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THE INCIDENT COMMAND SYSTEM: HIGH RELIABILITY ORGANIZING FOR COMPLEX AND VOLATILE TASK ENVIRONMENTS*

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THE INCIDENT COMMAND SYSTEM: HIGH RELIABILITY ORGANIZING FOR COMPLEX AND VOLATILE TASK ENVIRONMENTS

Abstract

The term incident command system (ICS) denotes a particular approach to assembly and control of the highly reliable, temporary organizations employed by many firefighters, police, and other public safety professionals to manage diverse resources at a wide variety of emergency scenes. Our inductive study of a fire department's use of the ICS identified three main factors enabling this distinctively bureaucratic system to produce remarkably flexible and reliable organizations for complex and volatile task environments. In general, this research suggests the possibility of new organizational forms able to capitalize on the control and efficiency benefits of bureaucracy, while at the same time avoiding or overcoming the considerable tendencies toward inertia that are thought to accompany bureaucratic systems.

Recent organization science research indicates that an expanding number of organizations are facing increasingly unforgiving socio-political-economic contexts (cf. D'Aveni, 1994). Operational failures resulting in inappropriate, incomplete, laggardly or otherwise mindless organizational responses to unexpected and demanding environmental contingencies (such as major and unforeseen competitive threats, product malfunctions and recalls, supplier collapses, technology breakdowns, etc.) are ever more likely to be immediately and critically disabling (Hanssen-Bauer & Snow, 1996; Lagadec, 1993; Pearson & Clair, 1998). Consequently, reliability—i.e., the capacity to continuously and effectively manage working conditions, even those that fluctuate widely and are extremely hazardous and unpredictable (Weick, Sutcliffe, & Obstfeld, 1999), is becoming a vital organizational quality or competency.

Traditional bureaucratic (Weber, 1947) or mechanistic systems (Burns & Stalker, 1961) ostensibly become more ***un***reliable as situational volatility escalates (cf. Weick, et al., 1999). In fact, Adler, Goldonftas, and Levine (1999) suggest that one of the most enduring ideas in organizational theory is that bureaucracies—characterized by structural features such as standardization, specialization, formalization, and hierarchy—enable the steady, efficient functioning organizations require to compete successfully under stable operating conditions, but they also severely limit the flexibility organizations need to cope effectively with complex, ambiguous, and unstable task environments. Not surprisingly, then, a growing number of managers are experimenting with new organizational forms that purportedly achieve flexibility, and thus a degree of reliability under turbulent conditions, by way of more organic and temporary work arrangements (Ilinitch, D'Aveni, & Lewin, 1996). Hybrid, network, and virtual are several of the terms that have been used to identify these emerging organizing principles.

However, our inductive study of a fire department's use of an approach to emergency or disaster management called the incident command system (ICS) points to the possibility of new, highly bureaucratic and temporary organizational forms able to attain remarkable reliability under a broad range of working conditions (including those marked by extreme uncertainty and instability). An ICS-based organization appears able to capitalize on efficiency and control benefits of bureaucracy, while at the same time avoiding or overcoming the considerable tendencies toward inertia (cf. Hannan & Freeman, 1977) usually thought to accompany bureaucratic systems. ICS-based organizations may be more reliable for extreme conditions than organizations founded on alternative approaches (e.g., organic systems). They appear able to structure and restructure themselves on a moment-to-moment basis, and provide members with means to oscillate effectively between various pre-planned organizational solutions to the more predictable aspects of a disaster circumstance and improvisation for the unforeseen and novel complications that often arise in these types of situations.

We organized this paper as follows: First, we describe the ICS and provide a brief history of its initial development. We also offer an account of some of the ways it exhibits flexibility. Then, we detail the inductive procedures used to develop the ICS model. Next, we present our theory, which centers on three main ICS factors; structuring mechanisms, organizational support for constrained improvisation, and cognition management methods—that, in combination, lead to exceptional organizational reliability under volatile environmental conditions. Subsequently, we discuss the potential for generalizing from the fire department's emergency management system to other more mainstream organizations, and we describe how our findings compare with current research on new organizational forms and organizing processes. The paper concludes with a consideration of the study's limitations and several practical implications of the ICS model.

THE INCIDENT COMMAND SYSTEM

The term ICS is the official designation for a particular approach used by many public safety professions (e.g., firefighters and police) to assemble and control the temporary systems they employ to manage personnel and equipment at a wide range of emergencies, such as fires, multi-casualty accidents (air, rail, water, roadway), natural disasters, hazardous materials spills, and so forth. The ICS was originally developed through a cooperative effort among a number of federal, state, and local governmental agencies in response to the harmful disorder that occurred among various organizations (e.g., municipal and county fire departments, the California Department of Forestry, and state and federal governments) attempting to suppress massive wildland fires in California during the 1970s. A task force investigating these incidents identified a number of recurring problems that suggested responding organizations lacked sufficient means to effectively coordinate activity in large, complex, and dynamic emergency situations. Examples of major deficiencies included a basic inability to adjust (e.g., expand or contract) organizations to accommodate shifting situational demands, nonstandard terminology and communication procedures among responding agencies, and problematic action planning protocols at emergency scenes. Designed to address these types of issues, the ICS approach turned out to be a major departure from previous large-scale emergency management methods.

Although initially developed in response to problems associated with wildland fire fighting, the ICS evolved into an all-risk system supposedly suitable for almost any type of emergency (e.g., natural disasters, riots, terrorist attacks) and for emergencies of nearly any size (ranging from a minor incident involving a single unit, such as a fire engine company, to a major event involving numerous agencies). Consequently, the use of fundamental ICS principals has expanded rapidly. For instance, the ICS was adopted by the National Fire Academy as its standard for incident response. Federal law now requires the ICS be used for management of hazardous materials emergencies. Many states have adopted the ICS as their model for responding to all types of incidents. Finally, the ICS is a cornerstone of Federal Emergency Management Agency's Integrated Emergency Management System (IEMS). The IEMS has the objective of developing and maintaining a credible, nationwide emergency management capability involving all levels of government and all types of hazards.

ICS Structure

The basic structure of a fully elaborated ICS, one appropriate for large-scale emergencies or disasters, such as massive wildland fires or powerful earthquakes occurring in highly populated areas, is shown in Figure 1. Table 1 defines major ICS elements. In the abstract, the ICS appears to exhibit many of the hallmarks of bureaucracy identified by Weber (1947). The system is highly formalized, characterized by extensive rules, procedures, policies, and instructions. Jobs within the ICS are specialized, based on standardized routines, and require particularized training. Positions are arranged hierarchically and related to one another on the basis of formal authority. Basic system objectives and plans are established at or near the top of the hierarchy and used as bases for decisions and behaviors at lower levels.

Insert Figure 1 and Table 1 about here

In general, the ICS is constructed around five major functions: command, planning, operations, logistics, and finance/administration. These building blocks presumably apply in both routine and non-routine situations and for ICS structures of all sizes. According to ICS logic, even when the system is very small, involving as few as two individuals, all five elements are likely to be relevant to some extent. When the system is small, however, one person may be able to manage the five elements altogether. Large-scale incidents usually require that components be relegated to their own "sections" where different individuals can manage each one separately. In addition, the sections may be divided into smaller functions as needed.

The *Incident Commander* is the highest-ranking position within the ICS. The person occupying this position is ultimately responsible for all activities that take place at an incident, including the development and implementation of strategic decisions and the ordering and releasing of resources. The incident commander is the one functional position that is always filled. Up to four sections report directly to the incident commander. At the section level, the person in charge is designated as Chief. The *Operations Section* is responsible for the development and execution of all tactical operations directly related to the primary goals and objectives of the ICS. The Operations Chief activates and supervises resources in accordance with the action plans developed by the planning section. The *Planning Section* develops the action plan to accomplish the system's objectives. It collects, evaluates, and disseminates information about the development of the incident and status of resources. Information is needed to understand the situation, predict probable courses of events, prepare alternative strategies, and control operations. The *Logistics Section* provides facilities and services to support ICS personnel. The *Finance/Administration Section* monitors costs related to the incident and provides accounting, procurement and cost analysis.

In addition, to the primary incident response activities of operations, planning, logistics, and finance/administration, the incident commander has responsibility for several other important services. Again, depending on the size and type of event, the incident commander may find it necessary to delegate authority for performing these functions to other individuals. These people constitute the Command Staff and are called officers. The *Information Officer* is responsible for the formulation and release of information about the incident to the news media and other agencies seeking information about the incident. The *Safety Officer* monitors and assesses safety conditions and develops measures to insure the safety of all personnel. The *Liaison Officer* is the point of contact for the assisting and cooperating agencies. Other major structural components employed as needed are shown in Figure 1 and defined in Table 2.

ICS Flexibility

Though highly bureaucratic in nature, the ICS seems to serve as a basis for the exceptional organizational flexibility required for reliable performance under highly variable and risky circumstances. For example, consider the account of the rapid coordination of diverse resources in response to an immense California fire. The event spanned ten days, and the fire was fought under volatile conditions both over treacherous or difficult-to-access wildlands and in various residential areas. From the outset, resource deployment proceeded at a torrid pace. Three minutes after the first call was received approximately 65 people, 7 engine companies, 2 water-dropping helicopters, and 1 bulldozer were dispatched to the scene. Within 80 minutes, the deployment had escalated to over 950 people and several hundred pieces of equipment. In the end, approximately 839 engines and 44 aerial units (consisting of helicopters and fixed-wing aircraft) were called into service. Firefighters responded from 458 fire agencies across twelve states and ultimately numbered more than 7,000. All personnel and equipment were managed through the ICS.

Furthermore, as the incident evolved, the dimensionality and uncertainty of the task environment increased substantially. Although fire suppression was the original focus, other operational imperatives rapidly emerged, including search and rescue, medical aid, residential evacuation, and hazardous materials containment. Moreover, personnel from a large number of non-fire agencies (law enforcement, Red Cross, city and county governments, Air National Guard, Federal Aviation Administration, Federal Emergency Management Agency) became involved with the emergency management effort, and their diverse contributions were coordinated through the ICS.

As this example suggests, ICS-based organizations can coordinate diverse resources in order to achieve specific objectives under turbulent, severely time constrained and hazardous conditions. Yet, despite its increasingly widespread usage, attractive qualities (e.g., flexible, adaptive, reliable) and apparent suitability to a broad array of organizational contexts, the ICS has not been the focus of systematic social science research. Our inductive study of a large California fire agency begins to address this dearth.

METHODS

The purpose of our research was to generate theory regarding how fire departments' emergency operations are able to maintain reliable organizational functioning across a broad range of dynamic and hazardous task environments. The model we detail below is grounded in qualitative data from a study of firefighters in a large California fire department. Our research design permitted unplanned themes to emerge from the data.

Research Site

The large county fire department that served as the site for this research is a cooperative venture between the county government and a number of constituent cities that contract with the county for fire department services. In other words, cities in the county either support their own fire departments or obtain fire services through a partnership arrangement with the county. The county fire department serves a population of over 1.2 million. Its jurisdictional area covers more than 560 square miles and consists of urban, industrial, and watershed lands in both city and unincorporated areas. Sixty plus fire stations are located in three major geographic divisions established for north, central, and south county. Each division consists of two or three battalions, and each battalion, in turn, is comprised of seven or eight stations. In total, the fire department employs over 800 full-time firefighters and 700 firefighters who are paid for each call.

Data Collection

Data collection took place at the fire department's headquarters and at two fire stations where call volume was exceptionally high and varied. Through this sampling strategy, the first author was able to see the system in action under different types of performance conditions. He was also able to conduct interviews with personnel having considerable experience with the ICS.

Data collection occurred in three phases and followed the tenets of theoretical sampling (Glaser & Strauss, 1967; Strauss & Corbin, 1990). Theoretical sampling involves a progressive tightening of focus, over the course of a data collection effort, on concepts and themes gaining relevance in an emerging model of the phenomenon of interest. Our initial focus was quite broad. We were interested in how firefighters maintain reliable organizational functioning in various risky and volatile emergency situations. As the research progressed, we became increasingly focused on the specific factors leading to the flexible and adaptive functioning of the ICS.

Phase 1 involved collecting data through unobtrusive observation, unstructured interviews, and reviews of various types of written material. The first author rode with engine companies as they responded to emergencies. (The designation "engine company" is given to teams—usually of four people consisting of a captain, an engineer, and two firefighters—operating fire engines and responding from them.) Concurrently, he conducted unstructured interviews with firefighters, asking them to clarify and expand upon what he had witnessed and to comment on their experiences in other emergency situations. Hand written notes of observations and interviews were taken in the field. In addition, archival sources of data, including training manuals, field operations guides, and after incident reports were reviewed and analyzed. During this phase, the importance of the ICS in organizing for emergency situations became clear.

During Phase 2, data were collected through fifteen semi-structured interviews conducted privately and face-to-face by the first author. We wanted to insure that a wide range of perspectives on the ICS was represented during the Phase 2 interview stage. Our strategy was to interview individuals who had performed as incident commanders, team leaders, and frontline firefighters. Furthermore, we sought to include in our respondent set people from various hierarchical positions who possessed different levels of training and experience. Consequently, our sample ranged from veteran battalion chiefs certified in numerous specialty areas (e.g., paramedic, hazardous materials handling, and urban search and rescue) to rookie firefighters.

These interviews were tape recorded, and their average length was approximately 1.6 hours. Participants were first asked to provide demographic information and brief professional and educational histories. Then, they were asked to describe situations that they were involved with where the ICS functioned particularly well or intelligently. Based on a participant's answer to this question, a series of queries followed intended to elicit responses helping further identify and clarify factors that either help or hinder effective ICS functioning. Next, informants were asked to describe a situation in which the ICS did ***not*** perform well or intelligently. Again, specific follow-up questions depended on initial answers. It should be noted that interviews were interrupted when firefighters had to respond to emergency calls. Often when this happened, the interviewer would ride with the engine company and observe how the system worked.

In Phase 3, the first author conducted ten semi-structured interviews that were both private and face-to-face. All interviews were tape recorded, and they averaged about 2.4 hours. The primary objectives during this phase were to address theoretical gaps that remained after the analysis of Phase 2 data and to insure variables and categories were theoretically saturated—i.e., that we were at the point where no new or relevant data was likely to emerge regarding our main theoretical constructs (Glaser & Strauss, 1967). After answering standard questions regarding their demographics and backgrounds, participants were again asked to recount incidents where the ICS performed exceptionally well or intelligently. However, based on the principles of theoretical sampling, many of the follow-up questions were focused much more specifically on aspects of the emerging model. As in Phase 2, interviews were occasionally interrupted when firefighters had to respond to emergency calls, and the interviewer would frequently ride along with the engine company when this happened to collect additional observational data.

Analysis

In order to develop the conceptual model, we followed a grounded theory methodology (Glaser & Strauss, 1967; Strauss, 1988; Strauss & Corbin, 1990). In so doing, we fully transcribed the Phase 1 field notes and the twenty-five tape-recorded interviews conducted during Phases 2 and 3. Detailed analyses of transcripts and archival materials were carried out both during and after each phase of the data collection effort.

Conceptual categories and the relationships among them emerged through an iterative process involving the various data, the developing theory, and organizational science literature. Throughout the data collection process we provisionally identified concepts and relationships from the data that seemed pertinent to the emerging model of how firefighters maintain reliable organizational performance under a variety of emergency conditions. These ideas were compared to literature and new data to help determine whether initial inferences should be retained, modified, or dropped. Similarly, we kept, revised or discarded concepts coming out of the literature depending on whether and to what extent they found support in the data.

ICS FACTORS LEADING TO ORGANIZATIONAL RELIABILITY

The construction and maintenance of a coherent response to an emergency situation, such as the California wildland fire discussed previously, represents a considerable accomplishment. The organizational approach must continually map to the requisite variety (cf. Buckley, 1968) of a dynamic and risky situation: The system in use must be able to expand and contract, change strategic orientation, modify or switch tactics, and so forth as an incident unfolds. Compounding the challenge is the notion that hazardous task contingencies may not have been previously experienced or predicted. Furthermore, system and task complexities coupled with the need for immediate local adjustments may preclude the possibility of sufficient or timely direction from superior hierarchical positions (cf. Weick, 1990). Yet, uncoordinated activities can drastically increase participants' hazard exposure, as we discuss later. Finally, many or most individuals comprising the organization may have never worked together before and may have the realistic expectation of never working together again.

Almost from the outset of the research program, the ICS came into view as a primary means through which firefighters manage these organizational issues. Consequently, a considerable portion of our data collection and analysis work centered on the identification of ICS factors contributing to flexible and adaptive response to emergency situations. The data analyses pertinent to this research yielded three major conceptual categories leading to reliable ICS performance under hazardous and dynamic emergency situations: structuring mechanisms, organizational support for constrained improvisation, and cognition management methods. Figure 2 depicts our basic framework. In the subsections that follow, we develop these categories and explicate how they lead to reliability in organizations confronted with demanding task contingencies.

Insert Figure 2 about here

Structuring Mechanisms

The ICS, as employed by the fire agency we studied, consists of at least four basic processes for rapidly altering organizational structure. Structure elaborating, role switching, authority migrating, and system resetting are the terms we put forward to identify these processes. They are contingent in nature, their appropriate use being largely a function of the task requirements confronting the ICS-based organization at any particular time. Our observations and informant reports indicate that when these processes are aptly applied, they function to enhance organizational flexibility and reliability.

Structure elaborating. Structure elaborating denotes the fundamental processes of organization construction. The ICS places considerable emphasis on system organization practices for several reasons. First, emergency management systems are typically assembled on-scene during the course of an incident. Additionally, they must be capable of rapidly organizing a few to several thousand people under demanding circumstances. These design requirements bring organizing processes themselves to the fore. The ICS structure elaboration process is highly developed, with the initial construction of all ICSs commencing in approximately the same way:

> That first unit in is the incident commander regardless of who it is or what it is . . . He's going to arrive on the scene; he's going to give his report on conditions; he's going to report resources. He's going to do what an incident commander does, for the initial stages of it. And then as this thing starts to build, and you have other people coming in of higher rank or higher positions, he may get bumped way down into the system, but at one point he was running the show. And all incidents start the same way. They start with the first unit on the scene. And they start building. (battalion chief, interview #1)

Another battalion chief described the organizational elaboration process for a large, and complex incident:

> They [incident commanders] go through the risk assessment deal, the communication of objectives, and the assignment of resources. Then they start going through those standardized tools and start putting some organization to it, it becomes more like things we have done before. And with the pattern people accept the leadership roles, they accept the organization, and start to function within it. Then it gets you moving down the line to catch up with that power curve. And then at some point in time you're going to have enough fire resources, or emergency resources, or cranes, or whatever else you need in place so you can start now to whittle away at this emergency so it's not an emergency anymore (battalion chief, interview #12).

The captain of the first unit to arrive usually becomes the incident commander and has at his or her disposal the basic organizational building blocks (see Figure 1 and Table 2) discussed in a previous subsection. The incident commander assesses the situation, identifies contingencies, develops objectives, ascertains resource needs, and generates an initial action plan. Then he or she begins to build an organization consistent with objectives and plans through an assignment of roles and tasks to incoming resources.

Informants reported that the ICS works best when the various ICS roles or positions are filled with people only to the extent required. In most instances, only the Operations Section (see Figure 1) is employed, and then only at single resource, task force or strike team levels. Furthermore, while the five major ICS activities (command, operations, etc.) are carried out, to some degree, at all incidents, they often are not assigned to specialized roles. In fact, the over development of higher-level components, such as sections, branches, and divisions, can compromise system effectiveness, as a battalion chief indicated:

> I'll tell you where it doesn't work. And I guess I know this has happened. You get some people in the incident command system, the first thing they start doing is they start filling in bodies in the all the boxes. 'I'm the incident commander. I need operations, plans...I'll just fill in the boxes.' And there's nobody left to put out the fire . . . They don't have any resources because they've used them. They've got an operations chief, and they've got a division supervisor here, a division supervisor there. And they've got this guy here and that guy there. And then they say, 'anybody got a line on the fire?' That's not using the incident command system as designed . . . I go in, I've got my hat on. I'm the incident commander. I'm also the operations chief, also the division supervisors. And until that thing gets big enough to where I'm dividing it, I wear all those hats. Or the engine company captain wears all those hats. (battalion chief, interview #1)

The structure elaborating process may persist until the emergency begins to abate. Within the most reliable systems, objectives and corresponding structural elements and relationships are adjusted swiftly in accordance with changing environmental contingencies. In fact, we noted that an incident commander's goals and plans might be revised completely, over the course of minutes or hours, depending on the evolution of a particular situation. A battalion chief describes how an organizational approach had to be altered frequently to combat an enormous wildland fire threatening numerous residential properties:

> We would put up lines of defense that the fire would blow through like nobody's business. So we had to constantly reevaluate our strategy. I think you've seen in our command development, normally we will come up with a set of incident objectives, we'll communicate to the troops. And 90% or better of the time that set of objectives is highly successful and stops the emergency. We developed seven sets of objectives that kept getting their butt kicked during the ___________ fire. And each time we lost a strategy, we had to pull out a map, write off more houses, think about the evacuation thing again, and try and beg more resources. (battalion chief, interview #12)

Role switching. Role switching compliments the structure elaboration processes. As described above, ICS roles are activated and role relationships are established in accordance with the functional requirements of the situation, as assessed by the incident commander. Positions are also deactivated when goals and plans no longer require them. Role switching involves the assignment and re-assignment of personnel to different positions within the organization. Whenever objectives and the appropriate role structure for an emergency situation change, personnel are either moved into newly created roles or discharged. Given that well-defined expectations and reporting relationships are attached to ICS roles, transferring individuals among roles represents a fairly efficient way of reorienting them to evolving conditions. A captain described a circumstance in which new roles had to be created to accommodate a situation that had changed:

> Okay, initially, we arrived at the scene [of a structure fire] and I established command and assigned people to different divisions: an interior division and a roof division. Once we had the system established, we sent somebody in for interior. Then, I get a report back that we have a hazardous materials incident. So, we pull all our people. Now the incident command structure changes slightly, where now we have to think in terms of hazardous materials. It went from what we call an incident command on a single family structure fire to a hazardous material incident. There is a whole different set of strategies and a different set of names for what you want people to do next. Before we were talking about interior division and roof division or ventilation division. Now we are talking about hazmat group, exposure group . . . Same people with others added. (captain/assistant fire training officer, interview #21)

Authority migrating. Critical expertise for solving problems associated with a particular situation is often distributed within an ICS (Flin, 1996). For instance, certain individuals may have specialized training (e.g., paramedic, hazardous materials handling, or urban search and rescue); others may have considerable knowledge in areas such as construction or chemical processing by virtue of holding second jobs. Informants repeatedly suggested that while formal authority relationships are fixed, informal decision-making authority, especially at the tactical level, can become explicitly de-coupled from the official hierarchy and migrate quickly among ICS positions to individuals who possess the expertise to solve particular problems. Roberts, Stout, and Halpern (1994) describe a similar phenomenon occurring on two nuclear-powered aircraft carriers. Roberts et al. note that individuals of superior rank tended to defer to lower-level experts who were more technically qualified when decision-making errors could have catastrophic consequences. Informants suggested that the ICS works better when supervisors permit and direct authority migration. An engine company captain provides an example of the authority migration process in an ICS:

> As a manager, it is really incumbent on me to recognize my weakness [in a particular area]. . . and that I don't have as much knowledge as maybe a guy standing here next to me. Maybe I've got one of the premier national USR [urban search and rescue] truck captains standing next to me, and this guy knows it like bread and butter. So I'd be a much better manager, and I'd basically build the trust of people better, if I said, "Okay, here's what the overall goal in this incident is: to get this truck off this guy. Okay? And Bob over here on Truck "45", or whatever, is the one that's going to basically direct the point-by-point operation of this." You know, because this is the guy that has the knowledge. So you bring in the experts. You bring in the guys that have all the tools and the knowledge, and you let them handle that end of it, and you still manage to hold the scene. You know, you're not relinquishing command of the whole thing. You're not relinquishing your position. You're basically using your resources to the best of your ability, and he's one of your resources. (engine company captain, interview #18)

System resetting. System resetting is another mechanism available to ICS members in their efforts to match changing situational factors. In cases where an initial strategy seems to have no effect or the system is confronted with a "nasty surprise" (e.g., an explosion of flammable materials that had not been previously identified) that calls into question the initial approach, the incident commander may opt to completely disengage the system from its task environment and redirect or reconfigure it. Disengagement is ideally done in an orderly and rapid manner under existing reporting relationships. A battalion chief explains how this option was employed after an unexpected explosion occurred while firefighters were trying to extinguish a fire in a garage:

> Things didn't go as planned. That fire should have gone out, and all of a sudden it's running at you . . . It took a turn of events that was unexpected. And they will do that to you. Some of them will go like clockwork, some of them will take that turn of events. And in a situation like that, that's a fall back and regroup. You're not going to get anybody hurt. You all back out. We had a couple of guys that got a couple of small burns and things because of the turn of events. But nobody was hurt seriously. But you fall back. And what happened is, you know, maybe you take a defensive posture now. Instead of an aggressive going in and putting it out. You go back and say, 'what do we have.' And maybe we let it burn, and we save the surrounding structures. It can change your whole tactic. So it's a fall back and regroup. What happened, and do we know why? If you know why, then you can change your plans. (battalion chief, interview #1)

Our discussion of structuring mechanisms in this subsection highlights the modular nature of the ICS-based emergency management organization we studied. A system is modular to the extent that its components can be separated and recombined in various ways, while system functionality relative to environmental demand is maintained or enhanced (cf. Baldwin & Clark, 1997; Sanchez & Mahoney, 1996; Schilling, 2000). In general, these structuring mechanisms represent a fairly explicit set of procedures for assembling and reassembling various organizational elements or modules (engine companies, search and rescue crews, hazardous materials teams, and so on) into a variety of configurations in response to changing working conditions.

Support for Constrained Improvisation

According to informant comments and our observations, the explicit procedures for altering the formal structure do not, in themselves, provide the full measure of flexibility required for an ICS-based organization to respond effectively to many multifaceted, volatile and hazardous task environments. In general, complex and dynamic systems are not fully comprehensible to those involved in them (Asch, 1952). The incident commander (and other supervisors) may not understand enough about the contingencies of the local situations facing subordinates to provide sufficient direction, especially if the incident commander is somewhat removed from the actual field of activity. In addition, because each emergency situation is, to some extent, unique, task environments often outstrip the experience base of those people in the ICS. Finally, decision errors made at the top of an organizational hierarchy can ramify and intensify as they move down the authority structure (e.g., Roberts & Moore, 1993; Turner, 1978; Vaughan, 1996). Higher-level errors can induce and interact with lower-level errors, resulting in an increasingly complex and difficult to understand situation.

To reduce the problems of explicit, centralized structuring, incident commanders and other supervisors possess considerable discretion regarding the extent to which they must give detailed instructions to their subordinates for any particular task situation. When the commander believes subordinates possess sufficient experience, training, and resourcefulness to adapt to local conditions, he or she typically leaves the task partially unstructured (unless an unusual degree of directed coordination is required for some other reason). In other words, supervisors provide subordinates with a degree of latitude to improvise—i.e., to activate and coordinate their own routines and to apply novel tactics to unexpected problems.

This improvisation represents an implicit or bottom-up structuring process. However, improvising is organizationally supported only as long as it produces behaviors consistent with general operational objectives. One captain described the constrained nature of improvising this way:

> Improvising is altering your tactics or your methods to still accomplish the same goal with an understanding of what the connection [between the altered tactics and the goal] is. (truck company captain, interview #4)

Another captain suggests the following definition:

> Improvising is still accomplishing the same task, but maybe not doing it specifically as it's outlined in the book. (captain/assistant fire training officer, interview #22, lines)

Again, improvisation is considered legitimate only to the extent that it fits with extant organizational goals and objectives and is not likely to cause harm to the improviser, other system members, or members of the community at large. However, while legitimate improvisation is constrained, its degree can vary considerably. This phenomenon maps to the improvisational continuum described by Weick (1998). He described a continuum in the musical realm ranging from interpretation through embellishment and variation, and ending in improvisation. Each successive type places increased demands on imagination and concentration.

> "Interpretation" occurs when people take minor liberties with a melody or when they choose novel accents or dynamics while performing it basically as written. "Embellishment" involves greater use of imagination, this time with whole phrases in the original being anticipated or delayed beyond their usual placements. The melody is rephrased but recognizable. "Variation" occurs when clusters of notes not in the original melody are inserted, but their relationship to that original melody is made clear. "Improvisation" on melody means "transforming the melody into patterns bearing little or no resemblance to the original model or using models altogether alternative to the melody as the basis for inventing new phrases (Berliner, 1994: 70, cited in Weick, 1998: 544-545).

In the ICS, the degree of improvisation is linked to, and limited by, the basis from which it springs. ICS members tend to act extemporaneously with regard to tools, rules, and routines. A truck company captain describes the improvisation that takes place frequently with ***tools***:

> We improvise all the time because we only have so much stuff on the trucks and when we get to the scene, we're expected to handle the situation with what we have on the trucks so we improvise . . . (truck company captain, interview #17)

In other cases, improvisation may involve more radical departures from established structures like adopting tactics, which directly contradict standard operating procedures. In these cases, individuals improvise with reference to the ***rules***. Most informants provided examples of cases where violations of standard operating procedures may be necessary. For instance, a firefighter reported that one standard operating procedure prohibits "opposing hose streams"—i.e., firefighters are prohibited from approaching a fire from directly opposite positions because one group can push the fire into the other. However, he discussed a situation in which his company effected a rescue in conjunction with another company using opposing hose streams as a main tactic. The degree to which an individual can engage in tactics that transcend or contradict standard operating procedures is a function of his or her experience level:

> Every incident is dynamic, and so every incident may require a different approach. If you absolutely have to do something contrary to standard operating procedures, that will be based on a decision that the commanding officer makes on the basis of his or her experience or outside knowledge—knowledge that maybe isn't a regularly trained activity within the department . . . A good example would be . . . an engine company captain who has hazardous materials training to a higher level . . . He may be able to base many decisions on just a higher level of training or higher level of expertise and so he may react a little different to the situation than say for example, a company officer who didn't have that level of training. (captain/assistant fire training officer, interview #21)

Finally, ICS members improvise with regard to the execution and coordination of their ***routines***. Standard routines, such as hose laying or ladder throwing, may have to be adjusted to accommodate local circumstances. Furthermore, the coordination of routines among companies may be somewhat improvisational in nature. As resources (e.g., engine companies, truck companies) arrive at an incident, they are assigned to particular tasks. At a building fire, for example, an engine company may be directed to enter the building and start fire fighting. A truck company, then, may be given the job of ventilating the structure. As a building burns, substantial smoke and heat can accumulate in its interior. Without proper ventilation the firefighters assigned to attack the fire from within the building may be at considerable risk, because smoke reduces visibility, and heat buildup can result in spontaneous combustion.

Teams such as these may have to coordinate their activities in unusual situations, such as when building construction is peculiar.

While certain types of improvisation are crucial to ICS flexibility and are supported by the ICS, others are detrimental to system functioning and are aggressively discouraged. The term used by informants to describe the latter sort of extemporaneous activity is "freelancing." Freelancing refers to behavior not directed at, or supportive of, ICS goals, objectives, and approaches at a particular incident. Freelancing can severely increase the hazard potential of an operation for those involved. One example of freelancing was described an engine company captain:

> We'll get an engine pulled up in the front of the house, and they take an interior attack line through the front door. They're inside. The place is not ventilated well yet so the smoke level is way down, you know. Pretty, fairly explosive environment inside. They're trying to put the fire out. Well, basically, all that heat's in there, and then you get a unit that comes like from the side of the house or the back of the house. It doesn't know what the unit in the front is doing, and then these guys just basically stick a line through the window and open it up. Well, that disrupts the whole thermal balance of that interior structure and all that heat goes to the floor, and now your firefighters are inside the house on the floor, so that heat comes down and steams them. (engine company captain; interview #18)

In sum, appropriate improvisation with tools, rules, and routines augments contingent structuring mechanisms, thereby enhancing organizational resilience and responsiveness. The detailed pattern of behaviors occurring within an ICS at any point in time is a consequence of the interplay between the contingent, more centralized and explicit structuring mechanisms and more diffuse improvisational behavior, which implicitly structures the task. The ICS must achieve a balance between, and resolve the tensions associated with, more preplanned and imposed versus more spontaneous and emergent task structuring activities. The paradox of at once relying on organizational structures and routines agreed upon in past situations to meet most contingencies, combined with experimentation (to one degree or another) to meet never before experienced and unforeseeable contingencies is necessarily played out as these systems respond to rapidly changing environmental circumstances. Our research suggests ICS cognition management methods provide a means that help resolve these tensions.

Cognition Management Methods

As previously discussed, the overall task structure of the ICS-based organization we studied is simultaneously a function of top-down, contingent and partial structuring, on the one hand, and bottom-up interrelating of local accommodation and improvisation, on the other. Our analysis suggests that the degree to which this organization is able to effectively coordinate behaviors emanating from these processes depends largely on the extent to which organization members are able to build and maintain viable understandings of the activity system to which they belong (see also Weick & Roberts, 1993; Weick et al., 1999). These understandings represent the basic cognitive infrastructure permitting individuals and groups to integrate effectively their behaviors with those of others on a moment-to-moment basis as an incident unfolds and evolves. Attention to these understandings or "operational representations" is, therefore, critical to the appropriate activation and balance of explicit and implicit task structuring processes.

We use the term operational representation to denote perceptions of the organization (including one's place in it) and its environment, the comprehension of the meaning of these, and the projection of their status into the near future (Endsley, 1997). High-fidelity and shared mental models of this sort have been shown to help members of high-reliability systems better coordinate their own behaviors and solve problems presented by complex and fluid task environments (cf. Roth, 1997). However, a number of factors tend to limit, fragment, and create discrepancies among operational representations. For instance, at the individual level, the cognitive limitations of human beings preclude the comprehensive representation of a complex activity system by any of its participants (Asch, 1952; Simon, 1976). In other words, all operational representations are quite limited. Moreover, individual differences in backgrounds and intellects affect the content and quality of different people's interpretations of the same situations. These factors are particularly apparent in firefighters' discussions of the extreme difficulties that rookies can have in comprehending emergency situations.

In many organizations, several elements cause further divergences among system understandings. For instance, organizing strategies, such as the division of labor, employed to compensate for individual-level deficiencies, tend to fragment situational assessments because people are given different responsibilities for representational content (cf., Hutchins, 1995). Individuals are also placed in various geographic and social locations within their organizations. Consequently, members are exposed to different stimuli, learning idiosyncratic "facts," as they construct situational meanings and mental models (March & Simon, 1958).

The general problems that organization members have in constructing shared operational representations are exacerbated in ICS. Structuring processes are continuous, and they are typically more intense and pervasive in the ICS than they are in more permanent organizations. The task structure of the system is often in a constant state of flux. Therefore, the assessments held by members cannot be finalized at any point in time. Furthermore, as an emergency management system becomes larger and more elaborate, fewer and fewer of its emergent properties are likely to be held in the mental model of any one individual (cf. Weick & Roberts, 1993). Consequently, evolving, discrepant and disconnected representations can become more and more widely dispersed across the system over a fairly short time period.

In the fire department we studied, several factors countered the forces discussed above. Our analysis suggests that ICS-based firefighting organizations possessing the greatest potential for flexibility are those in which the most attention is given to developing, communicating, and connecting individuals' understandings. Firefighters regularly use the term "size-up" to describe ***developing*** operational representations:

> We call it size up. What's going on? What's the time of day? What's the wind, weather like? What are the traffic conditions? What type of building are we going to? What type of engine? And then what is it when we get there? We have this picture of what's happening. We constantly evaluate that. We're supposed to constantly evaluate what is going on to see if we have to make any changes . . . It's an ongoing picture. It's an ongoing process, we are constantly evaluating it. My wife gets mad at me because I do this at home (engine company captain, interview #2).

For large incidents or complex tasks, developing these types of representations is an effortful accomplishment on the part of system participants, and their construction is typically initiated immediately upon receiving a call. An engine company captain discusses the size-up process as follows:

> I start building a picture as soon as I'm dispatched. I start thinking of the neighborhood, what's in that neighborhood, what kind of houses we have—big houses, little houses. If it's an industrial area, what chemicals they have. I certainly start the size-up of it as soon as I read the dispatch. We do the size-up right away. (truck company captain, interview #15)

A battalion chief provides a similar description:

> And actually we're doing things before we even get there. I start managing this at the time I walk to my car. I'm thinking about the address, where I'm going, what it is, the time of day, the weather. All those things are going through my mind from the time that the pager goes off. On the way to the car, you're listening to what action has already been taken. (battalion chief, interview #7)

For ICS participants, operational representation is the outcome of a process that relies heavily on intense ***communicating***. The communication of accurate and timely representational information is critical to the early stages of system development. The initial size-up provides the context within which objectives are formulated and roles activated. Additionally, in the case of a large incident (e.g., an immense structure or wildland fire), the first incident commander is usually a company captain who will likely transfer command to a higher ranking and more qualified individual. To facilitate a smooth handoff of command and insure that incoming resources can efficiently coordinate their activities with the evolving system, the first incident commander is required to communicate his or her size-up of the situation as follows:

> **Battalion Chief**: He gives me a report on conditions. He's painting a picture. He's painting a picture on the radio. He gives it on the radio. Let's just say it's engine 21. "Engine 21 is on scene. I have a two-story single-family residence." Right away you've got a picture of a two-story single-family residence. "I've got smoke and fire showing out of the back south corner." You know on your map where that is. You've got a pretty good idea. He's painting a picture telling you what you have.
>
> **Interviewer**: And you know when you show up how you will relate to everybody else?
>
> **Battalion Chief**: Hopefully. That's the whole purpose of painting the picture. And that's part of what we do. You have to give a report on conditions. And you're painting the picture not only for the battalion chief coming in, but also for all those other units that are coming in. They're going to have a pretty good idea of what they've got before they get there. That's real important. You have . . . I guess, the decision making process starts before you get there. You start thinking about this. You've got the picture painted. What do I got? This is what I've got. When you get in there you're not surprised. If you are surprised, somebody didn't do his job right. You shouldn't be surprised. (battalion chief, interview #1)

Communication to all participants of activated structural elements is one major way of normalizing or regularizing representations. That is, several of the structuring mechanisms discussed previously produce outcomes (objectives, goals, roles, etc.) that present system participants with consistent sets of cues around which meanings are constructed. For instance, the designation of an incident as a structure fire or a wildland fire with the specific objective of saving a life or preserving a particular property provides common representational elements for all organizational members. A battalion chief discusses how the ICS provides an orienting function in a wildland fire situation:

> We were up there eight days, and when we first got there, the fire had burned somewhere around--I'm going to estimate--70,000 acres. The incident command system at that time was developed to the point to where it had not only an incident commander to operations, but the fire also had four branches. Those branches were divided into about twenty divisions, and then those divisions were further divided down into the strike teams. It organized it so that everybody that had a part in the fire worked together so that they all had the ultimate goal of to knock this thing down and put it out. So, regardless of your part in the fire, you knew that with what you were doing, with what somebody else was doing, it was organized before you even went out there as to what the expected outcome would be. (battalion chief, interview #1)

Despite the attention to communication of representations, perspectives on the system can remain divergent and disconnected. One main reason for this is that the cognitive or perceptual requirements of particular tasks can be so demanding that individuals performing them are not able to maintain an awareness of the surrounding system. For instance, the tasks of ventilating a burning structure by cutting a hole in its roof or extracting an individual from an automobile using the "Jaws of Life," require individuals to tightly focus specific problems. Few cognitive resources are left over for the situational awareness required for mutual accommodation. A firefighter explains his representation of the situation:

> I'm not overly conscious of what they're doing because I'm involved with the roof [i.e., cutting a hole in it]; I could fall from the roof. And I'm concentrating on my own job and getting what he [the incident commander] wants done. My productivity. But I am cautious of who is down there and how many . . . that I know. Did I get them [i.e., drop part of the ceiling on them] or didn't I get them. (truck company firefighter, interview #9)

The exceedingly narrow system representation produced by this type of circumstance is addressed by ***shifting*** representational responsibility to others. For the better functioning ICSs, when the nature of a person's task is such that he or she cannot maintain a viable operational representation, his or her representational responsibility is off-loaded to another ICS participant who is in a better organizational position and possesses sufficient cognitive resources to build and maintain an understanding of the activity system. In other words, the second person helps to insure that the first persons' behaviors maintain coherence with those of others in the organization.

Representations also involve a sort of ***nesting*** in terms of scope and detail. This nesting is frequently consistent with the lines of authority. In the situation discussed by the firefighter in the previous example, his captain would be the individual most likely to be responsible for maintaining the perspective necessary to insure that the firefighter's activities were sufficiently integrated with those of others in the system. The hierarchical process is suggested by the following comments regarding the major representational concerns of progressively higher-ranking individuals in an ICS:

> **Firefighter**: This saw is going to need a new chain. I'm running low on my fuel because I know how long I can last on a tank of fuel in my chain saw. This ladder is too close to the fire. Just stuff like that at my level. (truck company captain, interview #9)

> **Truck company captain:** I'm thinking about what equipment I'll be needing a little bit later, or manpower, or in keeping ahead of it. And that way I can order it prior to needing it. You don't want to order things when you need them because you're behind. As a firefighter, it's pretty much task oriented. I think they're pretty much zoomed into cutting a hole, doing that, doing it in a safe way, and waiting for more instructions. (truck company captain, interview #10)

> **Battalion Chief as Strike Team Leader**: I have the big picture over my strike team, over what they're doing. I have that overall picture, and I report to a division supervisor. And then he has the overall picture of that whole division. He reports to a branch. That branch has the overall supervision picture of that branch. They all report to the operations chief who has the overall picture of the whole thing . . . But what I'm actually responsible for is not the big overall picture, it's the picture of my assignment. (battalion chief, interview #1)

The incident commander is designated as the individual who attempts to maintain the "big picture" of the operation. Terms, such as "having the bubble" (Roberts & Rousseau, 1989) and maintaining “situational awareness” (Endsley, 1997) have been used to identify similar concepts. These phrases denote “the integrated big picture of operations in the moment” (Weick et al., 1999). Rochlin (1997: 109) describes the notion of “having the bubble” in US Navy combat situations this way:

> Those who man the combat operations centers of US Navy ships use the term "having the bubble" to indicate that they have been able to construct and maintain the cognitive map that allows them to integrate such diverse inputs as combat status, information sensors and remote observation, and the real-time status and performance of the various weapons and systems into a single picture of the ship's overall situation and operational status.

If the incident commander, or some other high-ranking member in the ICS, is able to achieve and maintain a quality operational representation, the system is more likely to be able to match environmental demands and forestall catastrophic system failures. Quality operational representations increase the potential of commanders to engage in effective small adjustments and major reorganizations when each is necessary.

According to Weick and Roberts (1993), the capacity for system flexibility is enhanced to the degree that overlapping representations can be established and maintained among system members. ICS participants whose operational representations exhibit similarity in important areas (e.g., basic situational definitions) are more able to work together effectively to achieve a viable balance between explicit and implicit structuring processes. However, given the array of factors potentially impinging on individuals’ perceptual and cognitive processes, fragmented and divergent perspectives are likely. In those ICSs with more response potential members work hard to establish and update mental models. They also try to shift and nest representations in attempts to overcome the limits on their cognitive resources.

DISCUSSION

This study identifies ICS factors permitting a fire department to respond reliably to dynamic, unpredictable and hazardous working conditions. The model developed through inductive analysis of observational, interview, and archival data centers on three main concepts: structuring mechanisms, organizational support for constrained improvisation, and cognition management methods. In general, an ICS-based organization works best when distributed operational representations are developed and connected so that suitable (i.e., commensurate with the functional requirements of the emergency situation) structures can be deployed and behavior emanating from imposed structures, on the one hand, and more local accommodation and improvisation, on the other, can be coordinated.

Systems constructed at emergency or disaster scenes on the basis of ICS principles have been categorized as high-reliability organizations (HROs) (Grawboski & Roberts, 2000). HROs are systems that exhibit continuous, nearly error free operation, even in multifaceted, turbulent, and dangerous task environments (Roberts, 1990). Several classic examples of organizations that should be highly reliable are naval aircraft carriers (Weick & Roberts, 1993), nuclear power generation plants (Schulman, 1993), air traffic control systems (Weick, 1990), space shuttles (Vaughan, 1996), and maritime systems (Wagenaar & Groenweg, 1987). Some HROs are designed for the expressed purpose of mitigating "crisis" (e.g., air traffic control systems), whereas others must be capable of performing under crisis conditions, even though their primary operations are more mundane (e.g., nuclear power generation). Since some social science scholars have tended to regard HROs as a fairly exotic organizational class (cf. Scott, 1994), questions about generalizability from research on HROs, such as a fire department employing the ICS, to more "mainstream" organizations appear warranted.

HROs have been considered unique primarily because of the perception that failures in them carry much more potential to produce rapid and devastating repercussions than failures in other types of systems (Weick, et al., 1999). However, HROs and supposedly more conventional organizations have become less distinguishable along this dimension as a result of the previously noted transformations taking place in many organizations' environments. In other words, the demanding task situations to which an increasing number of mainstream organizations are exposed have much in common, in an abstract sense at least, with those that HROs manage. Both are often characterized by substantial complexity, ambiguity, dynamism, risk, and time constraints. As a result, Weick, et al. (1999: 82) suggest that HROs represent "harbingers of adaptive organizational forms for an increasingly complex environment" and "provide a window on a distinctive set of processes that foster effectiveness under trying conditions."

The idea that the ICS, in particular, may represent a precursor to, or suggest the possibility of, a new organizational approach for difficult conditions is consistent with the observation that basic ICS qualities identified in our study find analogues in recent research on new forms or processes of organizing. We discuss below how the major facets of our model relate to current research on the co-presence of bureaucratic structure and organizational flexibility, the relationship between structuring and useful improvisation, and the notions of mental models and collective mind in organizations. We conclude this section with a consideration of research limitations and implications for future research and practice.

Bureaucratic Structure and Organizational Flexibility

Our emergent theory emphasizes the role that bureaucracy plays in producing rapid structural variation in response to situational contingencies. The possible co-existence in organizations of both extensive bureaucracy (in terms of rules, routines, procedures, and so forth) and exceptional flexibility is suggested by the work of Adler et al. (1999). These researchers studied model changeover events at Toyota's NUMMI automobile assembly plant and found that the highly bureaucratized and efficient NUMMI organization is also quite flexible. They identified four mechanisms (meta routines, enrichment, switching, and partitioning) that function to shift the typical tradeoff between efficiency and flexibility, enabling the NUMMI system to attain higher levels of each concurrently. In a sense, these mechanisms increase organizational flexibility by augmenting and transforming more traditional bureaucratic structures.

Similarly, our model identifies features of the ICS (e.g., variable structuring and support for improvisation) that operate to augment more standard bureaucratic arrangements. However, the theory we develop extends Adler et al's. (1999) by suggesting that basic bureaucratic elements, such as roles and reporting relationships, can serve as important sources of flexibility when they are combined with structuring processes. In this regard, the ICS resembles Ciborra's (1996) platform organization.

Following scholars such as Giddens (1984) and Weick (1993a, 1993b) and based on his study of Olevetti's evolving global technology strategy over more than a decade, Ciborra conceived of the platform as a sort of "formative context" providing top managers facing frequent environmental surprises with resources for generating new combinations of structures and routines to produce whatever specific organizational form (hierarchy, matrix, network, etc.) is required to match current circumstances. Ciborra (1996: 115) asserts the platform:

> is a virtual organizing scheme, collectively shared and reproduced in action by a pool of human resources, where structure and potential for strategic action tend to coincide in highly circumstantial ways. . . Schematically, the platform can be regarded as a pool of schemes, arrangements and human resources. . . [T]he platform is supported by a composite bedrock of practices, that consists of pasted-up routines, transactions and other organizational arrangements. In the platform one is

> continuously confronted with the coexistence of a multiplicity of organizational structures. Flexibility is achieved in practice by pasting up structures that have a high potential for action in response to chaotic events."

Ciborra's (1996) platform represents an assortment of activated and latent organizational components (e.g., departments, division, functions, etc. may constitute single components for some platforms) from which top managers select and (re)combine elements in accordance with their situated and subjective interpretations of the task environment. Ciborra insists that such a "metaorganizational context" is not designed. Instead, "it emerges as the result of the managers' situated rationality and actions, while they busily recombine those very arrangements, and artfully operate them. . ." (Ciborra, 1996: 115).

The ICS and Ciborra's (1996) platform are similar in that both represent formative contexts containing resources for structural variation. However, the ICS and the platform are distinguishable in important ways. Platform elements and associated structuring processes are indefinite and accumulate largely in a sedimentary manner where structures and processes build up over time in the practices and cognitive bases of organizational members. Further, there is little attention to the discarding of platform elements. According to Ciborra (1996: 116), "On the surface, the platform organization looks as a stable pool of 'junk' resources, 'badly organized' according to efficiency criteria, but ready to be deployed when the technology or marketing strategy requires it." In contrast, ICS structures and structuring processes tend to be more deliberately and purposively developed and are codified, to a certain extent, in a set of formal procedures. Furthermore, while ICS elements do accumulate, approaches that prove unviable are frequently thrown out. Consequently, the development and retention of structures and processes is much more strategic in the ICS relative to the platform.

Relatedly, Ciborra's (1996) platform resides largely in the imaginations of the very top managers. As a function of an intense training and socialization regime, knowledge of ICS roles, routines, and processes are distributed widely throughout the organization. Thus, the ICS is quite transparent to members in that participants typically possess a general understanding of how the system works and how the various roles they may assume generally contribute to the larger activity system. In this regard, the ICS is more of an enabling bureaucracy (Adler & Borys, 1996) and, therefore, should support more flexible and adaptive constituent behavior compared with the platform. Finally, the platform structuring process discussed by Ciborra (1996) appears almost exclusively top-down in nature. The ICS extends the platform concept by highlighting how limiting explicit structures permits crucial local accommodation and improvisation.

Partial Variable Structuring and Constrained Improvisation

The notion that partial or under-specified structure is conducive to, and required for, improvisation has been explicated by a number of scholars (Brown & Eisenhardt, 1997; Moorman & Miner, 1998; Weick et al., 1999). For example, Brown and Eisenhardt's (1997) study of firms pursuing multiple product innovation develops the concept of semistructures. Semistructures are manifest in organizations "where some features are prescribed or determined (e.g., responsibilities, project priorities, time intervals between projects), but other aspects are not. Semistructures exhibit partial order, and lie between the extremes of very rigid and highly chaotic organization" (Brown & Eisenhardt, 1997: 28). Brown and Eisenhardt (1997: 29) argue, "change readily occurs because semistructures are sufficiently rigid so that change can be organized to happen, but not so rigid that it cannot occur. Too little structure makes it difficult to coordinate change. Too much structure makes it hard to move" (Brown & Eisenhardt, 1997: 29).

Moorman and Miner (1998) investigate conceptually the relationship between organizational improvisation and organizational memory in predicting the novelty, speed, and coherence of organizational action. They define improvisation as "the degree to which composition and execution converge in time" (Moorman & Miner, 1998: 698). According to Moorman and Minor, structural elements such as organizational procedures and practices are major reservoirs of organizational memory. Consistent with Brown and Eisenhardt's argument (1997), Moorman and Miner (1998: 702) contend that "improvisation involves a semi-ordered activity," such that improvisation leading to novel, speedy, and coherent organizational action requires the presence of sufficient organizational memory.

However, extant models of organizational improvisation highlight the significance of partial structure without adequate consideration for the type of situation or the potential for detrimental extemporaneous activity. In contrast, the theory developed in this paper considers the effects of *variable* partial structuring on constrained improvisation. Our model suggests that benefits may accrue to systems able to manipulate the degree of structure experienced by organizational members. For instance, when an organization is confronted with a relatively stable external condition or is made up of less competent individuals, more specific direction to subordinates may yield important efficiency and control gains. Alternatively, when an organization is faced with a turbulent and unpredictable task environment and consists of skilled, knowledgeable and resourceful people, latitude for subordinate improvisation may be vital to organizational effectiveness.

Yet, even under the latter circumstance, improvisation within the more reliable ICS-based organizations is meaningfully constrained. In this regard, the present research makes an important distinction between more and less potentially useful improvisation. Within the better functioning organizations, more useful improvisation is characterized by extemporaneous activity performed with an understanding of, respect for, and deference to, the objectives and structure of the extant system. The possibility always exists in organizations for an empowered individual to work against organizational goals and cause confusion and harm to others (Simons, 1995), particularly in extremely fluid situations. Social sanctions on freelancing and cognition management methods help to reduce the probability of this occurrence in the ICS-based organization we studied.

Mental Models and Collective Mind

The current research directs attention to the potential importance of well-developed mental model formation and management methods within organizations confronted by rapidly fluctuating environmental contingencies. In particular, our analysis of an emergency management system indicates rapid structural variation and significant local improvisation can lead to either organizational flexibility or organizational disintegration, depending largely on how well behaviors emanating from explicit and implicit structuring processes are integrated and coordinated. Potential for behavioral integration and coordination is, in turn, largely a result of the integrity and regularity of the operational representations that system participants are able to achieve and maintain. Yet, because individual- and organization-level factors conspire to fragment and distort people's understandings, the mental models driving organization-level reliability at the scenes of difficult emergency situations are largely a collective accomplishment. Our analysis indicates the processes of developing, communicating, and shifting and nesting operational representations during implementation of the ICS give rise to a collective representational infrastructure helping to protect individual members against cognitive overload and facilitating appropriate moment-to-moment interrelating of their behaviors. Given the widely acknowledged limits to human cognition, the nature and function of cognition management methods in this and other organizations requires much more research attention in the future.

It is worth noting the ideas that “understanding” or “awareness” may be usefully conceptualized as a group-level phenomena and that “cognition” occurs not only within individuals but also between or among them as a function of the quality of the connections or interactions they are able to accomplish with each other, have been gaining currency in organization science research (e.g., Hutchins, 1990, 1991, 1995; Weick & Roberts, 1993; Weick et al., 1999; Resnick, Levine, & Teasley, 1991; Resnick, Saljo, Pontecorvo, & Burge, 1997; Taylor & Van Every, 2000). For instance, Weick and Roberts (1993: 366) suggest that collective mind is manifest where organizational members’ “heedful” interacting connects distributed task-related know-how such that situational demands are met. From this perspective, a continuous interrelating of activities synthesizes, constructs, or represents a capacity for “comprehension” in collective *action* that no one person could possess in his or her individual mind. People working together heedfully “respond *as if* the complexity of the system in question were understood by the group” (McGrath, MacMillan, & Venkataraman, 1995: 255 emphasis in the original). We argue that cognition management methods in combination with explicit, partial structuring and constrained improvisation give rise to the action that is collective mind in fire department emergency management operations.

Limitations and Future Research

The initial goal of our work was to generate conceptually grounded theory regarding how members of a fire department organize themselves to effectively manage complexity, ambiguity, and risk at emergency scenes. Therefore, our framework should be regarded as quite provisional until future research verifies it in similar and other contexts. Further, the theory we present is somewhat abstract. A comprehensive and detailed treatment of such a complex system would go well beyond the scope of a single paper. So, while we attempted to highlight the major ICS qualities that contribute to organizational flexibility and reliability, future research is needed to specify further system elements and more completely establish theoretical boundary conditions. Below we discuss several factors that may be especially likely to limit the generalizability of the emergent model.

First, the viability of the system we studied appears predicated, in part, on a value system that is clearly defined and almost completely accepted by organizational members. The legitimacy of life preservation and environmental protection are essentially unquestioned by firefighters as overarching departmental purposes. Similarly, major functions, such as fire suppression, medical aid, and hazardous materials cleanup, receive almost universal support as valid spheres of activity within which those purposes can be pursued. It is likely that such value consensus reduces severity and occurrence of certain types of behavior (e.g., political behavior and power struggles; cf. Pfeffer, 1981; 1992) that could disrupt ICS organizing processes. Future research is required to ascertain the extent to which the model presented here is generalizable to contexts wherein fundamental organizational purposes are more ambiguous or contested.

Additionally, the ICS-based organization we investigated possesses a clearly defined and compelling authority system. Those employing explicit structuring mechanisms rely on the authority system to legitimate their directions. Also, the authority system is relied on heavily as a mechanism to resolve disagreement and conflict, with the incident commander being the final arbitrator of disputes. To the extent that conventional firms do not possess such salient and potent authority systems, the integrity of an ICS approach may be compromised.

Next, the emergency management organization we studied may not always be constrained in the same ways as more mainstream firms. For instance, in life-or-death circumstances, resource constraints are often relaxed to a considerable degree. In contrast, more conventional organizations can face quite severe resource limitations most or all of the time. Our preliminary work suggests that the highest levels of system reliability (in terms of the capacity to continuously and effectively manage working conditions, even those that fluctuate widely and are extremely hazardous and unpredictable) may depend on commensurate resource allocations.

On the other hand, our data do not show that the ICS approach itself breaks down in the absence of massive resource commitments. In fact, it appears more likely that the ICS enhances reliability and flexibility for any given resource commitment level. As a practical matter, major firefighting operations are frequently under-resourced to varying degrees, especially during the initial stages of an emergency. For example, the first units to arrive at the scenes of incidents, such as the large California wildland fire described previously, must perform certain functions very reliably—i.e., without error or miscue—even though equipment and personnel may be abysmally inadequate to manage general working conditions over the short- or even medium-run. In cases such as this, reliability is likely to be more narrowly focused on averting injury while building the infrastructure for an organization capable of managing situational demands once sufficient resources arrive. Future research in emergency management and other contexts is clearly required to more precisely ascertain the relationship between resource level and reliability for ICS-type programs.

Finally, there are other differences between emergency management and more conventional organizations that may impact model generalizability. For example, basic system purposes or outcomes may be more uncertain for many organizations in hypercompetitive environments than for fire departments in most emergency situations they face. Attaining reliability may be increasingly difficult as such uncertainty escalates. Also, the level of trust among organization members may be higher in emergency management as compared with other organizations. Trust typically facilitates organizing processes and may be particularly relevant to high-risk organizational contexts. The implications of these and other factors for model generalizability should be examined in subsequent studies.

Organizing Temporary Systems for High Reliability

With the above caveats in mind, we discuss implications of the ICS framework for the design and control of temporary systems. Organizations increasingly employ temporary systems to absorb or manage demanding environmental contingencies (Grabowski & Roberts, 2000). Such organizational forms often consist of diversely skilled or knowledgeable individuals working on complex tasks (frequently across functional, group or organizational boundaries) to achieve specific objectives over a limited time period (cf. Goodman, 1981; Goodman & Goodman, 1972, 1976; Palisi, 1970), frequently in high-risk or high-stake situations (Meyerson, Weick, & Kramer, 1995). They may involve co-located individuals or people interacting within a virtual context. In either case, temporary systems are intended to perform important adaptive functions for organizations by significantly enhancing their ability to manage fluctuations in working conditions. Examples of temporary systems include certain types of alliances, consortia, product development groups, and crisis management teams.

While the implications may be more general, our research specifically suggests when certain types of temporary work arrangements, such as those discussed above, may be less prone to dysfunction. For example, the availability of extensive structural resources may help to forestall system dysfunction under complex, high-velocity conditions. The structural resources available to members of many types of temporary organizations are not nearly as extensive as those accessible by participants in the ICS-based organization we investigated (cf. Goodman & Goodman, 1972, 1976). Yet, as with the emergency situations confronting fire departments, the hypercompetition conditions or crisis circumstances faced by more mainstream organizations may often contain a number of foreseeable situational features and task requirements (cf. Pearson & Mitroff, 1993). In the case of a major product failure and recall, for instance, an organization can expect to be confronted with investigatory, legal, and public relations issues, among others. Our research suggests that, to the extent an organization has the capacity to implement pre-planned organizational solutions rapidly enough to meet the more predictable aspects of an evolving incident, potential reaction speed is increased, unnecessary depletion of cognitive and other resources is reduced, and the probability of organizational dysfunction is diminished.

For another example, sufficient means to minimize misdirected or disjointed activity from “empowered” individuals can avert organizational dysfunction. Empowerment involves the decentralization of decision-making authority and responsibility, and it purportedly improves organizational flexibility by permitting more localized adjustments to more localized contingencies (cf. Kirkman & Rosen, 1999; Spreitzer, 1996). Within the ICS, the emergence of improvisation depends critically on empowerment. However, empowerment can also lead to control problems (Simons, 1995). Our research suggests that serious organizational dysfunction may occur when empowered individuals operating in turbulent environments are not provided with sufficient means to adequately integrate their behaviors. Within the ICS, the presence of cognition management methods promotes useful, as opposed to detrimental (or ineffectual), empowered behavior.

Our framework also points to a number of suggestions for developing the organizational capacity to construct, control, and dismantle highly reliable temporary systems, which may be useful for absorbing or managing extremely demanding environmental contingencies. Major and unforeseen competitive threats, supplier collapses, product malfunctions/recalls, technology breakdowns (e.g., e-commerce system failure), technological sabotage, hostile takeover attempts, and natural disasters are examples of events for which the ICS approach may represent an especially viable organizational solutions. Inept reaction to these sorts of incidents can lead to catastrophic consequences for organizational stakeholders (cf. Lagadec, 1993; Pearson & Clair, 1998). We provide several general recommendations for developing the capability to implement highly reliable temporary systems.

1. **Design structures in advance to manage major potential contingencies.** Consistent with previous recommendations (Pearson & Clair, 1998; Pearson & Mitroff, 1993), our research underscores the importance of identifying roles and establishing routines for the general classes of events for which immediate and appropriate organizational response would be imperative (e.g., major competitive threat, high-profile product failure). One

outcome of this process may be an organizational chart such as the one depicted in Figure 1.

2. **Devise guidelines to rapidly deploy and alter structures**. This study suggests that advance consideration of the following types of questions is vital for developing structuring guidelines or procedures: Considering event type, requisite organizational elements, and available communication and transportation technologies, how should initial system construction commence? When and under what circumstances should certain individuals be responsible for activating and deactivating organizational elements? What are the options for re-structuring the system as an incident evolves? What are the alternatives for efficiently demobilizing resources as an emergency abates? Under what circumstances should tasks remain relatively unstructured so that individuals can improvise?
3. **Institute protocols for mental model development and maintenance**. The fire department we studied maintains guidelines that function to promote the development and maintenance of useful mental models. Their approach indicates that mental model development processes should address the following kinds of issues: When and how should individuals initiate mental model development? What types of data are likely to be most pertinent to comprehension in different situation? What communication protocols would help to insure effective dissemination of information critical to mental models? In general, how much attention should be directed to situational comprehension? When task demands preclude the possibility of an individual directing sufficient attention to mental model development and maintenance, what are the

procedures for "off-loading" representational responsibility? How can fragmented mental representations be connected?

4. **Set up training programs to develop system competence**. Given the complexity of an ICS-style coordination system, substantial training and significant experience with the system seem to be prerequisites for effective individual performance. The fire department we studied provides its members with numerous ICS training programs, ranging from classroom lectures to simulation experiences. Further, individuals in the better functioning systems gain ICS competence through simulation.
5. **Assess methods and operations frequently**. The organization we studied conducts extensive formal assessments of organizational operation after each major incident. More informal evaluations are conducted after miner incidents. Reliability is enhanced to the extent that major organizing problems are identified and appropriate changes are made to guidelines, procedures, training programs, and so forth.
6. **Establish an inter-organizational ICS-style program**. Catastrophic events, such as the collapse of a major supplier, government regulatory action, or a product failure, can adversely impact several or many organizations in a particular industry, market, or supply chain. Effective "crisis" management under these circumstances may necessitate swift, appropriate and coordinated action between two or more organizations. The ICS was designed to integrate resources not only within, but also between and among, organizations. Benefits may accrue to firms able to establish inter-organizational ICS-type framework for disaster management.

A likely scenario through which an inter-organizational ICS-style coordination program is likely to emerge is one where a motivated firm possessing leverage over other firms in a network (based on, for instance, market or ownership power) takes the lead in developing the ICS approach and encouraging its adoption. A number of system requirements (e.g., the need for common language, standards, training, procedural updates, and so forth) seem to call for a degree of centralized administration for such an organizing scheme. However, our theory does not necessitate such dictation. Certainly, firms in a low power differential network may jointly develop an ICS approach and then administer it through a consortium of some sort.

CONCLUSION

In the end, our study indicates limits to effective flexibility may be determined largely by the extent to which an organization is able to activate and manage oppositional organizing modes. The system we studied achieves its remarkable response potential through effective integration of distinct and, in some respects, contradictory processes—i.e., explicit structuring and improvisation. The former typically involves the imposition of order from upper hierarchical positions. The latter often entails the emergence of task structure from lower organizational levels. Each contributes uniquely to the flexibility potential of the system.

We identified several activities that seem crucial to the proper functioning of a flexible system, including advanced design of organizational elements and structuring processes, establishment of training programs to enhance members' organizing competence, and implementation of procedures for after-incident assessment and learning. Perhaps most important is the development of protocols for mental model formation and maintenance. The capacity of organization members to form and maintain high-fidelity cognitions at individual and collective levels facilitates the appropriate or reasonable subordination of behaviors to basic system requirements at any one point in time. In a sense, cognition management methods provide crucial means through which tensions associated with contradictory organizing processes can be accommodated or resolved.

Building and maintaining an effective ICS-type response capability is likely to require a non-trivial commitment of organizational resources. However, under conditions where error tolerance is extremely low and, thus, reliability is paramount, highly reliable temporary systems may be superior to alternative organizational forms (e.g., purely organic or mechanistic systems). These temporary systems appear to offer more organizing possibilities than other design options. Investing in a capacity to deploy an ICS-based organization may become increasingly imperative for the growing number of organizations facing an expanding number of catastrophic scenarios.

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FIGURE 1

Incident Command System

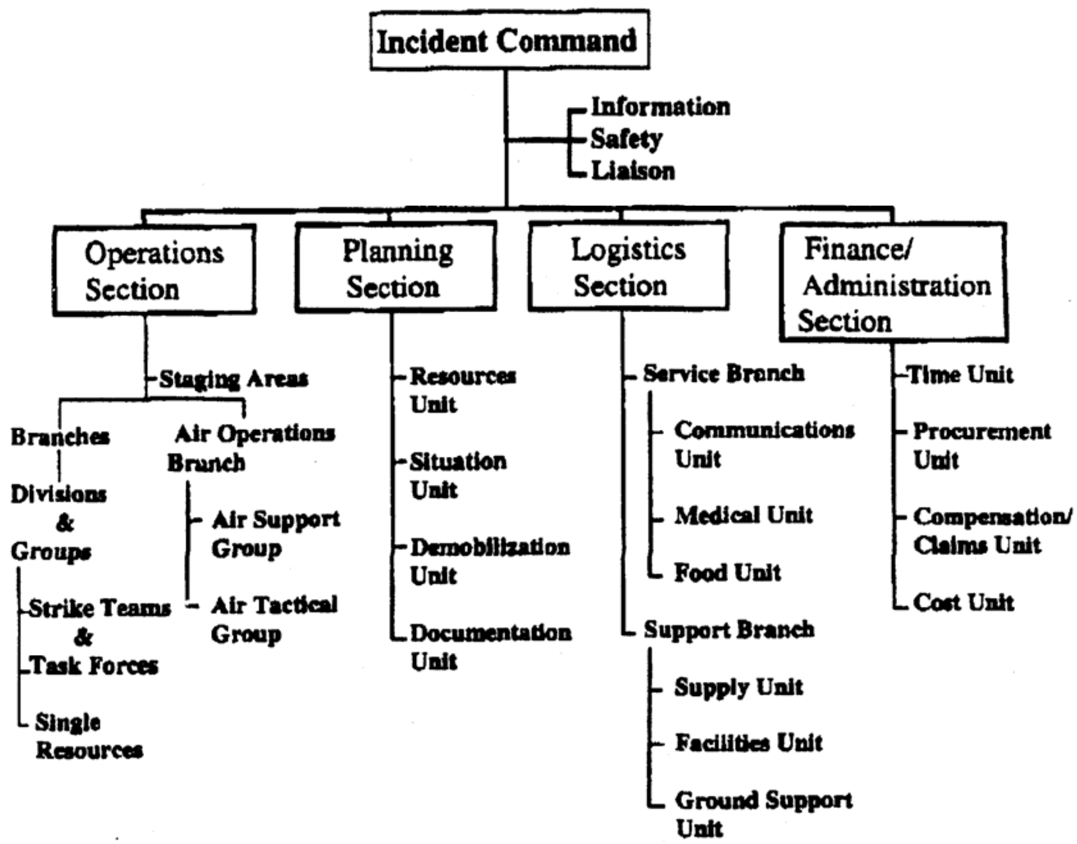

FIGURE 2
ICS Factors Leading to Organizational Reliability in Complex and Volatile Task Environments

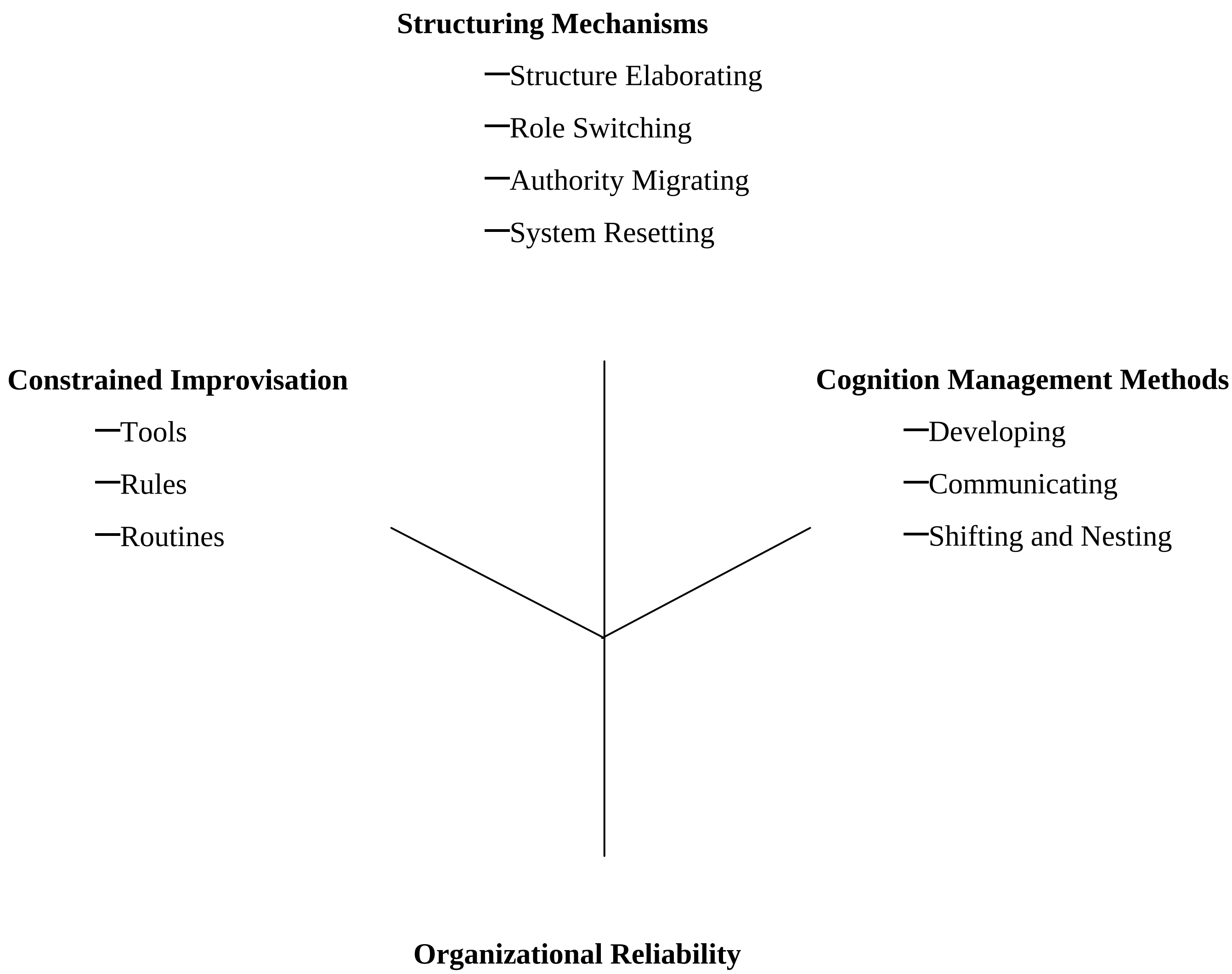

TABLE 1
ICS Structural Components

Component	Definition
Section	Organizational level where the major ICS activities (i.e., command, planning, operations, logistics, and finance/administration) are managed. The section is located between branches and the incident commander. A section is managed by a Chief (e.g., Operations Chief, Logistics Chief).
Branch	Organizational level located between sections and divisions and having either functional or geographic responsibility for major parts of incident operations. Branches may be activated to resolve supervisory span of control issues, or they may be used to subdivide the organization according to disciplines (fire, police, medical aid, etc.), major operations (e.g., air), or governmental units (e.g., local, state, federal). A branch is managed by a Branch Director.
Divisions	An organizational level responsible for operations within a defined geographic-type area. Divisions are established to define the incident and help maintain reasonable spans of control for supervisors. For example, the area of a wildland fire may be divided into two, three or more divisional areas. The floors of a burning high-rise building may be designated as divisions. Divisions are on the same organizational level as Groups (see below). A division is managed by a Division Supervisor.
Group	An organizational level responsible for a specified functional assignment. Examples of groups include, fire suppression, search and rescue, and evacuation. Groups can operate across divisional areas and are considered on the same organizational level as divisions (see above). A group is managed by a Group Supervisor.
Strike Teams	A collection of resources of the same size and type (e.g., five engine companies, five police patrol units) managed by a Strike Team Leader.
Task Force	A combination of single resources assembled for a particular operational need and managed by a Task Force Leader.
Single Resource	An individual, a piece of equipment and its personnel compliment, or a team of individuals who report to an identifiable supervisor.
Unit	An organizational element having functional responsibility for a specific incident planning, logistics, or finance activity.
Facility	An officially designated area at which a major organizational activity takes place. The three main ICS facilities are: *Incident Command Post*: The location at which the primary command functions take place. The incident commander oversees all incident operations from the incident command post. *Base*: The location at which primary service and support functions are coordinated and administered. The base may be co-located with the incident command post. *Staging Area*: Location where resources can be held while they await tactical assignments.

Bio Statements

Gregory A. Bigley is an assistant professor of human resource management and organizational behavior at the University of Washington. He received his Ph.D. from the University of California, Irvine. His research interests focus on trust, motivation, leadership, and the social-psychological foundations of high-reliability/performance organizing.

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AMJ MS# OF98-0037
Responses to Special Issue Editor Comments

Dear Professor McGrath,

We were very pleased to hear you conditionally accepted our manuscript entitled “The Incident Command System: High Reliability Organizing for Complex and Volatile Task Environments” (MS# OF98-0037) for publication in the *AMJ* Special Research Forum on *New and Evolving Organizational Forms.* Also, your comments were quite helpful to my co-author and me as we attempted to work the paper into publication form. Below is a point-by-point response to each of the issues raised in your last review.

1 As your comment #1 suggests, our work is germane to the literature on modularity. However, in the previous version of our paper, we hadn’t made the explicit connection between the ICS-based organization we studied and the modularity literature. You comments sparked us to do this (see page 18).

We now conclude the paper (pp. 45-46) with a summary of what we think we have learned about the limits to effective organizational flexibility in general and what must be done for flexible systems to work properly.

2,3,5 We saw items #2, #3, and #5 as pertaining to generalizability or boundary condition issues, in one way or another. In general, we have attempted to address your concerns in this area through a more considered and detailed discussion of the study’s limitations (pp. 38-40). We comment more specifically on each of your points below.

In item #2 you point out that in several respects conventional organizations may be more constrained than the emergency management system we studied. We certainly agree with your speculation that in many life-or-death situations, resource constraints on emergency services operations are often relaxed (at least to some extent). However, while our research does seem to indicate that the highest levels of organizational reliability may depend on correspondingly high levels of committed resources, the data do not show that the ICS organizing process itself breaks down when resources are more limited. Actually, the ICS seems to be an approach that can potentially enhance reliability for a given level of resources. We explain these ideas on pages 39-40.

Item #2 also correctly points out that disagreements regarding, for instance, the seriousness of an incident may inhibit ICS processes. Fire services personnel recognize this. They rely heavily on a very salient and potent authority system for conflict management. In other words, the incident commander’s decisions are final. Conventional firms that don’t possess such clearly defined or compelling authority systems may find conflict will interfere with the organizing processes we described. This potential limitation is noted on page 38-39 .

Item #3 speaks to the issue of technology and task uncertainty. As you asserted, the fire department’s technology and task environment are often not characterized by high degrees of uncertainty. However, many fire fighters recounted incidents where technology (broadly defined) and task uncertainty were quite high. For example, one hazardous materials team captain told us of an incident where his group was dispatched to a methane fire at an abandoned oil rig in Newport Beach, CA. When team members arrived on scene, they had no idea how to approach the disaster. Considerable analytical search ensued. (We would be happy to send you the portion of the transcript were the HAZMAT captain recounts the incident. It makes for quite interesting reading). So, while the fire department we studied may not be as high-tech as some other organizations, substantial uncertainty may surround both technology and task. The ICS training you mentioned helps to ensure that firefighters respond efficiently to the more anticipatable features of an emergency situation. Efficient response, in turn, conserves resources (e.g., cognitive energy, time) that can then be used to deal with more uncertain incident features, should they manifest themselves. We tried to emphasize the potential for this uncertainty in several places (for example, see pp. 3 & 7)

Also, we removed the Grove quote to avoid confusion.

Your item #5 points out that many conventional organizations may face more uncertainty regarding end states than the fire department. We tend to concur. Still, the type, desirability, and certainty of outcomes do vary substantially, both during the course of a particular emergency situation (as when a fire suppression operation evolves into a hazardous materials containment project) and across different sorts of events (Northridge, CA earthquake, Oklahoma bombing, baby Jessica rescue), and the degree of end state uncertainty can be quite high at times. Nevertheless, the differences you identify may affect the generalizability of the model and are duly noted in the limitations section (p. 40).

In addition to the issues you raised, we have listed a number of other factors that may limit model generalizability (p. 40).

4 Yes, we mean something more generally applicable. We have made the changes you suggested (p. 42-44). Thank you.

6 How could an ICS-style coordination system emerge without being imposed from the top? This is an interesting question. Certain requirements of the approach (common language, standards, training, procedural updates, and so forth) seem to call for a degree of centralized administration. Therefore, one might expect such an organizing scheme to more readily emerge within a network where a motivated firm has sufficient leverage (in terms of, say, market power or ownership) to lead and sustain an ICS program. However, there is nothing in our theory that absolutely necessitates such dictation. We can imagine various situations in which all firms in a network acknowledge a common need for an inter-organizational approach to crisis management. For instance, firms in a tightly coupled supply chain may recognize their common vulnerability to a myriad of potential system breakdowns and the need for rapid collective ICS-style interventions. Program administration may be carried out through a consortium. This is exactly what is done in

oil exploration consortia. We briefly discuss this issue in the paper (p. 44-45). We hope we have addressed your question.

Our paper has benefited enormously from your input and the input of the anonymous reviewers. Thank you for your time and insights. It has been a pleasure working with you.

Sincerely,

Greg Bigley