful lesson from this set of conditions is that the common operating picture must be established before the disaster.

Second, without a common operating picture, emergency response operations tend to revert to hierarchy as a means of control. This condition creates asymmetry in the information processes, whereby jurisdictions and organizations with higher levels of responsibility and authority transmit orders to lower levels without requesting or listening to feedback from field operations personnel or organizations outside the formal chain of command. Instead of building a shared perspective on priorities for disaster operations, asymmetric information processes deny managers the operational feedback that is essential to identify and correct errors. Instead, information is skewed to support largely political priorities, and the basic functions of disaster response, design, and delivery of assistance to families who have lost their homes tend to go badly off track. Instances of failed judgment, corruption, and mismatch of resources and needs are exacerbated by communication processes that are unidirectional. Without clear, timely feedback, organizations lose the possibility of correcting mistakes and adapting their performance to changing conditions.

These two factors—heterogeneity among actors and asymmetric information processes—combine to produce a third dysfunction, asynchronous dissemination of critical information to participating groups. That is, different groups receive critical information at different times and initiate their own actions without an awareness of the impact on other organizations or groups. For example, such a dysfunctional information process led to the regrettable stand-off between evacuees from New Orleans and public officials in Gretna, Louisiana, on August 30, the day after the hurricane struck. The evacuees, largely poor minorities who had been displaced from their homes in the flooded city, were told to walk across the Crescent City Convention Bridge to relative safety in the middle-class suburb of Gretna. They were stopped at gunpoint by the Jefferson Parish sheriff and his deputies to prevent them from entering their community

(MacCash 2005). Exhausted, without food and water in sweltering heat, many of them camped on the bridge, waiting for assistance that took hours to come. Federal agencies still had not fully mobilized response operations; the New Orleans emergency service organizations were overwhelmed trying to maintain order in the Superdome; and hundreds of residents of the city of New Orleans were stranded without support or access to safety. Neither the evacuees nor the Jefferson Parish Sheriff's Office had received timely information about alternative strategies for shelter and sources of potential support.

Table 1 shows the heterogeneity of the 535 organizations reported in the *Times-Picayune* as participating in disaster response organizations. The striking observation regarding these data is the high number of federal and national organizations engaged in disaster response, followed by the late entry of these organizations into the disaster response system, shown in figure 1. While local organizations from the city and parish levels took some action before the storm, it was only on September 1, four days after landfall, that a sizable infusion of support arrived from federal agencies.

The record of operations from Hurricane Katrina compels a redefinition of the organizational framework and standard terms of emergency management. Effective intergovernmental performance requires both structure and flexibility. The difficulty lies in achieving a balance between the two and recognizing that the appropriate balance varies with the size, scope, and severity of the event and the initial conditions of the communities in which disaster occurs. The conceptual framework for an emergency management system must necessarily accommodate change and uncertainty. Consequently, the rigid, rule-bound structure of the National Response Plan, with its focus on terrorism and the specific requirements of the National Incident Management System, failed to function in the severely damaged context of New Orleans, with its vulnerable physical environment, civil infrastructure, and population, as well as in surrounding regions before and after the storm.

If the operational capacity for intergovernmental crisis management is conceived as an evolving, complex system with multiple components that form and reform in response to changing conditions (Comfort 1999), then the emerging structure more closely resembles a networked organization than a hierarchical structure with precisely defined allocations of responsibility and authority. In actual events, personnel with assigned responsibilities may not be available, their capacity to act may be reduced by damaged infrastructure, or their resources and experience may be inadequate to respond to the conditions they face. The capacity for adaptation to a suddenly altered or rapidly changing environment is critical for effective performance. This capacity still depends on the critical functions of cognition, communication, coordination, and control, but it needs to be understood in a new way. Each process, however, can be redefined in ways that support the capacity for adaptation and change in extreme events

Cognition

Cognition provides the initial content and activating link to the subsequent processes of communication, coordination, and control. Drawing on insights from Simon (1997), Weick (1995), and Klein, Orasanu, and Calderwood (1993), the capacity for cognition depends on a clear mental model of how the system under observation should work. Emergency managers using cognition do not review the entire set of rules of operation for the system but rather scan the margins for discrepancies or malfunctions. It is the discrepancy between what they view as normal performance and the change in status of key indicators that alerts them to potential danger. The indicators may be vague or disparate, such as a sudden change in the color of the sky, or a marked drop in barometric pressure, or a telltale sag in a levee footing, but an observant and experienced manager, with a clear recognition of how sound operations should perform, will be alert to signals of dysfunction. These signals will lead him or her to ask questions, check performance, and initiate further inquiry. Cognition in emergency management is a process of continuing inquiry, building on prior knowledge of the region at risk and integrating

Table 1 Frequency Distribution of Organizational Response System by Sector and Distribution, Hurricane Katrina, August 26–September 19, 2005.

	Public		Nonprofit		Private		Special Interest		All Organizations	
	N	Percent	N	Percent	N	Percent	N	Percent	N	Percent
International	11	2.1	3	0.6	6	1.1	0	0.0	20	3.7
Federal/national	69	12.9	23	4.3	75	14.0	1	0.2	168	31.4
Regional	1	0.2	7	1.3	25	4.7	0	0.0	33	6.2
State	78	14.6	7	1.3	4	0.7	2	0.4	91	17.0
Subregional	11	2.1	12	2.2	10	1.9	0	0.0	33	6.2
Parish/county	69	12.9	3	0.6	1	0.2	0	0.0	73	13.6
City	66	12.3	29	5.4	22	4.1	0	0.0	117	21.9
Total	305	57.0	84	15.7	143	26.7	3	0.6	535	100.0

Source: *Times-Picayune* (New Orleans), August 26–September 19, 2005.

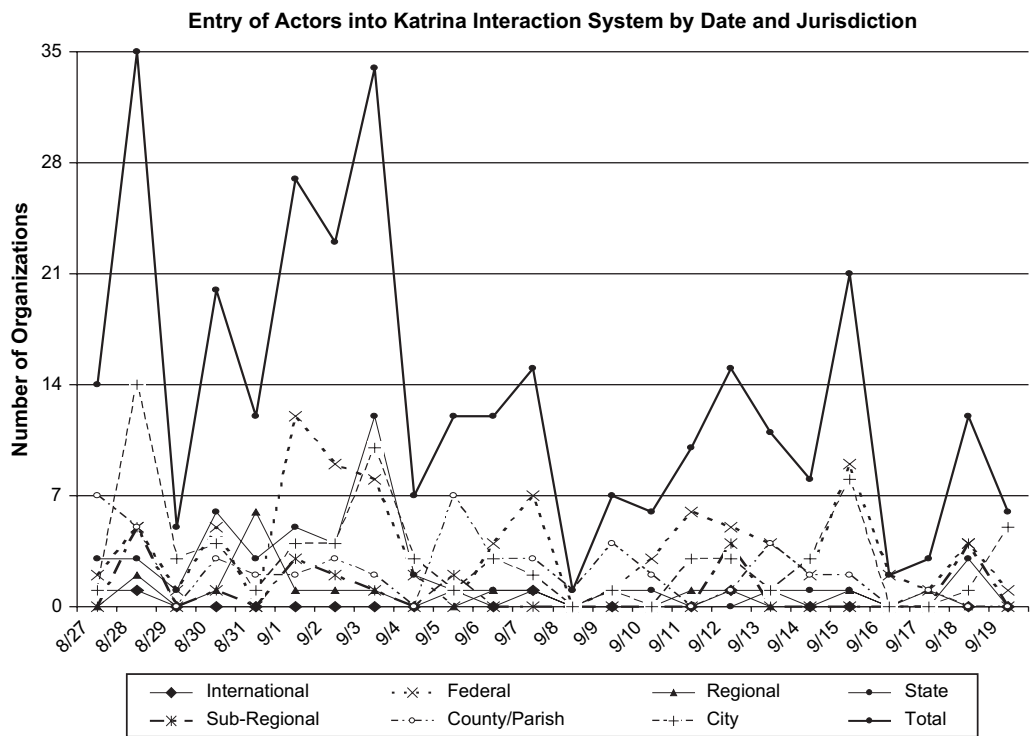


Figure 1
Source: *Times-Picayune* (New Orleans), August 26–September 19, 2005.

incoming information on changing conditions and system performance into a current assessment of vulnerability of the community.

Communication

Communication in emergency management practice has focused on the interoperability of mechanical devices, such as radios, hand-held data devices, cell phones, and landline and satellite telephone networks. In practice, communication necessarily involves the capacity to create shared meanings among individuals, organizations, and groups. Niklas Luhmann, in his book *Ecological Communication* (1989), refers to communication as the process of activating the creative spark, or *autopoiesis*, in self and others. By this, he means the capacity for innovation or finding new ways to solve immediate problems. This capacity generates a larger concept of *resonance* between an organization and its environment. That is, if the organization articulates its goals and mission in ways that have meaning for others, individuals and organizations in the wider society will respond with resources and support to achieve that goal. Creating and sustaining resonance between the organization and its wider environment are central to achieving effective action in crisis management.

Luhmann identifies a third factor in the evolution of systems as the capacity to create unity from the differences among the components, or a new system that is created by mutual recognition and respect for the differences among them. The intent of communica-

tion, then, is to reframe the differences among the component elements in ways that allow the components to focus on the characteristics that unify rather than differentiate them from one another. For example, if the sheriff of New Orleans Parish had articulated the common goal of regional safety and security to the sheriff of Jefferson Parish, would the evacuees from New Orleans have been welcomed into Gretna instead of driven back to their drowning city? These are not easy goals to achieve, but the concept of communication clearly includes the creation of shared meanings among different members of an interacting system.

Coordination

Coordination means aligning one's actions with those of other relevant actors and organizations to achieve a shared goal. Again, the capacity for coordination depends on effective communication. If the communication processes do not elicit sufficient shared understanding among the parties to align their priorities for action, the likelihood of achieving a common action framework among multiple actors will be seriously diminished. Coordination has a further characteristic. The term assumes that the participating actors align their activities voluntarily. If this does not occur, managers are left with only two options. They can either coerce the recalcitrant actors into changing their performance (at which point the process can no longer be called coordination), or they can ignore the fact that some actors are not participating fully and essentially become "free riders" on the energy and talents of other members of the group. Such discrepancies breed

discontent in any group and lead, sooner or later, to discontent, frustration, and ineffective performance. Voluntary coordination depends on effective communication and reinforces the capacity for adaptive performance in dynamic conditions.

Control

Too often, the concept of control is misused as the exercise of power over members of an organization by a small group of privileged managers. In the dynamic, uncertain environment of disaster operations, control means, rather, the capacity to keep actions focused on the shared goal of protecting lives, property, and maintaining continuity of operations. Control in this sense is maintained through shared knowledge, commonly acquired skills, and reciprocal adjustment of actions to fit the requirements of the evolving situation. In disaster environments, control means the capacity to focus on the critical tasks that will bring the incident to a nondestructive, nonescalating state. It is self-imposed and, in its effective use, sets the example for others to follow in adapting their performance to a changed environment. This concept of control is similar to that articulated in military environments for “third-generation warfare,” which characterizes the capacity of military personnel to frame strategies of action to achieve the goal outlined by their commander (Goodrich 2007) but is based on their own orientation, observation, decision, and action (Boyd 1986).

Individual instances of control were common in disaster response operations, but in the overall performance of disaster operations, emergency response agencies largely lost control of their capacity to act in the days immediately after landfall. The fact that FEMA employees were told to leave the damaged city until federal reinforcements arrived on September 1 regrettably illustrated the loss of control within the Superdome, the sorry refuge for those who were left behind.

In summary, intergovernmental crisis management can be reframed as a complex, adaptive system that adjusts and adapts its performance to best fit the demands of an ever-changing physical, engineered, and social environment. This capacity depends on a well-designed information infrastructure that can facilitate the processes of cognition, communication, coordination, and control among participating actors and organizations.

Redesigning the Crisis Management Process

Reflecting on the costs and opportunities that have been created by the public dialogue following Hurricane Katrina, it is possible to reframe intergovernmental crisis management as an auto-adaptive system (Comfort 1999). Such a system can be conceived of as a dynamic interorganizational system that is characterized by four primary decision points: (1) detection of

risk, (2) recognition and interpretation of risk for the immediate context, (3) communication of risk to multiple organizations in a wider region, and (4) self-organization and mobilization of a collective, community response system to reduce risk and respond to danger. The decision points move from individual to organizational to system levels of aggregation and communication of information that are used as a basis for creating a “common knowledge base” to support collective action to reduce risk. In practice, it is at these four transition points of escalating requirements for action that human cognitive, communicative, and coordinating skills frequently fail. When they do, the organizations inevitably lose control of the situation.

Building the awareness of risk to support collective action is a cumulative process. If the first three steps of risk detection, cognition, and communication have not been carried out successfully, the effort to engage organizations from a wider arena into a coordinated emergency response system is likely to flounder or fail, losing control.

One model for achieving this task of communicating critical information to focused audiences is the “bow-tie” architecture for decision support (Comfort 2005; Csete and Doyle 2004). As shown in figure 2, this design identifies key sources of data that “fan in” simultaneously to a central processing unit (or “knot”), where the data are integrated, analyzed, and interpreted from the perspective and performance of the whole system. The new information is then “fanned out” to the relevant actors or operating units, which use the information to make adjustments in their specific operations informed by the global perspective. This design fits well with an emergency operations center, where status reports from multiple agencies are transmitted to the service chiefs who review the data from the perspective of the whole community. The service chiefs collectively integrate, analyze, and interpret the data in reference to the performance of the whole response system and then transmit the relevant information to the respective agency personnel, who adjust the performance of their units informed by the operations perspective for the entire system. The capacity for reciprocal adjustment of performance among multiple organizations based on timely, valid information represents self-organization in emergency response, guided by the shared goal of protecting lives, property, and maintaining continuity of operations for the whole community (Axelrod and Cohen 1999; Comfort 1994).

This theoretical framework acknowledges the importance of both design and self-organizing action in guiding coordinated action in a complex, dynamic environment. It can be modeled as a set of networks that facilitate the exchange of incoming and outgoing information through a series of analytical activities

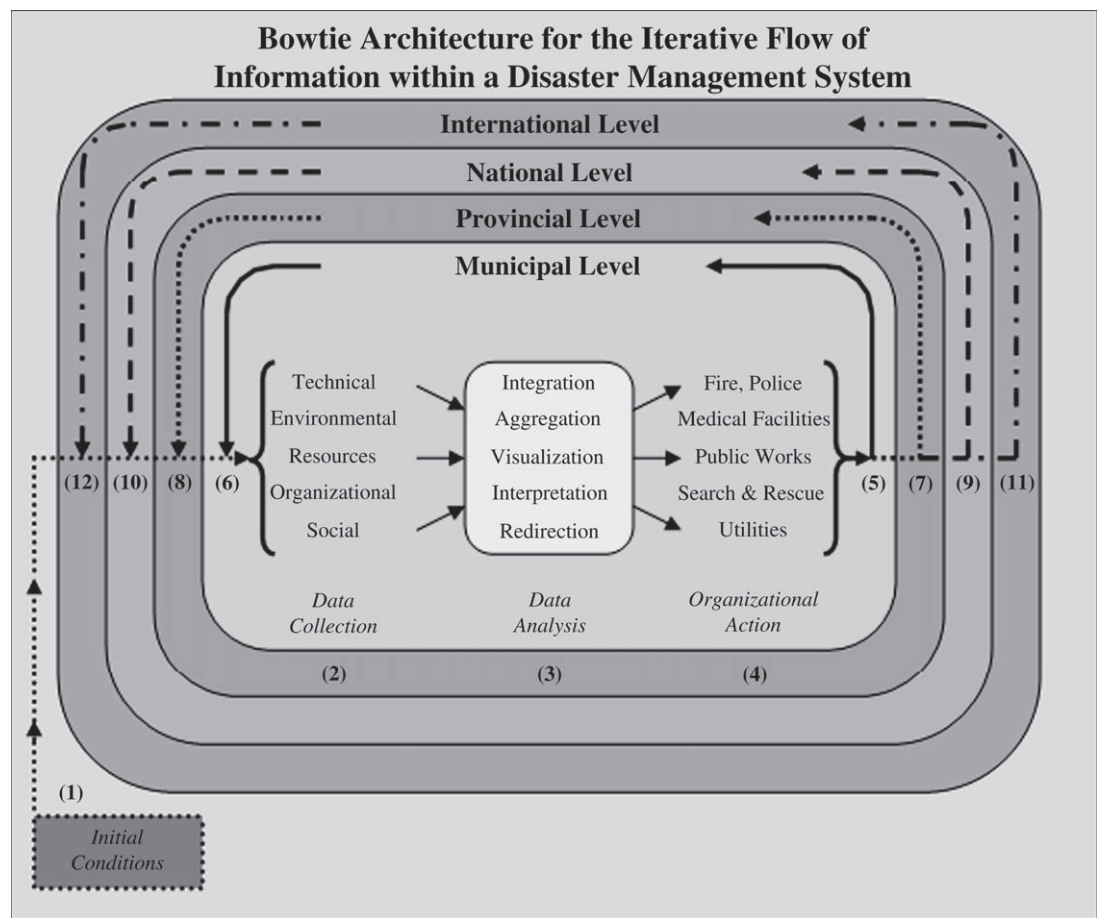


Figure 2

that support systemic decision making. The information flow is multiway but gains efficiency through integrated analysis and coordinated action toward a clearly articulated goal for the whole system. It operates by identifying the key sources of information, the key processes of analysis and interpretation for the whole system, and the key routes of transmission. It maintains self-organizing functions in that personnel, with informed knowledge, adjust their own performance to achieve the best performance for the whole system. Design, self-organization, and feedback are central to the effective performance of distinct organizational units within the global system.

Such a design depends on sufficient investment in the technical information infrastructure to support the interdependent tasks of cognition, communication, coordination, and control requisite for collective response to an extreme event. This financial investment, most appropriate at the federal level, is essential to creating and sustaining the individual and organizational learning processes characteristic of successful auto-adaptive systems.

Design, self-organization, and feedback are central to the effective performance of distinct organizational units within the global system.

Five propositions regarding constructive change for the intergovernmental crisis response system serve as an initial justification for investment in a nationwide information infrastructure that would facilitate the development of a common operating picture in extreme events. Such an investment would build on the human capacity to learn, and use the technology to monitor performance, facilitate detection and correction of error, and enhance the capacity for creative problem solving and responsible performance. They include:

- Human capacity to perceive risk increases with the timeliness, accuracy, and validity of information transmitted in reference to a core set of risk indicators for the community.
- Human capacity to recognize risk conditions can be increased

by focusing risk data in formats that are directly relevant to the responsibilities of each major decision maker in the system.

- The capacity for coordinated action among multiple organizations can be increased by the simultaneous transmission of relevant risk information to

each manager, creating a common operating picture of the status of the region.

- The collective capacity of a community to act to reduce risk can be increased through timely information search, exchange, and feedback processes that create an interorganizational learning system across jurisdictions and sectors.
- Without a well-defined, functioning information infrastructure supported by appropriate technology, the collective response of a community exposed to serious threat will fail.

Living with risk is endemic to this restless planet.

Learning to manage risk more efficiently and effectively is attainable through carefully designed sociotechnical systems that incorporate on a process of continuing organizational, inter-organizational, and interjurisdictional learning.

Living with risk is endemic to this restless planet.

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