

**SEARCHING FOR UNITY: ACHIEVING COORDINATED AND EFFECTIVE
MANAGEMENT OF LARGE-SCALE DISRUPTIVE EVENTS**

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The coordinated and effective management of major disruptive events requires the collaboration of highly trained cadres of emergency services professionals, known in the public safety vernacular as *unified command teams*. Confronted by complex, dynamic, confusing, time sensitive and dangerous environments, they must make their decisions under rapidly evolving conditions.

The consequences of inadequate incident command can be devastating on the lives and fortunes of those affected by major disruptive events. Yet finding the formula for efficacious emergency management is complicated by the disjointed configuration of public safety agencies throughout the United States, and compounded by the ad hoc nature of these multidisciplinary command teams, which are often assembled quickly from among disparate groups of public safety agencies. This research strives to develop an understanding of the small group processes which guide the work of unified command teams by investigating the following elements:

- The impediments and facilitators of command team formation and collaboration.
- Mechanisms of leadership emergence and the characteristics of effective team leaders.
- The architecture of incident scene communications and information systems.
- The processes utilized by small problem solving teams as they make decisions under uncertainty.

Emergency response has been addressed by scholars mostly at the macro-level, focusing on national or international disasters. By studying emergency management on a regional basis, this research helps to fill a gap in the current literature. Utilizing a grounded, mixed methods approach, the bulk of the primary evidence is gathered through 75 semi-structured interviews with experienced incident commanders. Modeling and simulation are also utilized to explore methods of decision support for command teams during complex emergency operations. The field study area consists of Allegheny County, Pennsylvania, a region with a disparate aggregation of over 450 public safety agencies.

The ultimate goal of this study is to suggest actions to enhance the effectiveness of emergency management during major emergency events. Accordingly, the key policy recommendation of this research is for the development of permanently established, professionally trained unified command teams that can provide large-scale incident management support to local municipalities throughout the region.

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LIST OF ACRONYMS AND ABBREVIATIONS

ACES	Allegheny County Department of Emergency Services
CAS	Complex Adaptive Systems
CDM	Center for Disaster Management
COP	Common Operating Picture
CP	Command Post
DAG	Directed Acyclic Graph
DSS	Decision Support System
EOC	Emergency Operations Center
EOP	Emergency Operations Plan
EMC	Emergency Management Coordinator
EMS	Emergency Medical Services
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
GPS	Global Positioning System
GUI	Graphical User Interface
HB	Heuristics and Biases
IMT	Incident Management Team
IAD	Institutional Analysis and Development Framework
IAP	Incident Action Plan
IC	Incident Commander
ICS	Incident Command System
NDM	Naturalistic Decision Making
NIMS	National Incident Management System
PEMA	Pennsylvania Emergency Management Agency
SA	Situational Awareness
SNA	Social Network Analysis
SOGs	Standard Operating Guidelines
RDM	Robust Decision Making
UCT	Unified Command Team

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Returning to graduate school after many years away from academia was not easy for me. I actually began my studies at the Graduate School of Public and International Affairs in 1990, but life, as it often does, got in the way and put my plans on what seemed like perpetual hold. When I finally returned to GSPIA in 2008 and sat in on my first class, I looked around at the mostly young faces and thought that surely I was a pretender among real academic achievers. The furtherance of my education almost ended that evening, but I decided to attend one more class – the Administration of Public Affairs course that I was enrolled in on Saturday mornings. There something interesting occurred. I began to form a bond with a group of public sector practitioners, all of whom were enrolled in the innovative Master of Public Policy and Management “2 + 2 Program.” This course of study allowed us to work toward our degrees with a programmed curriculum which we could complete as a group, learning from each other’s experiences all along the way. And then something else happened. Before the semester was half over, I rediscovered an old love for learning; a thirst for new knowledge. In short, I found that I enjoyed academics! The rest is history.

While I would never have believed that I would still be in school seven years later, my journey to a PhD would not have been possible without the support of many fine people. Within the university community, it was Dr. David Miller who first fired my ambition to learn all I could about the field of public administration, as he opened my eyes to a rich and diverse body

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It is often suggested that those engaged in a doctoral program should keep a journal of their experiences as a way to maintain their sanity and to help prevent them from giving up. Instead of a journal, I chose to relate my experiences to a couple of close friends who worked with me at the Allegheny County Airport Authority. So thank you Tim and Laura for listening to my long and boring tales with patience and kindness, all the while providing encouragement, letting me air my frustrations and sharing my joy at each milestone I achieved.

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1.0 THE POLICY PROBLEM: INEFFECTIVE MANAGEMENT OF LARGE-SCALE EMERGENCY EVENTS

The effective management and control of large-scale emergency events – particularly those of significant size or scope – require the collaboration of a broad range of highly trained specialists, known in the vernacular as *incident commanders*. These emergency services leaders make decisions in constantly changing environments that are complex, confusing, time sensitive, dangerous, and dynamic.

It is said that modern emergency management presents a paradox, because it requires meticulous organization and planning, yet must be carried out in a spontaneous manner by incident commanders (Waugh and Streib, 2006, Danczyk, 2008). Additionally, the leaders of today’s public safety response agencies have the responsibility to act with certainty while remaining open to new information, and must coordinate efforts of personnel and the deployment of equipment resources (Pfeifer, 2013). Complicating the work of incident commanders is the reality that accomplishing their goals is rarely possible without the willing cooperation of large networks of emergency services resources.

“Emergency services agencies cooperate with one another when they coordinate planning and strategy of hazard assessment, resource mobilization, and operations with other entities, both laterally and vertically” (Col, 2007, p. 114). Today, interagency cooperation, or *mutual aid*, has

taken on a critical role in the management of emergency incidents throughout the United States, although in in geographic areas featuring highly fragmented municipal services, cooperation among public safety entities can be problematic. A disjointed mutual aid network can preclude effective management by incident commanders by blocking the set-up of a cohesive incident command structure, by hindering effective leadership, by inhibiting the creation of a comprehensive communications network, and by short-circuiting the processes needed for efficient problem solving and decision making.

The consequences of an *uncoordinated and ineffective* incident command establishment are far reaching. Without competent and collaborative management, the use of available resources and personnel is not optimized; leading to unnecessary property damage and the potential of injury or death to members of the public. Dysfunctional incident management elements become manifest in an incoherent *plan of attack* that prevents an effective combination of skill and specialization, and poses an unnecessary risk to response personnel.

1.1 SIGNIFICANCE OF THE POLICY PROBLEM

Major regional events pose “extraordinary operational demands” upon local emergency response networks, as agencies converge from distant locations and must be skillfully coordinated in spite of having rarely or ever worked together before (Howitt and Leonard, 2009, pp. 4-5). In addition, the notion that *all emergencies are local* is a common one throughout the emergency services community, and speaks to the fact that even response to the largest events begins with the efforts of regional responders, and that these responses often transcend local boundaries (Danczyk, 2008).

Local and County officials throughout the United States are charged with setting procedures in place to assure that regional public safety agencies are able to cope with large-scale events (Waugh, 2007). Yet Howitt and Leonard (2009, p. 2) describe how most public officials in the U.S. focus on emergency preparation and management mainly when “highly visible events are handled poorly.” They go on to suggest that while local responders strive to train themselves for an array of scenarios, their preparation usually covers only routine emergencies, which are commonplace (Howitt and Leonard, 2009).

When faced with non-routine, regional events, the capabilities of even the most adept emergency response agencies are thus severely challenged. In these situations, local public safety agencies must call upon the resources of neighboring jurisdictions to provide the “surge capacity” needed to cope with large-scale events (Howitt and Leonard, 2009, p. 6). Even so, interagency activities at the local level often feature a lack of planning and coordination, a situation exacerbated by the *fragmentation* of municipalities and emergency services agencies found in many areas of the U.S. (Sylves, 2008).

1.2 PURPOSE OF THIS STUDY

The primary purpose of this exploratory inquiry is an effort to understand the dynamics of regionally assembled groups of incident commanders; known in the lexicon of the Incident Command System and referred to throughout this study as **Unified Command Teams, or UCTs**.¹ Specifically, this research explores the factors which affect the collaborative efforts of

¹ Unified Command Team is a part of the terminology of the Incident Command System (FEMA, 2008).

these regional teams of public safety officials who come together to bring a major emergencies under control in the most expeditious manner possible. It investigates how these *sociotechnical systems* come together as functional and collaborative entities, and how leadership emerges from within; how these groups “self-organize” during events that have the potential to cause large-scale loss of life or severe property damage (Comfort, 2007).

This study is also an exploration of small group cognition and decision making, and how these processes are aided by current systems of communications and information. In doing so, it examines the dynamics of regional unified command posts, where leaders “connect, collaborate and coordinate to devise innovative ways to solve novel problems” (Pfeifer, 2013, p. 1). An ancillary objective of this research is to determine whether modern methods of information technology and decision support can be used to enhance the decision making abilities of these teams, thereby enhancing their effectiveness. The ultimate goal of the study is to provide recommendations to augment the effectiveness large-scale incident management, thereby increasing the resilience of regional emergency response systems throughout the United States.

To accomplish the objectives of this research, a *grounded, practical field approach* is employed to investigate the manner in which incident command teams are affected by four critical aspects of the emergency management process during large-scale regional events:

- 1. The formation of and collaborative efforts utilized by unified command teams.**
- 2. The process of leadership emergence within the structure of the command teams.**
- 3. The communications and informational systems utilized during incident operations.**
- 4. The dynamics of command team decision making under conditions of uncertainty.**

Through a combination of theoretical frames, this research explores the intricacies and processes of the unified command teams which manage large regional emergency events. This

study is designed to fill a gap in the current literature, while simultaneously building on the work of previous scholars in the field of emergency incident operations and management.

1.2.1 Focus of Research – Major Regional Disruptive Events

This study focuses on large-scale, complex incidents that occur on a geographically regional basis, referred to in this research as *regional emergency events* or *major disruptive events*; those which employ the resources of at least three municipalities and require at least six hours to bring under control. These events occur irregularly, pose difficult complexities to incident managers, and necessitate immediate action under high levels of uncertainty and time pressure (Perry and Lindell, 2006). They are typically handled by local resources, without assistance from state or federal agencies.

Examples of large-scale regional events include: major commercial or business district fires, widespread search and rescue efforts, flooding which encompasses large areas, major hazardous materials releases, medical mass casualty situations, or significant law enforcement situations. This research is also applicable to large-scale events of a pre-planned nature, such as a major regional holiday celebration, a major event such as a regatta or air show, or a conference of visiting dignitaries. Research bounded in this manner permits a fine-grained look into the actual collaborative work done by members of the unified command teams during their efforts to bring major disruptive events under control.

1.3 DISASTERS AND EMERGENCIES

According to William Waugh (2007, p. 35), disasters and emergencies can be conceptualized by considering their extent, and may be broken down into three distinct levels:

1. Local, day-to-day emergencies, including fires, limited flooding, search and rescue, minor hazardous materials releases, and other small incidents which are dealt with by municipal emergency response agencies.
2. Events of a regional nature which are still primarily considered local, but where wide-ranging regional – local, county, and possibly state – resources are needed for the response.
3. Widespread and highly destructive disasters which require the assistance of local, state and federal resources, along with the efforts of a number of other public and private organizations and resources.

The Federal Emergency Management Agency (FEMA) provides an instructive definition of large-scale events through the lens of *incident complexity*. FEMA (2008) documents provide a list of factors that impact incident complexity and with it the ease or difficulty of incident control:

- Geographic area involved
- Jurisdictional boundaries
- Threat to life, property, and the economy
- Potential for cascading events

- Political sensitivity, outside influences and media relations
- Organizational complexity
- Availability of resources
- Weather and other environmental influences
- Agency policy.

1.4 COLLABORATIVE, LARGE-SCALE INCIDENT MANAGEMENT

Emergency management is a system responsible for “reducing vulnerability to hazards and coping with disasters” (Waugh, 2007, p. 5). It is a collaborative, comprehensive, risk-driven process charged with integrating and coordinating emergency services efforts to assure preparedness for and response to major disruptive events. Incident commanders are required to manage the efforts of multiagency, multijurisdictional and multidisciplinary public safety and associated agencies to cope with large-scale events (Waugh, 2007). The accepted segments of emergency management, as listed by Mileti (1999, p. 11), consist of:

- Mitigation
- Preparedness
- Response
- Recovery.

The four emergency management elements offer a comprehensive method to approach and study the dynamics of large-scale incident planning and operations. This research focuses on the third element of this categorization, which consists of the *response* activities of public

safety agencies, which are defined as providing emergency assistance, reducing the probability of secondary damage, and minimizing problems for recovery operations (Sylves, 2008).

It has also long been recognized that when the resources of numerous emergency response agencies are needed, some form of organization and management is necessary to coordinate their efforts (FEMA, 2008). It follows that the command structure of regional emergency response organizations holds the key to effective incident control during all types of large-scale; *all hazards*² occurrences (AHIMT, 2007). Utilizing locally obtained resources, therefore, regionally assembled unified command teams are normally responsible for *all phases* of emergency response during major disruptive events.

1.4.1 Decision Making Under Uncertainty

The main thrust of this research lies in the investigation of how unified command teams, operating at large regional emergencies, can overcome the extreme stress, complexity and uncertainty of such events to bring them under control with minimal loss. The literature on decision making under conditions of uncertainty has been well developed by authors such as Simon, Argyris, Kahneman, Klein, Weick and Hutchins. By investigating how the unified command teams collaborate to make effective decisions on the scene of a major emergency, this research hopefully adds a new sub-section to the field of study.

² All hazards incident management is terminology used by FEMA (2008) to designate the use of the Incident Command System at any type of emergency event.

1.5 THEORETICAL SIGNIFICANCE

This research helps to fill a gap in the emergency management and response literature by adding the missing element of metropolitan area command systems. It also adds to and refines the work of scholars like Louise Comfort (2007, 2010, 2013), and her colleagues from the University of Pittsburgh's Center for Disaster Management³, who have examined the factors that facilitate cooperation and collaboration among wide-ranging emergency service organizations. The theoretical significance of this study also includes research into the use of decision support systems to assist unified command teams as they grapple with the informational and technological challenges posed by the complexity of incident management.

Interagency collaboration has been well researched at the *national level*, mostly as it relates to large-scale disasters and emergencies. This is particularly true of the major natural and man-made disasters of the first decade of the twenty-first century; notably the terrorist attacks of September 11, 2001, and the devastation caused by Hurricane Katrina in 2005.

While the literature regarding the response to major disasters of a national scope has been well developed by scholars, these events are relatively rare. Mutual aid operations are far more likely to be conducted on a *local* basis, during emergency incidents that require the cooperation of large numbers of metropolitan emergency resources. In contrast to national events, research into incident management at the *regional* level is relatively scarce and offers rich opportunities for empirical study. As Reddick and Rohm (2010) point out, collaboration is critical to emergency preparedness, but little research has been done to investigate cooperation among county level agencies.

³ The Center for Disaster Management conducts research on decision making in rapidly evolving emergency events, and is an arm of the University of Pittsburgh's Graduate School of Public and International Affairs.

1.6 PRACTICAL SIGNIFICANCE

Research into the operation of unified command teams is linked to the concerns of practice of emergency managers and incident commanders (Marshall and Rossman, 2006). Many small public safety agencies find it increasingly difficult to mitigate large-scale emergency incidents without involving effective teams of decision makers. The practical significance of this investigation stems from its potential to *inform local emergency services officials* who influence and guide command team formation and operation on a regional basis.

As this research looks in the practical aspects of communications during major events, it could also assist emergency managers as they struggle to build comprehensive networks of information gathering and dissemination. Additionally, by studying the dynamics of joint incident management, this research offers the possibility of serving as a guide for collaborative and effective problem solving efforts by regional incident command teams. Finally, through modeling and simulation, the current work explores the possibility of using computer-based systems of decision support, which can aid the human decision making process by considering a wide range of alternatives and providing option awareness during complex events.

1.7 ORGANIZATION OF THIS DISSERTATION

This study is divided into 10 chapters.

Chapter 1: The Policy Problem: Uncoordinated and Ineffective Management of Large Regional Emergency Incidents presents an introduction to the study and outlines its purpose and

focus, as well as its practical and theoretical significance. This chapter includes an introduction to the disaster and emergency field, and a brief discussion of collaborative incident management.

Chapter 2: Theoretical Framework and Key Conceptual Issues lays a comprehensive foundation for research that, while grounded in field investigation, remains firmly anchored to sound theoretical roots. It begins with a detailed description of the Incident Command System and the National Incident Management System, both of which serve as a basis for much of the field investigation described in later chapters. Chapter 2 continues with salient theories that bear upon the work of unified command teams, including a review of organizational culture, learning, and leadership. The importance of modern systems of communications and information management are described, as they figure prominently in any study of command team decision making. Theories of complex adaptive systems and Elinor Ostrom's (2005) Institutional Analysis and Development framework are also discussed and evaluated for their relevance. Human cognition, collaborative decision making under uncertainty, and small group dynamics are the most important theoretical concepts that guide this research, and they are given a comprehensive treatment in Chapter 2.

Chapter 3: Research Methodology identifies the overarching and subordinate research questions of this study, and relates these questions to the techniques used to obtain answers to them. Accordingly, heavy emphasis is placed on the main method of data collection; 75 semi-structured interviews with domain experts. In addition, the procedures used for data coding and analysis are detailed, and the chapter concludes with a discussion of the issues of validity and reliability.

Chapter 4: Context of Regional Operations in Allegheny County identifies the history of large-scale incident management in the field study area and makes the case for why this particular county offers an appropriate geographical area for the exploration of the research questions posed in Chapter 2. Some of the key milestones along the way to the current regional incident management system are discussed, as is the present role of the Allegheny County Department of Emergency Services.

Chapter 5: Inhibitors and Facilitators of Effective Unified Command Team Formation and Collaboration is the first of five consecutive empirical chapters which represent the content and findings of the field investigation carried out in this study. This chapter outlines the processes that lead to the formation of incident command teams during major regional events. According to the informants of this study, the main determinants are the presence of previous cooperation and familiarity among regional emergency services agencies, and the organizational policies and procedures of the agency that has legal authority to manage the incident scene.

Chapter 6: Leadership of Unified Command Teams investigates the process of how team leaders emerge from among a group of experienced incident commanders. Prominent among these reasons, according to informants, are jurisdictional authority, knowledge and specialized expertise, management skill, years in practice, and strong personality type. This chapter also lists the key skills and characteristics needed by team leaders, as related by domain experts: communications skills, command presence, critical thinking, and the ability to facilitate a small group of decision makers.

Chapter 7: Information and the Command Team focuses on some of the most important elements undergirding effective incident decision making. In this chapter the study's informants discuss the communications systems used by first responders in the field study area, and how command teams supplement radio technology with direct face-to-face reporting. Limitations of current technology are described, and the utility of newer systems is discussed. Chapter 7 also discusses how information is gathered, analyzed, and disseminated by unified command teams as they attempt to stay ahead of incident developments. Informants provide rich descriptions of how commanders overcome incomplete information, maintain their situational awareness, and provide a common operating picture throughout the incident scene.

Chapter 8: Decision Making by Unified Command Teams takes an in-depth look at the collaborative decision making process utilized by small decision making groups. Beginning with a comparison of the benefits of joint command, this chapter moves into a discussion about the importance of a good incident action plan. Informants identify such facilitators of effective command team decision making as flexibility, proactivity, creativity, and the free flow of ideas among team members. Inhibitors of the collaborative effort are also identified, including the lack of familiarity with other team members, the failure of the team to accept information from operational sectors or to change course when necessary, and succumbing to pressure to conform to the majority view. Chapter 7 concludes with a discussion of how the command team makes decisions in the absence of a complete informational picture.

Chapter 9: Decision Support Systems explains the process of building a computer based Bayesian network model to enhance the option awareness of command teams and thus increase

the accuracy of their decision making. Focusing on decision making difficulties during highly specialized events, a scenario is presented which consists of a rapidly escalating gas release and fire on one of the Marcellus Shale well pads on the property of the Pittsburgh International Airport. Experienced emergency managers and shale gas experts were consulted for the appropriate model design, and fire officers from the airport's fire department were engaged to evaluate the utility of the model.

Chapter 10: Major Findings and Policy Recommendations present the study's conclusions and offers policy recommendations to improve command team effectiveness during large-scale, regional emergency events. The chapter concludes with limitations of this research and possible avenues of future study.

2.0 THEORETICAL FRAMEWORK AND KEY CONCEPTUAL ISSUES

William Waugh (2007) argues that in order to understand the processes involved in emergency and disaster response, a *multidisciplinary* approach to research should be undertaken. He suggests that the researcher should begin an investigation of emergency management by exploring the fields of organizational theory, decision making, leadership, communications, interpersonal relations, and group dynamics. Accordingly, this chapter opens with a description of the Incident Command System, which is the basis for understanding unified command team operations, and a prerequisite for this investigation. It continues with a review of pertinent organizational theories that bear upon the operation of a collaborative command post, including the literature on small group dynamics. To assure a solid theoretical foundation for this research, theories of human cognition and decision making under uncertainty are considered.

2.1 THE INCIDENT COMMAND SYSTEM

Formalized procedures for on-scene emergency management are rather recent phenomena, and their development can be traced to the advent of the Incident Command System, or ICS.⁴ A management system designed to integrate resources to control emergency events, the Incident

⁴ A similar effort, known as the Fireground Command System, developed along a parallel track and was pioneered at the Phoenix, Arizona Fire Department by Chief Alan Brunacini.

Command System encompasses all hazards emergency response (FEMARC, 2010). The use of ICS by public safety agencies in the highly complex arena of emergency operations helps to bring “order out of chaos” (FEMA, 2008). A basic synopsis of the Incident Command System follows:

ICS represents the *best practices* [emphasis added] of emergency management and is the standard for emergency management across the country. ICS is a management system designed to enable effective and efficient incident management by integrating a combination of facilities, equipment, personnel, procedures, and communications operating within a common organizational structure, and is designed to enable effective and efficient incident management. A basic premise of ICS is that it is widely applicable for both emergency and planned events, and can be used by all levels of government and the private sector. ICS is also applicable across disciplines, and facilitates command, planning, operations, logistics, and finance and administration during an event (FEMA, 2008).

2.1.1 The History of ICS

The Incident Command System is patterned after the tactical command structure favored by the military, and is rooted in a series of catastrophic wildland fires in California’s rural-urban interface during the 1970s. Such fires were often attacked by multiple agencies with few common procedures and spotty communications capabilities. The result was an unnecessary level of property damage and a tragic loss of lives among the responders. An effort, known as the FIRESCOPE project, sought to improve a dysfunctional system of wildland and forest fire response (AHIMT, 2007).

FIRESCOPE investigators tasked with examining the California wildfire situation studied the case histories and discovered that most of the poor incident outcomes could rarely be attributed to a lack of resources or a failure of tactics. Rather, the investigators found that response problems were far more likely to result from *inadequate incident management*,

especially with regard to the coordination efforts between the U.S. Forest Service and the local California fire departments (FEMARC, 2010). The FIREScope team offered a number of suggestions for wildland firefighting in particular and emergency incident management in general. Formalized ICS grew out of these suggestions, which were further developed through the collaborative efforts of fire service leaders throughout the United States, and promulgated by the National Fire Academy.⁵

2.1.2 Basic Structure of the Incident Command System

ICS is a standardized, all hazard, on-scene emergency management system designed to aid in the command and control of personnel and material resources during emergency incidents or planned events of any size. According to FEMA (2008), public safety agencies using ICS are able to:

- Adopt an integrated organizational structure matching the complexities and demands of emergency incidents or planned events of any type, size, or level of complexity.
- Achieve a seamless integration of responders from all jurisdictions into the overall incident operation.

The Incident Command System model is used by jurisdictions and agencies throughout the United States, both public and private, to organize field-level incident management operations. Designed to facilitate on-scene incident management, ICS is based on the following

⁵ The National Fire Academy is an arm of the Federal Emergency Management Agency, and is located in Emmitsburg, Maryland.

principles (FEMA, 2008):

- Modular organization
- Integrated communications
- Information and intelligence management
- Common terminology
- Unity of command
- Unified Command
- Consolidated action plans
- Manageable span of control
- Designated incident locations and facilities
- Comprehensive resource management
- Management by objectives
- Complete on-scene accountability of personnel.

The Incident Command System facilitates the development of an emergency management organizational structure in five major functional areas (FEMA, 2008):

- Command
- Operations
- Planning
- Logistics
- Finance and Administration.

When organizations use the incident command model as the basis for their emergency management and disaster planning, they adopt predefined management hierarchies, processes, and protocols. The ICS command structure provides an orderly chain of command that is consistent across responding organizations. The command function may be headed by a single incident commander, or by a multi-agency unified command team (FEMA, 2008).

2.1.3 The Single Incident Commander

According to FEMA protocols (2008), the officials in charge of an emergency incident must have the ability to quickly assess the situation, establish incident priorities, determine incident strategy and objectives, establish an Incident Command Post (ICP), develop an appropriate response organization, formulate and implement an Incident Action Plan (IAP), and assure the safety of all responders (FEMA, 2008).

Using single command procedures, *one* Incident Commander (IC) is solely responsible for establishing incident objectives and strategies. He or she is also responsible for ensuring that all functional responsibilities are directed toward the accomplishment of those objectives and strategies. Acting alone, the single incident commander manages response efforts, coordinates with other key agencies and officials, and requests additional resources as necessary.

A drawback to the single incident command structure is that during escalating scenarios of increasing complexity, a lone IC, with the limited cognitive capacities common to humans, can be quickly overwhelmed by his or her responsibilities, and be forced to settle for less than adequate solutions; “satisficing” at the expense of effective incident management, as Herbert Simon (1977) might say.

2.1.4 The Unified Command Team

The practice of collaborative problem solving, which lies at the heart of this research, is particularly relevant to the study of emergency management (Hutchins, 1995, Comfort, 2007). Experience has proven that during incidents involving multiple agencies, there is a critical need for integrating the management of resources into one operational organization that is supported by an integrated, multi-disciplined organization (AHIMT, 2007). To overcome the deficiencies of using a single incident commander, a *unified command team* is often utilized.

The unified command organization consists of incident commanders from various jurisdictions or agencies, operating together to form a single command structure (FEMA, 2008). Under the rubric of unified command, officials designated by their jurisdiction or agency work together to determine objectives, strategies, plans, resource allocations, and priorities. Using a team approach, they execute integrated incident operations and maximize the use of assigned resources.

The unified command approach allows a variety of agencies having *jurisdictional or functional authority* to jointly provide management and direction of an incident. In theory – if not always in practice as the command team must of necessity be limited – all agencies are represented and therefore no agency’s input is neglected. The key benefits of unified command include:

- A single set of objectives developed for the entire incident.
- A shared understanding of priorities and restrictions of potential actions.
- A collaborative approach to develop strategies and achieve incident objectives.
- Improved information flow between agencies and functional units.

- A joint understanding among agencies of incident priorities and restrictions.
- Improved resource utilization.
- Reduced or eliminated duplication of effort.
- Optimization of the combined efforts and strengths of all agencies as they perform their respective assignments under a single Incident Action Plan.

Unified command is a team effort that allows for collaboration among a number of experienced and trained incident commanders (AHIMT, 2007). Employing a unified command approach, incident leaders are able to “connect, collaborate and coordinate” to devise innovative ways to solve novel problems” (Pfeifer, 2013, p. 2). Unified command team members arrive at decisions through *consensus*, and orders are issued by a team leader; a process often referred to as the one command voice (FEMA, 2008). In geographic regions where response agencies suffer from limited resources and personnel, the unified command approach to incident management has become a necessity in most locales (Informant 19). Figure 1 illustrates a typical unified command post organizational chart. Additional ICS examples are located in Appendix B.

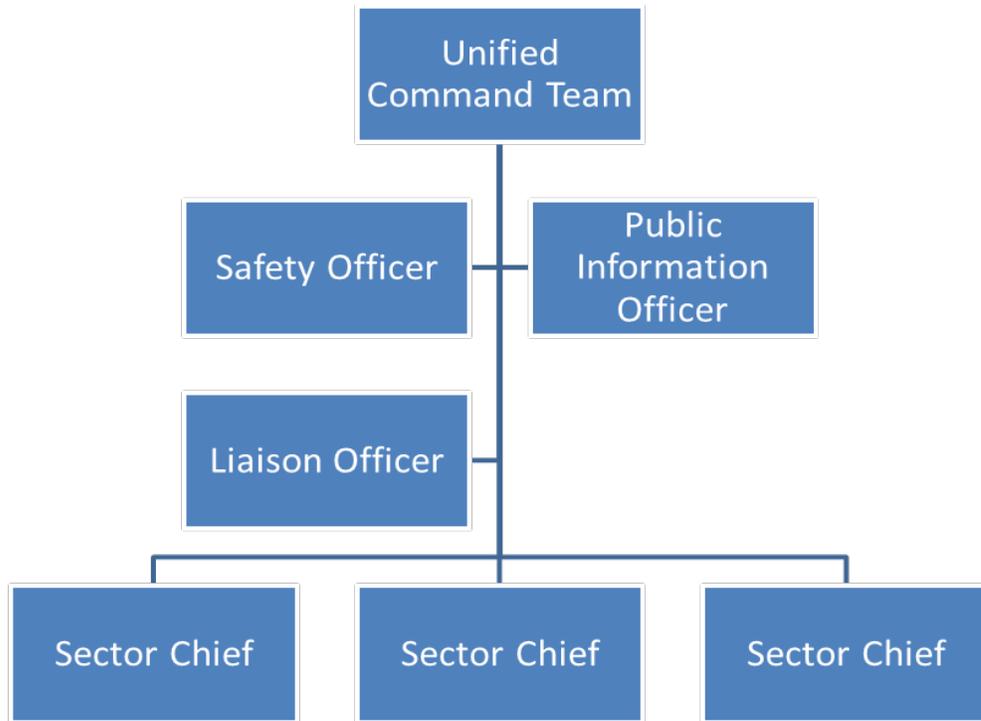


Figure 1: Unified command Team Organizational Chart

2.1.5 The Incident Action Plan

The single incident commander or unified command team is responsible for preparing the *Incident Action Plan* (IAP). The IAP describes how resources will be utilized and includes mechanisms for setting incident priorities, integrating responder functions, establishing relationships between operating agencies, and ensuring that systems put in place support all incident management activities (FEMA, 2008).

2.1.6 The National Incident Management System

Following the attacks upon the United States on September 11, 2001, the U.S. government, led by the Federal Emergency Management Agency (FEMA), began an effort to disseminate ICS

principles, as practiced by the nation's fire service agencies, to federal agencies across all levels, jurisdictions, and specializations. Known as the National Incident Management System (NIMS) and mandated by *Homeland Security Presidential Directive (HSPD) 5*, it has become the national model for all hazards incident management, and can be applied to emergencies of all types and sizes. According to FEMA (2008):

The National Incident Management System provides a consistent nationwide approach for federal, state, and local governments, the private-sector and nongovernmental organizations to work together effectively and efficiently to prepare for, respond to, and recover from domestic incidents, regardless of cause, size or complexity.

Based on the proven concepts of the Incident Command System, NIMS includes a core set of concepts, principles, and terminology (FEMA, 2008). The NIMS approach is intended to be flexible enough for use at all types of incidents, yet of a standardized foundation to provide a coordinated, efficient response to every incident.

One of NIMS main objectives is to achieve compatibility and interoperability across jurisdictions, disciplines and sectors, by using a standard set of core concepts, principles, terminology, and technologies. NIMS was also established to ensure a standardized framework for communications and is intended to facilitate interoperability, reliability, scalability, and portability, as well as the resiliency and redundancy of communications and information systems during large-scale response activities (FEMA, 2008, Jensen, 2014).

2.1.7 Critiques of ICS and NIMS

There is broad agreement that ICS and NIMS have been successful in facilitating the management of relatively straightforward emergencies, but not everyone agrees that these

guidelines are well suited to scenarios which are complex or of a large-scale. As Howitt and Leonard (2009, p. 133) put forward, the Incident Command System functions best within a “well-defined, reasonably consistent, or clearly prioritized set of objectives.” When such clarity is not present, as when the incident command team is presented with unclear goals or when multiple avenues exist for achieving incident objectives, ICS lacks the mechanisms to decide which course of action to follow (Howitt and Leonard, 2009).

While ICS is FEMA’s preferred “mechanism for inter-organizational coordination,” designed to impose order on potentially disorganized and chaotic incident scenes of *any* size, it may not in reality offer a comprehensive emergency response solution (Buck, Trainor, and Aguirre, 2008). Renaud (2010) suggests that ICS has become a series of checklists and tasks, tending to focus first responders on *process* [emphasis added] instead of purpose, and preventing incident commanders from using a sensemaking process.

As it has branched out from its fire service roots and been incorporated into the tapestry of the National Incident Management System, ICS has come in for negative commentary regarding its suitability across disciplines. Some have noted that the NIMS / ICS blend has become too formal and rigid to easily accommodate the disparate public safety agencies which are brought together during large-scale operations. The NIMS / ICS command structure is seen as having its least utility when non-fire agencies are brought into the mix; especially law enforcement personnel who have the least experience with ICS (Buck, Trainor, and Aguirre, 2008).

It has proven equally difficult to integrate civilian-styled public agencies and private sector organizations, such as public works departments, road departments, volunteer organizations, or local business concerns, which have little or no experience with emergency

services practices or ICS principles (Fox, 2009). As Renaud (2010) indicates, the structure of ICS is difficult for the layman to understand, and the issue is compounded by the fact that it uses its own lexicon. Further, while non-public safety organizations might conduct a cursory level of training, few follow this up with the recurrent training and practical exercises needed to achieve and maintain enough proficiency to operate effectively during a major disruptive event.

Jensen (2014) relates a common theme among researchers when she suggests that NIMS implementation has not led to a greater level of preparedness for local communities. She also remarks that there are still many organizational challenges to be overcome before NIMS can become the “single solution to emergency response in the United States” that FEMA proposes (Jensen, 2014, p. 14).

2.1.8 ICS Adaptability

Recent research indicates that it may be possible to overcome some of the shortcomings of ICS, especially as they relate to the integration multidisciplinary resources. Moynihan (2009, p. 897) explains that today’s major emergencies require a *networked response* from the resources of multiple agencies and jurisdictions, operating in what he calls a “coordination and communication” model of collaboration. Such networks, which can undermine the chain of command concept due to their interactivity, are not addressed in ICS structure but may be necessary while managing large-scale events.

It has been found that authority and decision making, in practice, are normally shared. It follows that incident commanders might allow variations of the strict, top-down command and control models through a traditional chain of command (Moynihan, 2009). Some have argued for a combination ICS with a command and control hierarchy with a cooperative structure that

emphasizes flexibility and initiative (Groenendaal, Helsloot and Scholtens, 2013). Likewise, a combination network and hierarchical structure is what Yaneer Bar Yam (2004) has in mind when he discusses hybrid organizations.

2.2 SALIENT ORGANIZATIONAL THEORIES

The management of large-scale events featuring high complexity and uncertainty represents a challenging undertaking for even the most experienced incident commanders. To understand the dynamics involved, it is important to review some of the organizational theories which bear upon their work. The literature on organizational culture, learning and leadership are especially appropriate.

2.2.1 Organizational Culture

According to the work of Schein (1992), organizational culture results from the embedding of the ideas that a leader has imposed upon a group. He posits that the culture of a group can be defined as a pattern of shared basic assumptions, which the leaders of a unified command team might be expected to exhibit. Schein (1992) maintains that effective leaders strive to bring out the special skills of their team members; an important idea in this investigation into unified command team dynamics. According to Schein, culture creation and management are at the heart of team leadership.

Efficacious problem solving groups have a firm grasp on their core mission, and are able to formulate mission strategies and objectives. Within the setting of a sociotechnical team, the

emergent culture reflects the group's abilities to cope and learn, and provides stability to the group setting (Schein, 1992). As a step toward understanding the UCT process, this study assesses how the group sets boundaries of action, how it distributes power, whether it can develop trust, and how it copes with new and unpredictable situations. Organizational culture also relates to the discussions of the advantages of established incident command teams in Chapters 5, 6 and 8.

2.2.2 Organizational Learning

Comfort (2007) posits that an emergency response network is “necessarily a learning system” because it depends upon the ability of its participants to generate valid information, facilitate informed choice, and foster a timely commitment to action.” She also suggests that the capability of an organization to manage a crisis must be based upon “the human capacity to learn, innovate, and adapt to changing conditions informed by timely data.” The challenge is to build these capabilities into “multiple levels of the organization” (Comfort, 2007). Theories of organizational learning inform the decision making discussions in Chapters 5 and 8.

In comments germane to communications between unified command team members, Comfort (1999) also explains that the “process of discovering shared meanings...stimulates an organization to integrate new information with previous experience and extends its capacity for mobilizing action to a larger social audience.” This statement suggests that officials from varying backgrounds, while collaborating at a joint command post, are able to discern new meanings – shared meanings – of on-scene developments, which would greatly benefit the situational awareness of the team. Of further use to the decision making processes of UCTs, Comfort (1999) suggests that a team can develop “its own autopoiesis, or self-generating

capacity for creative action.”

Simon’s (1997) work is applicable to this research, as he posits that a team learns from the knowledge of its shared experiences and memories, as well as from information that is stored in its files. Additionally, he feels that an organization can enhance the learning process of its staff by admitting new members – who bring their own skills and experiences – or by having a means to readily access historical information stored in computing systems. Unified command team dynamics progress through a similar process.

Argyris (1993) explains that organizational learning occurs when errors are detected and corrected, eliminating the mismatch between intentions and results. Impediments to learning occur in situations where “defensive routines” inhibit the detection and correction of error, as when participants avoid threats or embarrassment in an uncomfortable situation. At a unified command post, these routines might be expected to develop among officials who hail from different jurisdictions, levels, or types of organizations, and may prove especially problematic when UCT members are not well acquainted with one another.

The work of Argyris is also pertinent to groups of established decision makers; those who have worked and trained together frequently. His theories imply that such well-established groups might be better able to learn from the successes they have shared and the joint mistakes they have made; in contrast to ad hoc command teams which have experienced no such history. Further, experienced groups share an understanding of each other that would help preclude the defensive routines which are so destructive to the collective learning process.

Carley and Harrald (1997) maintain that organizational learning plays a major role in emergency response, and that feedback from actual events assists the process. Their comment that response organizations fail to learn from feedback points to a problem that commonly

impacts command team decision making. Blaming it on a tendency to regard negative feedback as criticism, they also argue that organizations which train their personnel to follow strict standard operating procedures tend to impede the learning process. If, however, responders are permitted to use their experience, they will learn and adapt, and thus allow the entire organization to learn from past actions (Carley and Harrald, 1997).

According to Moynihan (2008), trial and error learning in a crisis is not ideal, yet it is often necessary and done quickly, as unified command teams conduct their operations in highly complex and uncertain environments. In such scenarios it has been observed that cohesive teams have the ability to undertake “intracrisis learning,” which is conducted during the unfolding of the actual emergency event (Moynihan, 2008, p. 353,). This idea is contrasted from the more common intercrisis learning which takes place as lessons are learned from one emergency event to another. Intracrisis learning can be tricky, as emergency events “narrow focus, limit information processing and lead to a recycling of old solutions” (Moynihan, 2008, p. 351). Thus unified command team members who have the chance to collaborate frequently might become adept at intracrisis learning, while those brought together on an ad hoc basis might not.

This research investigates how the members of unified command teams, especially those groups who work together on a regular basis, use information to arrive at innovative solutions as they adjust to changing incident conditions. This study makes the assumption that organizational learning is a crucial element in the command team effectiveness, as it allows those at the command post to gain knowledge of their environment and adjust their strategies to changing incident conditions. Understanding the elements of organizational learning as espoused by scholars provides the researcher with a solid foundation for the exploration of the decision making process, and guides the development of the semi-structured interview process.

2.2.3 Organizational Leadership and Motivation

Chapter 6 of this study explores the mechanisms of leadership emergence, and considers the most important characteristics of unified command team leaders. Schein (1992) posits that the connection between organizational culture and leadership is clearest in settings he describes as micro-cultures, which are similar to the kind of sub-organizational groupings that might be found at a unified command post. Schein (1992) also suggests that the group leader must win group acceptance, since the members are free to accept, modify, or reject the leader's decisions. It can be argued that such ideas are especially important in non-hierarchical settings, where lines of authority and responsibility are unclear as is often the case during collaborative command activities.

Peter Northouse (2001, p. 8) described leadership as the art of influencing others to accomplish a common objective, usually in a group context. He suggests that a group leader might exercise one of two types of power:

1. Position power, which is derived from formal organizational ranking.
2. Personal power, which is the capacity to influence others through personality and knowledge.

When multifunctional teams with dissimilar backgrounds are brought together for a limited time and with a common objective, the leader's role is critical in assuring collaboration (Waldman, 1994, Fox, 2009). In *The Leadership Challenge*, Kouzes and Posner (2008) suggest that leaders of groups need to inspire a shared vision and build trust by empowering all team members and by recognizing their contributions. They also remark that team leaders should not be afraid to experiment and take calculated risks when the situation calls for it, as is often the

case during rapidly evolving emergency events (Kouzes and Posner, 2008).

According to John Gardner (1990), good leaders place heavy emphasis on establishing a vision of group goals, expectations and purposes. In addition, they assure an environment of trust by sharing complete information and explaining intended actions and procedures to the team. Good leaders have the political skill to cope with conflicting requirements and multiple constituencies; conditions often found at a multiorganizational and multidisciplinary incident command post.

Don Seaman (1981) stresses the importance of organizational leadership when it comes to facilitating the decision making processes of a small group. He posits that the group leader be experienced in group dynamics, possess expert knowledge of the subject matter, and be able to clarify the team's thoughts and decision making processes. Seaman also stresses the inevitability of conflict among individuals of differing backgrounds, and suggests that leaders channel such disagreements in a positive direction by asking questions to broaden the scope of the discussion (Seaman, 1981). Facilitated leadership and facilitated collaborative problem solving involves a group decision-making team led by a leader who brings all parties together in a face-to-face meeting where they work to build consensus on a course of action (Straus, 2002).

A thorough understanding of the leadership literature is needed for the researcher to conduct an exploration of how leaders emerge from within an already formed unified command team. It is also needed to query domain experts on their opinions of the most important skills and characteristics of effective command team leaders.

2.3 COLLABORATION DURING MAJOR EMERGENCIES

Eugene Bardach (1998), who studies collaboration among public and nonprofit organizations, defines *interagency collaboration* as those activities that create public value when two or more agencies work together by sharing their resources and expertise. In a similar vein, Comfort (2013) argues that major emergencies require the efforts of sociotechnical systems of “individuals, groups, organizations, and jurisdictions” that must align their actions in an uncertain and dynamic environment to bring the event under control.

This study assumes that collaboration is an essential component of effective unified command and is more effective than the traditional command and control approaches to large-scale emergency management. This research also considers that *cooperation and coordination* among public safety agencies are necessary prerequisites to collaboration among them. Chapters 5, 6 and 8 of this study are based in large part on the collaborative work discussed in this chapter.

2.3.1 Cooperation and Coordination

According to Rogers (1982), coordination is a formal relationship among agencies, while cooperation is characterized by informal trade-offs and by attempts to establish reciprocity in the absence of rules. While both concepts represent steps along the way toward full collaboration, cooperation and coordination occur only as a *part* of the process. Further, they represent static patterns of activity, rather than the dynamic and emergent processes of team collaboration (Rogers, 1982).

2.3.1.1 Cooperation

Cooperation is a voluntary agreement in which two or more entities engage in a mutually beneficial exchange of resources or capabilities. Cooperative efforts are designed to prevent divergence and dissent within and between organizations, eliminating most forms of conflict (Denise, 1999). Within the parameters of this study, cooperative efforts include the sharing of resources between public safety agencies in a regional mutual aid network, and extend to the exchange of incident management expertise by helping to staff a unified command post. This research also proceeds from the assumptions that simple cooperation alone will not create an environment for effective decision making, and that too much cooperation can squelch new or innovative ideas among a small team of decision makers (Denise, 1999).

2.3.1.2 Coordination

Coordination can be defined as the resolution of interdependencies between the activities of different organizational units (March and Simon, 1958, Mintzberg, 1979, Smith and Dowell, 2000). According to Denise (1999), coordination refers to efficiency and the bridging of differences between people and groups to achieve structural harmony, and informs each entity about how it fits into the overall plan of action and what it must do to achieve its portion of the operation.

Comfort (2007) explains that coordinated efforts “align one’s actions with those of other relevant actors and organizations to achieve a shared goal.” According to Comfort (2007), coordination is necessary for incident commanders to achieve a common understanding of the situation in order to agree on strategies to bring the incident under control. Coordinated activities have also been said to aid the shared cognitive capabilities among teams of interdependent individuals (Patterson and Stephens, 2012, 173).

To the outside observer, public safety entities often seem a collection of unconnected entities where the coexistence of incompatible agency goals encourages the avoidance of responsibility (Chisholm, 1989). These incongruities, known as *multi-organizational sub optimalities*, hinder cooperation between organizations (Chisholm, 1989). Without coordination, public organizational entities will suffer from the effects of overlap, redundancy, or separation (Denise, 1999).

2.3.2 Collaboration and Collaborative Advantage

Collaboration, according to Denise (1999), is the process of shared creation, where group members with complementary skills work together to achieve what they could not have done by acting alone. Collaboration is concerned with the creation of *synergy* between collaborating organizations or individuals (Huxham, 1996). Unlike coordination and cooperation, collaboration thrives on differences and requires sparks of dissent to achieve its maximum potential for joint action in a team setting (Denise, 1999). Barbara Gray (1991, p. 5) touches on the creative aspect of collaboration:

Collaboration is a process through which parties who see different aspects of a problem can constructively explore their differences and search for solutions that go beyond their own limited vision of what is possible. Collaboration is based on the simple adage that two heads are better than one and that one by itself is simply not good enough.

Collaborative advantage, according to Gray (1991) is an arrangement that generates collective value through the addition of each actor's unique competencies and by combining their capabilities synergistically. Gray's (1991, p. 10) description of the need for a collaborative enterprise is particularly apt with regard to the environment at a unified command post, where

the following conditions are present:

- Problems faced by the team aren't precisely defined.
- Several agency officials have a vested interest in the outcome of the process.
- The team members are not necessarily identified or organized a priori.
- Power disparities exist among the command team members.
- Command team members have varying levels of expertise and experience.
- The problems faced by the team are technically complex and uncertain.

2.3.3 Interagency Collaboration during Large-Scale Emergency Response

Major emergency events can strain and overwhelm the ability of local public safety agencies, necessitating responses that are multiagency, multidisciplinary, and multijurisdictional in nature (McGuire, 2009). James Austin's (2000) concept of "inescapable interdependence" illustrates the situation facing many of today's public service organizations, where no one agency can address major situations on its own. An example of such interdependence is a large-scale firefighting operation; a multiagency event where police, EMS, fire, public works, and road department personnel from a number of political sub-divisions might be required to bring the situation under control.

A multidisciplinary, multijurisdictional mutual aid network is composed of interdependent parts that must be coordinated on a comprehensive basis (Chisholm, 1989). Yet William Waugh (2007, p. 166) suggests that incident command teams should emphasize the following practices in order to enhance the collaboration process:

- A shared vision of incident goals and objectives.

- Creativity and an openness to change of the command team's initial plans.
- Good leadership and shared ownership of the incident action plan.
- Cooperation among team members toward a positive outcome.

In the field study area, multiple agency activity is a necessity in the face of dwindling resources and limited capabilities of the response forces of political sub-divisions (Informant 19). Correspondingly, Pfeifer (2013) suggests that interagency activity requires incident commanders to “rapidly move from a single organizational command model to a system of collaboration with other agencies” (Pfeifer, 2013). While suggesting that the command structure be flattened to take advantage of the participation of all agencies, Pfeifer also stresses that *genuine collaboration* is the key to the team's efforts.

2.3.4 Establishing a Collaborative Relationship

Discussing the evolution of strategic alliances, Austin (2000) remarks that an understanding of the need for an association, including the potential costs and benefits involved, is a basic first step in the collaborative process. Once partnering opportunities are identified, Austin (2000, p. 20) suggests that a collaborative development process be set up along a *continuum* which begins at the “philanthropic phase,” with minor efforts to assist each other, continues to a “transactional stage” where “two-way benefits are identified and sought,” and culminates in an “integration stage,” where the organizations become much more linked and the advantages to each increase accordingly.

Austin (2000, pp. 99-103) also urges the adoption of “smart practices” which highlight each partner's unique capabilities and offer a “core competencies exchange” between

organizations. Once a collaborative effort is underway, the creation of value – combining multiple resources and capabilities to generate benefits for all – should be the key determining factor in the endeavor. Each agency’s needs and capabilities should be examined to assure a strategic fit, and enough time should be invested to foster an environment of *trust* which builds a culture of joint problem solving (Austin, 2000). One of this study’s goals is to examine how regional mutual aid response agencies create value for each other by collaborating during joint command operations.

2.3.5 Impediments to Collaboration

Setting up a collaborative network can be a difficult endeavor. The often competing interests of independent jurisdictions can frustrate coordination and connectivity, and regional public service agencies are sometimes uncoordinated and in disarray (Waugh & Streib, 2006). In extreme cases, public safety policymaking takes place in political and administrative systems that are fragmented to the point of chaos (Waugh & Streib, 2006).

Austin (2000) explains that in order to realize the benefits of a collaborative alliance, each partner must be willing to give up some control over the situation; an arrangement which some agency heads may view as a loss of control and accountability. Gray (1991) cautions that in many cases, stakeholders are unable or unwilling to collaborate, especially in locales where jurisdictional or agency rivalries exist. This research, as emphasized in Chapter 5, explores the methods used by agency leaders in the field study area as they struggle to overcome the obstacles to interagency collaboration.

2.3.6 Maintaining a Collaborative Relationship

Chapter 5 considers the nature of collaborative command team associations, as informed by the domain experts interviewed for this research. Collaborative relationships are dynamic in nature and the value and benefits provided by each partner can erode over time (Austin, 2000). In the field study area, individual levels of experience and skill are particularly likely to decrease, as experienced command officers leave their organizations, or as organizations in the mutual aid network lose proficiency in their areas of specialty. In addition, complacency can set in among partnering agencies, leading to stagnation and a loss of public value.

Managing collaborative relationships among emergency services leaders might best be accomplished by providing frequent opportunities for trust-building and communication, since potential command team members may not be in regular contact with one another. Austin (2000, p. 134) suggests that ongoing evaluations of the association be conducted and should begin by asking “What kind of collaboration do we have, and how might it evolve over time?”

2.4 THEORIES OF GROUP DYNAMICS

The synergy among incident commanders working to manage large-scale events is informed by theories of small group dynamics. Originating with Kurt Lewin’s 1930s research into small face-to-face teams, the study of group dynamics seeks to understand and explain the characteristics of group interaction (Patton and Giffin, 1978). Lewin argued that the *interdependency* of individuals with one another is the essential aspect of successful collective activity (Shaw, 1976).

2.4.1 Characteristics of Small Decision Making Teams

The unified command teams examined in this research consist of small, interdependent work groups, as detailed in Chapter 8. Don Seaman (1981) explains that groups are often formed for some specific purpose, and that decision making is among the most difficult of challenges for them. He also states that successful groups often feature heterogeneity, with members of varying attitude, background, and experience.

Studies of group judgment and group problem solving suggest that team members exert an influence over one another which results in a group product that is greater than the mere combination of their individual efforts (Shaw, 1976). Cecilia Ridgeway (1983) explains that group interaction is influenced by the requirements of the situation and by the relevant skills of each member. Paul Hare (1992) adds that decision making teams feature role differentiation, and thus are mutually dependent upon each other's expertise. Accordingly, group members must agree on a clear and achievable set of goals, and should work under the aegis a facilitating group leader.

According to Ridgeway (1983), the most important aspect of small group structure is the status hierarchy, which plays a central role in controlling the activities and goals of the group. Status refers to degree of "deference, esteem, and power" that one uses to influence others. The observable signs of a member's power and prestige include the rate of participation in group discussion, the type of evaluation this participation receives, and the degree of influence wielded. For status systems to persist and serve the group effectively, they must be perceived as being fair and just (Ridgeway, 1983).

Small group *performance* is directly impacted by the *size* of the group. Very small groups cannot attain much collaborative synergy, while a larger group setting often sets the stage

for interpersonal issues that result in fewer active participants and more difficulty achieving consensus (Shaw, 1976). The ideal group decision making size is approximately five individuals who are able to achieve cohesiveness through familiarity of frequent collaboration (Patton and Giffin, 1978). The Incident Command System recommends a command team size ranging between three and seven members, also suggesting that five is optimum (FEMA, 2008).

Small group *influence* is directly related to how the skills of individual members impact the achievement of group goals, which can serve as a catalyst for others (Shaw, 1976). Groups characterized by “friendliness, cooperation, and interpersonal attraction” exert strong influences upon members to behave in accordance with group expectations. Members of cohesive teams tend to work harder to achieve group goals and thus reflect a higher level of productivity (Shaw, 1976).

2.4.2 Small Group Leadership

Chapter 6 cites the importance of a leadership on the collective efforts of the command team. An effective team leader is someone who can win the support of the group and is able to influence their actions without adopting an authoritarian stance (Shaw, 1976). Leadership in the small group setting provides the impetus to work toward team goals, and leaders have a profound effect on the collaborative decision making environment (Straus, 2002). Bardach (1998) uses the term *managerial craftsmanship* to denote a leadership ability that builds value into the collaboration” in an innovative and meaningful manner. In contrast, an anarchic group structure can emerge if no one person assumes constant leadership of the team process, but this has shown to be an effective arrangement only where there is little concern about task accomplishment (Ridgeway, 1983).

According to Shaw (1976), the successful team leader must be motivated to lead, and should have knowledge and skill related to the group's tasks in order to guide its members. In a small group situation, according to Shaw, the core of leadership is threefold:

1. The exercise of an executive function.
2. The assumption of responsibility for structuring behavior.
3. The direction of decisions as a part of the group's effort to pursue goals.

Leadership in small teams is a “complex, highly variable phenomenon that develops out of the interaction of the specific group, its environmental situation, and the nature of its members (Ridgeway, 1983). In light of the “basic conflict between individual desire for independence and need to belong, the group leader takes on special emotional significance,” for the leader alone has the ability to unify independent action with the solidarity of the group (Ridgeway, 1983).

2.4.3 Small Group Communications

Chapter 7 examines communications procedures as they relate to the collaborative efforts of unified command teams. Team members must be able to communicate easily to function effectively. Accordingly, a good system of communication, in the words of Shaw (1976), is the vital element by which small groups meld, and lies at the heart of the group process. Through open communication, group members interact and influence each other's behavior, and the group is brought to life. Additionally, when a small group is *restricted to a specific physical location* (e.g. emergency services officials at a unified command post), its communication network is often structured by that environment. The closer the team members are in physical proximity, the greater the number of communication channels available to them (Ridgeway, 1983).

The communications interactions of a small team can be discerned by observing *who talks to whom*, and by considering the content and substantive nature of the message (Ridgeway, 1983). The communications network, in turn affects the degree of cohesiveness among the group, and status is often an important component of this process. The leader is likely to receive more communication than others, have more influence on group decisions and thus is most likely to become the center of attention within the group. One caveat is that if communications are directed mainly to members of high status, or if those influential members restrict their interactions with lower status members, the network may become heavily biased in an upward direction (Ridgeway, 1983).

2.4.4 Problem Solving and Decision Making in Small Groups

Chapter 5 demonstrates that teams are often formed to solve problems and make decisions, and research suggests that such groups perform at the level of the best individual decision makers and significantly better than those of lesser expertise (Bonner, Baumann & Dalal, 2002). One reason for superior group performance is that individuals of differing backgrounds and expertise can combine their efforts into an “aggregate group product or decision” (Bonner, et al., 2002, p. 719). Thus a key consideration regarding collaboration is its interdependent nature, and the fact that it establishes a “give and take” among the team members that is designed to “produce solutions that none of them working independently could achieve” (Gray, 1991, pp. 11-12).

Straus (2002) advocates the following procedures assure effective collaborative decision making:

1. Involve all relevant stakeholders.
2. Come to agreement by building consensus, but specify what happens if it cannot be

achieved.

3. Design a process map; a pathway to reaching consensus.
4. Designate a team leader.
5. Harness the power of group memory – the collective group experience.

2.4.4.1 Group Decisions

Throughout the decision making process, information is gathered and evaluated, issues are clarified, opinions are aired, and steps toward consensus are taken by group members (Patton and Giffin, 1978). Patton and Giffin lay out a list of commonly accepted decision making procedures used by small problem solving teams:

1. Mutual identification of the problem.
2. Joint analysis of problem scope, along with the setting of group goals.
3. Critical evaluation of alternatives, with the airing of each member's ideas and concerns.
4. The development of a plan of action agreed upon by the group.

Group decision making does not always proceed logically, or easily; it can be adversely affected by hidden agendas among the members, or because of biases, emotions, or arguments (Patton and Giffin, 1978). Further, the type of high stakes decisions that occur during a large-scale emergency can be short-circuited because of poor decision making processes that don't allow the issues to be fully discussed, or because of a fear of negative consequences (Seaman, 1981).

2.4.5 Group Confidence, Cohesiveness, and Conformity

Much of the behavior of people in groups is the result of peer pressure to fulfill group expectations (Patton and Giffin, 1978). Group cohesiveness is regarded as the strength or solidarity with which the group is bound together, and is a basic dimension that defines the degree of "group-ness," or unity that they achieve (Shaw, 1976). Conformity is a willingness or unwillingness to adhere to group norms, while deviance is behavior that violates these norms. Since conformity is generally rewarded by the group, members will attempt "social control" to reduce or eliminate any deviance from group norms (Ridgeway, 1983).

2.4.5.1 Group Confidence and Groupthink

Chapter 8 sets out to understand conformity, which is greatest among cohesive groups, and they often try to stick together as much as possible, possibly leading to a phenomenon known as *groupthink* (Patton and Giffin, 1978). Groupthink, or the tendency for *concurrency seeking*, occurs when a sense of collective self-confidence and loyalty to the team replaces a careful evaluation of alternatives for action; it is a psychological pressure to live up to group expectations (Patton and Giffin, 1978). Groupthink causes decision making teams to become too sanguine about the risks involved in a particular choice, and is a common event in crisis situations (Ridgeway, 1983).

Samuel Fraidin (2003) describes a dynamic akin to groupthink, in which the team as a whole favors one course of action, even while one or more individual members have evidence to the contrary. If such information remains unshared, group members do not have the chance to debate its merits, and decision making accuracy is negatively affected (Fraidin, 2003).

Several informants of this research acknowledge that decision making teams can become

presumptuous about their ability to guide events. Correspondingly, Janet Sniezek (1992) postulates that *group confidence* is at least as important as, and directly related to, the quality of group decisions. She explains that while groups display more problem solving skills than individual decision makers, the process can be short-circuited by a failure to explore enough alternatives. The result can be a sense of “inappropriate confidence” which results in poor decisions (Sniezek, 1992).

Anchoring and Adjustment

Overconfidence is also caused by a process of anchoring and adjustment, where the team anchors an estimate of current events based on past experience, and adjusts that estimate to account for current conditions (Druzdzel, 2013). While anchoring and adjustment provides a starting point in the absence of good information, the previous experience may not pertain to the current situation, and thus the team isn't able to adjust correctly. Further, the anchors might be biased by member backgrounds; yielding different conclusions (Druzdzel, 2013).

Closely related to overconfidence is confirmation bias, where the group tends to reconfirm an existing decision, and to “discount, ignore, or reinterpret” evidence that runs counter to that already formed interpretation (Hutchins, 1995, p. 239). In these cases, overconfidence can lead to the phenomenon known as the “risky shift” where individuals in groups become willing to make more perilous decisions than they would if operating alone (Shaw, 1976). Thought to occur because responsibility for negative consequences becomes diffused throughout the decision making team, Sniezek (1992) advises that such “underestimation biases” can be eliminated through open and honest group discussion.

2.4.6 Group Creativity

According to Druzdzel (2013), creativity is the ability to devise novel, insightful, clever, unique, different, or imaginative concepts. Small groups are said to be superior to individuals during key decision-making activities, as they exhibit a greater variety of judgment and skills, have a better opportunity to detect and correct errors, and have more energy to bring to bear on complex tasks (Patton and Giffin, 1978). These ideas suggest that small teams of incident commanders should be able to generate a much wider range of alternatives for action than any single commander could. Chapter 8 identifies critical factors in the creative process, as conveyed by domain experts.

Brainstorming, where ideas are solicited and examined without fear of criticism is a highly effective vehicle for group creativity. Considered to be an example of fluent and flexible thinking, brainstorming allows the team to come up with many ideas quickly, and “stimulates variety” among them (Druzdzel, 2013). It can also prevent a team from settling too quickly on a particular alternative. Brainstorming demonstrates the possibilities of ideating novel solutions to challenging problems, and the benefits of allowing individuals to freely express their opinions, even if that means disagreeing with the majority view of the group (Patton and Giffin, 1978).

2.4.7 Group Conflict

Seaman (1981) stresses that decision making groups, owing to the varying background experience and attitudes of their members, *will* experience conflict. While he admits that some discord facilitates the group process, he advises leaders to be alert for the signs of excessive group animosity: impatience with one another, criticisms or distortions of the ideas of others,

disagreement on even the most routine of issues, and constant opposition to the leader's suggestions (Seaman, 1981). Patton and Giffin (1978) also believe that disagreement among group members is an important part of the creative decision making process, as long as the conflict does not escalate to the point where members take sides or attack one another on a personal level. Informants to this research display mixed feelings about group conflict during decision making activities, and their comments are recorded in Chapter 8.

2.4.8 Established, Semi-Permanent Incident Command Teams

Chapters 5 and 8 allude to the superior decision making abilities of long-established and cohesive command teams. According to Gary Klein (1998, p. 233), a problem solving team is an “intelligent entity” which has an ability to determine courses of action which exceed the capabilities of any one individual. Studying the decision making activities of aircrews and fireground command teams, he puts forward that small teams often exhibit a “collective consciousness” or “team mind.”

The fireground teams that Klein (1998) study are quite successful, he explains, because they are members of a stable, closely knit network of highly experienced professionals who have worked together often over a period of years, and know that they will be working together in the future. These factors allow them to specialize individually, while collectively making rapid decisions with incomplete information. Additionally, long-established teams are able to constantly evaluate the progress of an incident and make the necessary adjustments to their strategies and tactics, allowing them to deal with highly uncertain conditions (Klein, 1998).

Klein (1998) differentiates well-established teams from those which come together on an infrequent or ad hoc basis. Unlike the experienced *mature* teams which have developed a team

identity, he finds that ad hoc associations, with little or no history together, are unaware of each other's skill sets. Further, established teams are said to share a common team cognition which allows them to understand the situation at hand, and are adept at creative decision making; improvised or immature teams struggle to understand one another and have little ability to manage the flow of ideas. In many ways, Klein's (1998) description of mature versus immature decision making collaborations is representative of the situation faced by many regions with uncertain staffing levels and a high volunteer firefighting component, where the capabilities of an incident command team often "depend on who shows up that day" (Klein, 1998, p. 245).

2.5 THEORIES OF COMPLEX ADAPTIVE SYSTEMS

The literature on complex adaptive systems (CAS) constitutes a germane theoretical framework for explaining the dynamic processes involved in achieving coordinated action among multiple organizations. Comfort's (2007) characterization of real world problems as "complex, multi-scale, and dynamic" bears on the unified command team process itself, which can be described as a complex adaptive system that "adjusts and adapts its performance" to the needs of an evolving situation. This is especially true as response organizations "seek to manage complex technical operations in environments of extreme risk," such as at the scene of a major regional disruptive event (Comfort, 1999).

Scott and Davis (2007) view most modern organizations as complex entities where systems integration becomes the primary challenge to modern administration. How managers synthesize an array of disparate systems components for collective action is a critical factor in organizational survival. The goal is to integrate individual specialists into a coherent system;

one that is able to make rapid-fire decisions under conditions of high stress, uncertainty, and complexity (Scott and Davis, 2007). Comfort suggests that systems operate at different *scales of size and complexity*, and that identifying the appropriate actions for each level of the operation is the primary task of improving performance.

Robert Axelrod and Michael Cohen (1999) believe that complexity arises when strong interactions exist between the elements of a particular situation, so that current conditions will impact the probabilities of future events. These authors describe how complexity can be harnessed by changing the structure of the system in order to increase its performance. They believe that *harnessing complexity* can be accomplished by acting sensibly, even without fully understanding the situation at hand, and cite military tactics that evolve during combat; an example analogous to the development of new strategies at the scene of an evolving large-scale emergency incident.

While this process of harnessing complexity is not entirely predictable, Axelrod and Cohen (1999) believe that complex interactions result in “emergent properties” that the individual parts do not possess. Miller and Page (2007, p. 44) also posit that group interactions lead to “emergent” phenomena, where individual behaviors “aggregate into global behaviors.” Comfort (2007) discusses emergence when she describes how actors “self-organize” to form new patterns of behavior and thought.

John Miller and Scott Page (2007, p. 3) characterize adaptive social systems as being composed of “interacting, thoughtful agents.” They argue that complexity arises when dependencies among the elements of a system become important. In these situations, as at a unified command post, heterogeneity among the officers may prove to be a key factor in the group’s problem solving abilities. Axelrod and Cohen (1999) postulate that new systems of

information technology can quicken the pace of adaptation in social and technical systems.

Yaneer Bar-Yam (2004, p. 91) puts forward that “complex tasks require complex organizations,” and that the key is to match system complexity to operating environment. Thus a group of incident commanders attempting to mitigate a highly technical hazardous materials release should expect to employ experts on the effects of such releases, as well as law enforcement and local public officials to assist with evacuation, and emergency medical specialists for treatment and transportation of victims.

Another of Bar-Yam’s (2004) insights is that hierarchical organizations are not well suited to undertake complex tasks, as they simply cannot facilitate the activities of an entity that needs to rely on adaptation and creativity to thrive in its environment. He insists that hybrid organizations, which blend elements of hierarchical and network structure, are needed to tackle complex problems. This line of reasoning from Bar-Yam adds an interesting dimension to the complex systems approach by suggesting that rule-bound hierarchies can be redesigned into *distributed or networked* entities to facilitate better collaboration. Yet he appears to disagree with Axelrod and Cohen by arguing that planning the design of a complex system is a task fraught with uncertainty. Rather, the leaders should facilitate a process of *competition and cooperation* that allows a more effective system to emerge (Bar-Yam, 2004).

2.5.1 Sociotechnical Systems

Complex adaptive systems often require a combination of human and technological assets to function effectively. Known as *sociotechnical systems*, these collaborations, if properly designed, will *jointly optimize* both components, rather than sacrificing one for the other (Comfort, 1999). According to Comfort, a sociotechnical approach helps disabuse today’s

emergency response organizations of their notion of “reactive, command-and-control driven systems, and turns them instead into inquiring systems.” It follows that sociotechnical systems may be very effective as *learning systems* in the uncertain environment of a unified command post.

The interaction of modern technological systems – sensor technology, communications hardware, and computerized information gathering systems – with the human beings, who interface with and derive assistance from them, constitutes a sociotechnical approach. To function seamlessly, the social and technical parts of the system must be properly matched, linked and integrated. Comfort (1999) has characterized regional disaster response networks and emergency services agencies as sociotechnical, complex adaptive systems which use information technology to assist the work of human decision makers. Another example can be found in a modern 911 dispatching center, where individual work stations match telecommunication officers with the latest technology in a way that offers synergy between both.

2.5.2 Network Theory and Unified Command Team Operations

Within the realm of complex adaptive systems lies network theory. Based on the study of relationships among interdependent components of cooperative activities, network research provides a means of understanding the links between individuals and groups (Wasserman and Faust, 1994). Networked relationships are defined by the *interactions* between organizational units, as in the case of Allegheny County’s mutual aid response networks. Network structure places emphasis on *lateral* forms of communication, where the ability to quickly interpret new information is critical to decision making. Network structure also encourages mutual obligation and trust (Powell, 1990).

Robert Agranoff (2006) lists a number of network elements which are salient to unified command teams: networks are non-hierarchical, the actors are considered equals, decisions are made by consensus, and resources are drawn from several sources. Further, Agranoff (2006, p. 59) states that network-style decision making is “the product of mutual learning and adjustment” among team members.

2.5.2.1 Social Network Analysis

Social network analysis (SNA) provides a means of mapping relationships between interacting entities, and provides researchers with the tools needed to explore interdependencies and dynamic interactions among seemingly fragmented agencies. Using social network analysis, *relational ties* are of primary concern, while actor *attributes* are secondary (Wasserman and Faust, 1994). Social network analysis adds rigors to an investigation into how multiple agencies, drawn from within a fragmented region, actually collaborate. Since networks represent systems of interdependent actors, network theory is particularly applicable to regional metropolitan emergency response systems like that found in Allegheny County, Pennsylvania.

Allegheny County’s Mutual Aid Network

An understanding of the nature of emergency agency relationships within regions where government structure is disjointed is necessary to gain insight into how public safety entities coalesce and make decisions. Mapping the networks among response organizations in a particular geographic region is an important aspect of understanding their overall capabilities in reference to natural or man-made emergency incident scenarios (Comfort, 1999).

This study builds on – but does not duplicate – the Allegheny County mutual aid and collaboration network research completed by Clayton Wukich in 2011. Investigating the reasons behind “cooperation without hierarchy,” Wukich (2011) determined the reasons why emergency services agencies in Allegheny County choose to work with one another. The current study delves into a greater level of specificity by looking at how command teams are formed from the mutual aid network that Wukich identified, and how they collaborate during large-scale regional incidents.

2.6 INSTITUTIONAL ANALYSIS AND DEVELOPMENT FRAMEWORK

Elinor Ostrom’s (2005) Institutional Analysis and Development Framework (IAD) provides a comprehensive scheme for the study of regional emergency response systems. Specifically, the IAD framework serves as a guide to explore how actors interact within a space which Ostrom (2005, p. 13) designates as an “action arena.” An action arena consists of an “action situation,” the physical and social space where individuals – the actors – interact for some purpose, while being affected by exogenous variables and limited by “rules” (Ostrom, 1999, p. 32). Thus the IAD environment is akin to the geographic boundaries of a major emergency event, or to the physical confines of a unified command post. Since IAD concepts relate directly to system function, it serves as an appropriate frame for the exploration of the dynamic processes at work during unified command activities.

Ostrom (2005) also provides a sound basis for the exploration of relationships within a command post by detailing the constraints and controls that actors exert over each other within an action arena. The Institutional Analysis and Development framework captures the cumulative

effort of humans as they attempt to design optimal systems of social interaction, describes the rules that serve as mechanisms of information transformation, and helps to uncover the assumptions and norms that govern patterns of social interaction (Ostrom, 1999).

Using IAD, Ostrom (1999) builds on Simon's writings regarding limited human cognition by explaining that actors within the action arena are "boundedly rational" and make decisions using incomplete information and imperfect information processing capabilities. Ostrom also informs that while humans make mistakes in choosing strategies designed to realize a set of goals, they also have the ability to *learn* from their errors and adopt new strategies. Ostrom's (2005) concept of "nested sets" of organizations is also relevant to this research, as it helps to explain how various entities coalesce to form unified command teams, and how one may be enfolded into another.

2.7 THE ROLE OF INFORMATION

Chapter 7 sets out to understand the methods of information gathering, analysis and dissemination utilized by members of the typical unified command team. Chapter 7 also examines the communications processes used during major events and explores how the flow of ongoing, but often incomplete, incident information is utilized by the command team to make decisions in an uncertain environment. The researcher relies on the work of scholars who investigate the role played by communications and information systems under a variety of situations.

According to Scott and Davis (2007), the gathering, transmission, storage, and retrieval of information are among the most important strategic activities that an organization can

undertake. Edwin Hutchins (1995) points out the importance of information gathering and dissemination during team oriented, problem solving tasks, and suggests that small groups can use this informational and communications process to come up with novel solutions to unusual or unexpected problems. Clemen (1996) states that decision makers facing uncertainty will attempt to clarify the elements of their environment by obtaining as much real-time and relevant information as they can.

Hutchins' (1995) descriptions of the communications processes used during team-oriented tasks demonstrate some of the most important aspects of effective information dissemination. He argues that the cognitive abilities of a *group* of people in an organization may depend more on the *communications style* between members than on the information held by the individual members themselves. Face-to-face communication, for example, allow members of the group to clarify specific meanings quickly, come to joint agreement, and issue effective and coherent orders. According to Hutchins (1995, p. 219), complex information is “intersubjectively shared” among members of a particular work group or team, making it easier for people to adapt to the task at hand, and assuring that a proper coordination of actions takes place. These concepts assist the researcher during the observation of command team activities.

As discussed in Chapter 8, information provides a structure for shared action and joint decision making, and is facilitated by a communications process with a common lexicon that is understood by all who use it. As Weick (1995) mentions, frequent interaction using familiar language allows for the production of a set of shared meanings among the group. In a similar vein, it is observed that “networked communities of practice allow professionals to interact, exchange information, and develop ad hoc teams of experts for specific problem-solving tasks” (Johnson, 2005).

Comfort (2004) looks into the role played by information during large-scale emergency response activities, and has found that it becomes especially important when collaboration is required, as in the case of mutual aid and combined command activities. She emphasizes the consequential role of what she terms “core” information, including details of event severity and time.

Mica Endsley (2001, p. 2) remarks that a disconnect frequently exists between the amount of data produced by modern systems of communications and the ability of human decision makers to “absorb and assimilate it in a timely manner.” While citing the importance of accurate information to incident commanders, Comfort (1989) issues her own caveat, arguing that humans do not have the capacity to assimilate all of the relevant and incoming information during a major emergency, and that the use of technologically based information systems can greatly enhance that capacity. These thoughts bear on the potential use of decision support systems, which are detailed in Chapter 9.

In their discussion of the sociotechnical systems, Axelrod and Cohen (1999) suggest that information technology can enhance human abilities to gather and work with information. Pekka Luukkala and Kirsi Virrantaus (2014) investigate the dynamics of information assimilation and processing in the group setting, explaining that each member’s actions depend on the other members’ actions and communication between the team members. They suggest that modern information systems can provide incident commanders with the situational awareness and common operating picture they need to effectively manage an incident (Luukkala and Virrantaus, 2014).

Naim Kapucu (2005, p. 210) is another scholar who insists that effective large-scale emergency action depends upon the proper gathering, analyzing and disseminating of

information, but he cautions that situations characterized by “uncertainty and rapid change” pose severe problems to the capabilities of standard hierarchical communication systems.” He also puts forward that since perfect communications in such environments is not possible, incident communications planners should anticipate and allow for a more decentralized – or networked – type of information sharing system (Kapucu, 2005).

According to Kapucu (2005), communications must be able to span organizational boundaries in order for incident operations to be successful in a dynamic environment. Therefore, interoperability of communications equipment is critical, and responders from myriad response agencies and organizations must be able to communicate with each other, and with the incident command team. In addition, the *size* of the communications network has a major impact on communications activities, and in Chapter 7, informants to this research illustrate how current radio and other technological communications systems can quickly become overloaded and ineffective.

2.7.1 Systems of Information Technology

According to Waugh (2007), effective communications is the basis for successful large-scale incident management. The National Incident Management System specifies the features of an effective communications network, including components that assure the reliability, portability, interoperability, scalability and redundancy of the system (FEMA, 2008). Additionally, information technology has changed substantially since the early years following the FIRESCOPE recommendations and the initial attempts at coordinated incident command activities. During the last two decades, improvements in communications networking, based on computer technology and evidenced by a host of modern devices, has greatly facilitated unified

command on a large-scale (Southerly, 2006).

Modern computer and software technology has enabled emergency responders to monitor and share information during even the most complex incidents. It has also provided unprecedented access to vital information, allowing unified command teams to make higher quality, better informed decisions (Southerly, 2006). Interoperable radio and cellular phone systems allow rapid information sharing between the UCT and the response agencies operating at the incident scene. Unified command posts can now be established at some distance from the “hot zone,”⁶ facilitating a less chaotic environment in which to make decisions. Advanced software can also be used to create *computer-based modeling* that simulates a wide range of emergencies and disruptive events. As discussed in Chapter 9, modeling and simulation provide opportunities for incident managers to conduct realistic decision making training.

Sensor technology – such as the type found in thermal imaging devices⁷ – permits the investigation of the most hazardous portions of an emergency scene without the need for risky human intervention (Waugh, 2007). Advances in robotic technology now permit the exploration of incident sites that would be untenable to human life (Southerly, 2006) Information gained can then be transformed into spatial data that can be examined by a command team to give them a real-time image of incident operations.

Medical sensors can monitor the biological status of responders, while global positioning systems (GPS) can follow their location on the scene (Southerly, 2006). Telemetry from critical personal protective equipment can monitor atmosphere, temperature, and air remaining in a

⁶ The *hot zone* is that portion of the incident scene which is most hazardous and requires the use of full personal protective equipment. This zone is established by the unified command team.

⁷ Thermal imaging cameras identify heat signatures of objects at a distance.

responder's self-contained breathing apparatus.⁸⁸ Toward those ends, The City of Pittsburgh has recently purchased laser cameras which will accompany their responders into structural fires and other hazardous locations while recording and displaying 3-D digital images of the environment inside (Majors, 2015).

Yet just as they can be immensely helpful, modern communications technologies can also be problematic on the emergency scene, largely as a result of difficulties in “human-technology” interface (Waugh, 2007, p. 148). As technology becomes more complex, its design rarely matches the human ability to use it quickly and easily, and such technologies are often designed generically, predisposing it to failure when used in extremely taxing physical environments (Waugh, 2007).

Another major impediment to effective communication during the management of large-scale incidents, according to Comfort (2004) is an “asymmetric information process” that distributes information unevenly among public safety agencies. Her solution is a sociotechnical approach that incorporates “individuals, organizations, and computers in an interacting system” that can store, manage, and retrieve information quickly (Comfort, 2004).

2.8 HUMAN COGNITION AND DECISION MAKING

Theories of human cognition bear on this research by explaining how people – alone or in groups – comprehend the emergency incident scene before them. Comfort (2007) discusses the impact of cognition when she states that the concept is closely tied to a capacity to recognize emerging

⁸⁸ Self-contained breathing apparatus (SCBA) is the respiratory protection device that permits operations in areas of high heat or oxygen deficiency.

risk in a rapidly changing event. She defines cognition as the capacity to recognize the degree of emerging risk to which a community is exposed, along with the ability to act on that information (Comfort, 2007, Danczyk, 2008).

Group decision making is often a difficult endeavor due to complexity of the issues being considered, the inherent uncertainty in the situation itself, a set of multiple and possibly conflicting objectives, and differing perspectives among the team members, which lead to divergent conclusions (Clemen, 1996). In what are known as *dynamic decision situations*, several decisions, in sequence, must often be made without knowing the ultimate outcome, which adds to the uncertainty (Clemen, 1996). These ideas assist the current study's investigation into command team problem solving during emergency conditions.

Cognition, when combined with coordination and control, helps incident commanders' form "situational awareness"⁹ and generate a "common operating picture"¹⁰ upon which to make decisions (Comfort, 2014). Under extreme conditions, reasoning is too slow and experienced leaders will draw on their background; their actions under similar conditions in the past (Comfort, 2007). Comfort also argues that cognition influences the human capacity to learn, innovate, and adapt to changing conditions, as a unified command team must do if they are to bring a large-scale event under control.

2.8.1 Decision Making Under Uncertainty

The work of unified command teams, as presented in Chapters 5 through 10, is characterized by

⁹ Comfort (2014) explains that situational awareness is created when "actors perceive the right information, comprehend the information as a whole, and comprehend the information in relation to the operative system and its goals and functions in order to anticipate how the situation will progress in the near future."

¹⁰ A common operating picture is an information system that allows critical incident information to be shared among several actors (Comfort, 2014).

decision making under conditions of uncertainty. Decision makers attempting to control an emergency in progress need skills which allow them to “recognize risk, formulate strategies for action, and coordinate with others” (Comfort and Wukich, 2013). Yet dynamic incident command is a challenging process, as Joseph Pfeifer (2013, p. 1), in his examination of crisis leadership, explains:

Leading an extreme event requires incident managers to make critical decisions under conditions of vast uncertainty and perform complex organizational tasks to protect life and property. They are asked to act decisively, yet remain flexible in the changing threat environment.

A number of theoretical streams bear on the type of collaborative and risky decision making expected of a unified command team during the course of a major emergency event. Known as *decision making under uncertainty*, this body of knowledge is closely related to recent literature that seeks to understand human cognitive abilities. Both are tied together in this research and are summarized in the sub-sections which follow.

March and Olson (1972) examine decision-making situations characterized by “inconsistent and ill-defined preferences, unclear technologies, and fluid participation (the shifting involvement of members in decision situations). They termed these conditions “organized anarchies” in which the ambiguity of choice in decision situations reaches high levels; a situation analogous to that encountered by a team of incident commanders managing a complex emergency event.

Lee Beach (1997) posits that decision making, in its most basic form, consists of: diagnosing the situation, exploring and selecting alternatives for action, and implementing those alternatives. In the context of *group* decision making, a common core of understanding allows people to work together and to communicate about the events and the goals they share (Beach,

1997). While each individual approaches the problem with different assumptions and biases, and while some team members might wield more power than others, a *shared understanding* of the situation and the team's goals is imperative for effective group decision making (Beach, 1997).

2.8.1.1 Bounded Rationality and the Decision Making Process

Rational decision making implies a complete knowledge of the situation, the alternatives for action, and the consequences of those actions. Herbert Simon (1997), however, cites the difficulty of this type of problem solving when he discusses how human decision makers operate in an environment of "bounded rationality" where complete knowledge of any situation, and thus the ability to conduct rational decision making, is not possible. Rather, decision making becomes "nearly rational" if it "maximizes given values" in a situation; leading to decisions which are deemed "good enough" (Simon, 1997). This process, which Simon terms as "satisficing," occurs within a range of options that are limited by the accepted practices of a particular profession, as within the ICS protocols used by fireground commanders.

Simon (1997) goes on to suggest that decision makers operate within the limits of their mental abilities, which he terms "limited cognition." Correspondingly, humans must *simplify* their decision making processes by examining only the most obvious alternatives in a given situation. Simon's work has major implications for the unified command team process. For example, to enhance informational processes, outside technical experts can be consulted when the specialized nature of a disruptive event lies outside the scope of experience of UCT members. Similarly, computerized systems that enhance decisions based on probabilities of outcomes might also prove useful.

Decisions must be made very quickly during emergency scenarios, and poor decisions can result in serious consequences. John Cosgrave (1996) lists three constraints on emergency

managers as they make decisions: time pressures, limited information, and what he terms *decision load constraint*, caused by the large number of decisions which incident managers must make in a relatively brief time period. Jean-Charles Pomerol (2001) puts forward that leaders operating under uncertain conditions attempt to make *robust decisions* that lead to a sufficiently good result, rather than searching for the one best solution.

2.8.2 Sensemaking

Sensemaking is a concept that has garnered much interest among scholars studying human cognition and decision making under uncertainty. Sensemaking allows people to understand complex situations which are laced with ambiguity and uncertainty (Renaud, 2010). Practitioners use sensemaking when they try to decipher the elements of an uncertain situation in order to frame it for problem solving (Weick, 1995). Using sensemaking, individuals look for *clues* in the environment which fit together to make the situation and its progression more understandable. Informants to this research discuss this phenomenon in Chapter 8.

In ambiguous situations, people engage in sensemaking because they are confused by too many interpretations, whereas in uncertain scenarios, they do so because they are ignorant of any interpretations (Weick, 1995). UCT members might be expected to utilize sensemaking during incongruous events in which the information they are taking in violates their “perceptual frameworks” and serves to confound their decision making (Weick, 1995).

According to Renaud (2010), who studied decision making in crisis situations, sensemaking is particularly useful during the initial, chaotic period of a large scale emergency, as it allows incident commanders to:

1. Understand the scene in terms of life and property hazards.

2. Determine critical tasks, in some semblance of order.
3. Gain a measure of situational awareness to facilitate decision making.
4. Avoid the narrow focus caused by tunnel vision.
5. Utilize the creative thought processes needed to bring the event “out of chaos and back to normalcy.”

2.8.3 Theories of Intuitive Expertise

An understanding of *human cognition* figures prominently in this study as a key ingredient in the incident management processes used by unified command teams. Accordingly, this research considers two long-established and sometimes contrasting theories of human intuition and experience, and examines how they influence decision making in uncertain situations. The work of Gary Klein has focused on *Naturalistic Decision Making*, while Daniel Kahneman has investigated the *Heuristics and Biases* approach. The work of both scholars can be framed by first examining an interesting approach to cognitive processes known as *Systems 1 and Systems 2* thinking.

2.8.3.1 System 1 and System 2 Thinking

Kahneman (2011), discussing concepts used in the psychological study of human mental processes, explains that the mind can be divided into two parts; System 1 and System 2. Humans make most decisions using System 1 thinking, which is based largely on past experiences and heuristics (Kahneman, 2011). Characterized by “intuitive, reflexive, and unconscious” processes, System 1 is a rapid but biased form of thinking. System 2 thinking, which is described as “intentional, reflective, and conscious,” employs reasoning and language

(Kahneman, 2011, pp. 20-21). System 2 is used for abstract and hypothetical reasoning (Luukkala and Virrantaus 2013).

Both Klein and Kahneman believe that System 1 is the source of involuntary, intuitive judgments, while System 2 – intervening when necessary – produces decisions that result from conscious thought and effort (Luukkala and Virrantaus 2013). In Klein’s research, System 1 helps to identify patterns or past courses of action, while System 2 mentally simulates the action, determining whether it should be tried, modified, or discarded. Kahneman believes that System 2 allows decision makers to consider the ramifications of each potential action, and facilitates the monitoring of each selected action (Kahneman and Klein, 2009).

2.8.3.2 Naturalistic Decision Making

Klein (2004), using the Naturalistic Decision Making (NDM) approach, studies *intuitive expertise*, a theory in which individuals draw on their past experience to generate decision options. According to Klein (1998, p. 1), naturalistic decision making occurs in situations of “time pressure, high stakes, experienced decision makers, inadequate information, cue learning, dynamic conditions, and team coordination.” Naturalistic decision making has its basis in Simon’s work on skilled intuition and recognition; the situation provides cues that give expert decision makers a chance to recognize past courses of action (Kahneman and Klein, 2009). Klein’s approach to Naturalistic Decision Making has come to be known as Recognition-Primed Decision Making (RPD), and it relies on intuition based on experience to recognize cues, clues, or key patterns in the current situation.

According to Klein (1998) decision makers settle not necessarily for the best option but rather the most workable option in a situation. Klein (1998) has studied how fireground commanders are able to rapidly determine good options without a comparison with other options,

often from the earliest phases of a large incident. These incident leaders are able to do so by drawing on *mental patterns* that they have accumulated from many years of field experience; “Even when faced with a complex situation, the commanders could see it as familiar and know how to react” (Klein, 1998, p. 236).

Klein (1998, p. 21) posits that incident commanders use an iterative process called “mental simulation,” where they imagine the situation “through several transitions,” thereby anticipating and predicting the future course of incident events. Using RPD, incident commanders mentally simulate and select a decision option to determine if it is appropriate to the situation; if not they move on to the next option (Luukkala and Virrantaus 2013).

2.8.3.3 Heuristics and Biases

In contrast to Klein’s postulations, Kahneman’s approach to decision making is far less sanguine about expert, intuitive judgment. Working under his Heuristics and Biases approach (HB), Kahneman (2002) has found that the intuition of purported experts is often flawed. His research has exposed unevenness and inconsistency among highly experienced decision makers, even when toiling under similar conditions and faced with almost identical scenarios; inconsistency is a major weakness of informal judgment, (Kahneman, 2002). Under the HB approach, biases on the part of the decision makers often contrive to prevent accurate prediction of developing events and so produce erroneous decisions.

Kahneman (2002) argues that decision makers working under conditions of stress and time pressure typically rely on simplifying heuristics or rules of thumb instead of expert experience, and do not fully comprehend incident complexities. Although such heuristics are easy and intuitive ways to make decisions under conditions of uncertainty, they can be biased – by the anchoring and adjusting phenomenon, for example – and lead to a poor selection of

options (Clemen, 1996). Thus in uncertain situations, incident commanders may substitute an easy answer where a complex solution would be more appropriate.

In situations where the decision makers have little or no previous experience, their heuristics based intuitions are prone to be particularly untrustworthy (Kahneman and Klein, 2009). Kahneman (2002) has also found that a reliance on intuition may lead to the “illusion of validity,” an unrealistic or even overconfident expectation of one’s decision making abilities. As discussed in Section 2.3.5, overconfidence can lead to serious and potentially tragic consequences at the scene of a developing emergency.

2.8.4 Situational Awareness

Endsley (1987), who has studied and modeled the concept of *situational awareness* (SA), cites its formal definition as “the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status into the near future. SA can be thought of as an “internalized mental model” of the current operational environment; an understanding of the situation as a whole, or “knowing what is going on” (Endsley, 2001, pp. 3-4). Situational awareness includes both structural factors such as the training and previous experience of the actors, and situational factors like the problems faced by the actors as they strive to make the correct decisions (Luukkala and Virrantaus 2013).

The concept of situational awareness is a key element in the study of decision making under uncertainty (Gasaway, 2009). SA is also critical to the investigation of effective incident management, as it guides the selection of actions and informs the decision making process (Comfort, 2007). Additionally, situational awareness on the emergency scene involves far more than the absorption of environmental information; it requires an *understanding* of the

information and the current status of operations, so that estimates may be made about where the incident is headed (Gassaway, 2009).

According to Skertich (2008), emergency managers are “bounded individual actors” who must identify and understand pertinent indications from the environment and make decisions based on imperfect information. Thus, situational awareness is dependent upon noticing cues from the environment, as when the command team notices an imminent change in the status of the situation, or when it receives urgent information from sector leaders (Gassaway, 2009).

Endsley’s (2001, pp. 4-5) model breaks situational awareness into three distinct components which can be related to operations at the scene of a large-scale, complex incident:

- **Level 1 SA** includes a *perception of the elements in the environment*. A unified command team requires Level 1 data on the type of incident, the location and capabilities of resources already deployed at the scene, and of any tactical operations initiated. The UCT assimilates this information from direct observation and from ongoing reports.
- **Level 2 SA** requires a *comprehension of the current situation*. Unified commanders, who need a deeper understanding of how the elements from Level 1 are affecting the situation, acquire Level 2 understanding using their cognitive abilities and through open discussion among team members.
- **Level 3 SA** is the projection of future status. Using their shared Level 1 and 2 understanding as a basis for decision making, the unified command team makes short term judgments and predictions about the course of the incident, and tries to stay ahead of developments.

The attainment of Level 3 situational awareness requires considerable expertise among the members of the command team (Luukkala and Virrantaus 2013). It also requires that the members of the command team scan the environment continuously for information (Moynihan, 2008).

Situational awareness is a construct that constantly changes, reflecting the dynamic nature of the environment and the cues to which the observer is paying attention. To maintain SA, incident commanders “must gather key facts, often under conditions of great confusion and uncertainty,” while analyzing this information in order to decide on a course of action (Howitt and Leonard, 2009, p. 8). SA may decrease or become more narrowly focused due to contextual effects such as time pressure, stress, or cognitive overload (Mohammed, Tesler & Hamilton, 2012).

Discussing its relation to dynamic human decision making, and to the command systems used by the fire service, Endsley (1995) noted that firefighters rely on SA to make decisions, and to do so they must “ascertain the critical features of widely varying situations” to determine the best course of action. Decision making requires up-to-date information, yet the environment is constantly changing (Endsley, 1995). Thus maintaining situational awareness becomes more challenging as incident complexity increases, and is exacerbated further by incomplete or inaccurate information flowing into the command post (Endsley, 1995).

2.8.4.1 **Team Situational Awareness**

Situational Awareness is normally maintained individually, but shared within the social context of the command team (Luukkala and Virrantaus 2013). The concept of shared, or *team situational awareness* refers to the ability of a command team to jointly understand ongoing operations, and has a direct bearing on this study’s exploration of command team collaboration.

According to Endsley (1995), team SA is facilitated when each member develops his or her own conception of their part of the operation, and shares it with the group. Team SA involves the interaction of processes like coordination and information sharing, and is attained as team members receive more exposure to a particular situation, or as the situation changes and new information is assimilated (Mohammed, et al., 2012).

2.8.5 Human Cognition

Cognition is defined as the way in which information is obtained and used. Cognitive psychology is an academic field that studies how people perceive, remember and learn about the external environment; how they obtain, process and store information (McLeod, 2007). Unlike the field of behaviorism, which focuses on observable behaviors, cognitive psychology is concerned with internal mental states. One subset of cognitive study seeks to understand and improve human problem solving and decision making abilities, making it highly salient to this research. In addition, studies of *team cognition* provide a framework to investigate the informational and decision making aspects of unified command team performance.

2.8.5.1 Collective, Distributed and Interactive Cognition

Collective cognition, according to Comfort (2009) “acknowledges that no one individual possesses the knowledge, skills, or capacity to manage rapidly evolving, interdependent events.” Collective cognition, also known as *shared or team cognition*, is a concept that encompasses a team’s collective knowledge and skills (Salas, Fiore & Letsky, 2012). Scholars suggest that a major ingredient of successful teamwork involves the interactive process of sharing cognition,

where team members engage with each other to develop an understanding of the aspects of their situation and of the tasks assigned to them (Salas, et al., 2012).

Recent research suggests that collective cognition during emergency events is vital to successful collaboration among team members. Groups engaged in joint problem solving activities must achieve and maintain awareness (i.e. situational awareness) of diverse aspects of their shared activity in order to coordinate effectively (Salas, et al., 2012). Additionally, the group's understanding of roles and boundaries, known as activity awareness, is achieved through the joint construction of a shared group knowledge, which is identified and agreed upon by members (Salas, et al., 2012).

Shared cognition is a cornerstone of why teams are believed to outperform individuals during complex tasks settings (Luukkala and Virrantaus 2013). Teams feature interdependence with regard to tasks performed, and if one member fails to share critical information at the appropriate time, the entire venture may fail (Salas, et al., 2012). Collective cognition is thus a process of “sharing, comprehending, correcting and learning,” and an exploration of its dynamics is crucial in understanding “how decision makers select a specific strategy” (Wukich, 2011).

Team mental models (TMMs), are “shared, organized understandings of...the teams relevant environment, and theoretically, the team will perform well if they share an adequate understanding of their tasks (Mohammed, et al., 2012). Because a team can accumulate much more information than any one member, they can store and use their knowledge to solve complex problems (Murase, Resick, Jinenez, Sanz, and DeChurch, 2012).

Effective leaders facilitate the collective cognitive process by building a team climate among the members to assure that everyone perceives the situation similarly, and it has been

suggested that the team leader's main function is to assure similar perception of information among team members in order to build consensus for goals and objectives (Murase, et al., 2012).

Hutchins (1995) research details how a problem solving team obtains the cognitive capacity to conduct joint problem solving. He describes a process of distributed cognition where each member knows how to coordinate with other members of the team, and with the technologies they employ. The human components therefore become highly adaptable and open to new ideas. Hutchins argues that a closely knit group can understand and respond to unanticipated problems (Hutchins, 1995). Hutchins' work is directly applicable to the study of the unified command team process, where complex and rapidly evolving conditions require a team approach to problem solving, as it is impossible for any one individual to integrate and process the volume of the incoming information.

Using his concept of an "organized task setting," Hutchins (1995, p. 39) postulates how individuals combine their efforts to produce ideas that wouldn't be possible had they been working alone. He posits that a team gathers key information from the environment to formulate as complete a picture of the situation as possible, and determines a plan of action based on that information. Hutchins (1995) posits that the system of distributed knowledge is flexible, and that it adjusts for one or more team members who are lacking in any particular aspect of the problem at hand. Additionally, errors by one member are likely to be detected and corrected by other observant and alert team members.

In a vein similar to Hutchins' work on distributed cognition, scholars investigating *interactive team cognition* (ITC) also view the collaborative process interactive phenomenon among members as they "coordinate, communicate, and make decisions, largely through verbal and face-to-face interactions within a particular context or task environment" (Cooke, Gorman,

Myers, & Duran, 2012). Unlike Hutchins writings, however, this stream of study does not hold that team members receive environmental stimuli which are processed into team activities. Instead, teams are said to be cognitive systems in which the main activity is the interaction among “heterogeneous individuals” (Cooke, et al., 2012).

2.8.5.2 **Macro cognition**

According to Kozlowski and Chao (2012), *macro cognition* is an emerging multidisciplinary area of research that is focused on understanding how groups, teams, and other collective entities learn, develop meaningful knowledge, and apply it to significant and challenging problems. According to scholars who study the phenomenon, knowledge is attained at the individual level, but is then shared and subsequently learned and amplified by other team members who did not previously hold it. The theory of macro cognition posits the following:

The process of learning is iterative and cyclical progress toward goal accomplishment is monitored, discrepancies revealed through feedback are diagnosed, and goals and strategies are revised in an iterative process directed toward learning and knowledge compilation. It is then captured and internalized as team knowledge (Salas, et al., 2012, p. 43).

Using a line of reasoning akin to Comfort’s writings on collaboration during crisis situations, scholars studying macro cognition describe it as a mental processe employed by teams to create *new* knowledge during complex, collaborative problem solving activities (Salas, et al., 2012). When team members share key information with one another, it enhances the macrocognitive team processes that lead to effective problem solving and decision making. Thus, in order to be successful, teams must create knowledge by sharing key information with one another. Shared cognition among team members is said to be tied to task complexity of the

environment, and can be enhanced by systems of technological support (Lyons, Lum, Fiore, Salas, Warner, & Letsky, 2012).

2.8.5.3 Cognitive Systems Engineering

According to Patterson and Stephens (2012), *cognitive systems engineering* (CSE) provides another relevant psychological perspective for this research, as it discusses shared cognition among individuals working in complex and uncertain environments, facing major consequences for failure, and using technological aids to support their work. CSE is based in large part on Klein's (2004) work, and postulates the following cognitive functions:

1. Detecting – Noticing changing conditions or events.
2. Sensemaking – Gathering and analyzing information to determine how it might fit into current or revised strategies.
3. Planning – Responding adaptively to new information by changing strategies or objectives.
4. Deciding – Committing to a course of action.
5. Coordinating – Managing interacting activities (Patterson and Stephens, 2012, p. 174).

The cognitive systems engineering perspective is based on research from complex, sociotechnical domains where cognition is distributed, tasks are interdependent, and expert practitioners are essential (Patterson & Stephens, 2012).

2.8.6 Common Operating Picture

Luukkala and Virrantaus (2013) stress the importance of situational awareness, which permits

informed decision making, *combined with* the collective knowledge processed within the context of collaborating teams as they perform interdependent tasks. Once a unified command team achieves and maintains situational awareness, it can then disseminate key aspects of SA to assure a *common operational picture* throughout the incident scene. According to FEMA's National Response Framework (2014), Common Operating Picture consists of:

A continuously updated overview of an incident compiled throughout an incident's life cycle from data shared between integrated systems for communications, information management, intelligence and information sharing. The goal is to provide emergency operations centers, incident commanders, and response personnel accurate and timely information concerning equipment distribution, location of personnel, onsite intelligence, and incident mapping when responding to and managing an incident.

Assuring a COP means that all relevant agencies and actors understand the incident action plan, as well as the operations underway to achieve its objectives. Comfort (2007) maintains that a common operating picture is "essential for clear communications and coordination of actions" among emergency response organizations. Comfort also suggests that the ability of a command team to establish a common operating picture is acquired over time, as a product of "common training, years of shared experience, and professional interaction." To maintain a COP, a command team must provide continuous updates to the operational units; especially in the event of changes to strategy and tactics.

2.8.7 Drawbacks of Hierarchical Command

Pfeifer (2013) argues that the traditional emergency management hierarchical command and control structure is inappropriate for routine events because it hinders the control and coordination of interorganizational responses from multiple jurisdictions by overwhelming the

incident command staff. Instead, he proposes a combination command structure that features elements of the “vertical command and control model,” along with a “horizontal network that can connect, collaborate and coordinate” with myriad agencies and response organizations (Pfeifer, 2013, p. 13).

Another difficulty with traditional incident management, according to Pfeifer (2013, p. 2) is that it focuses attention on “the threat or physical environment,” rather than the entire range of factors that should inform their action, as listed below:

- Physical – The force of the threat environment or incident.
- Psychological – The force of cognitive bias that restricts judgment.
- Social – The force of organizational bias that limits interactions to one’s own group.
- Political – The force of rivalry among key players.
- Operational – the force of limited capability, capacity and delivery.

The elements that Pfeifer (2013) describes present an interesting perspective on the obstacles that an incident command team must overcome while managing a large regional event. These factors can produce extreme stress among members of the command team, overwhelm their attention span, restrict their collective judgment, and cause them to disregard the information and ideas of those outside of the command post. If carried to extremes, he asserts that “cognitive narrowing” can lead to “operational addiction” by micromanaging each tactical function, rather than broadening UCT focus to overall strategy. To assure group understanding, Pfeifer (2013, p. 13) suggests that incident commanders take preemptive and adaptive actions – all of which are addressed in this study:

- Form networks by connecting all agencies.

- Flatten command structure for better collaboration.
- Leverage core competencies to coordinate resources.
- Manage the incident with a unified system of command.

2.9 SUMMARY: INTEGRATED FRAMEWORK TO GUIDE STUDY

This study employs a multidisciplinary approach to investigate the processes used by teams of emergency managers to control regional disruptive events. Due to the complexity of the incident command process, the researcher has selected a diverse, yet germane body of knowledge to undergird this investigation. The theoretical framework constructed in Chapter 2 helps to assure that this study, while field-oriented and exploratory in nature, remains firmly grounded in the literature of public policy and management. As described throughout this chapter, each excerpt from the chosen assemblage of scholarly literature and theory contributes directly to the investigation of one or more of the overarching and subordinate research questions.

The selected theoretical approaches presented in this chapter facilitate a mixed-methods and multi-angle approach to this study of the problem-solving work of regionally established unified command teams. Additionally, the concepts presented here guide the researcher during development of appropriate field study methods, and provide a basis for the development of the semi-structured interview protocol. Finally, the varied literature of Chapter 2 provides a substantial basis of understanding for the analysis of the data garnered from this examination, and for the drawing of accurate conclusions about it.

Chapter 2 begins with a detailed look into the Incident Command System; the all-hazards emergency management system from which the unified command concept is drawn. Next, the literature of organizational culture, learning, leadership and motivation is presented to set the stage for research questions that deal with command team formation, collaboration, and leadership emergence. A detailed examination of the dynamics of interagency collaboration provides an awareness of the processes utilized by incident command teams. Theories of small group dynamics and decision making further illustrate the problem solving work of UCTs, while suggesting that long-standing teams offer superior command abilities. Another key research question relates to communications and information systems, which are crucial to large-scale incident management. These systems are described in detail in Chapter 2. Theories of complex adaptive systems are applied to the unified command team process as decision makers operate within the action arena of Ostrom's Institutional Analysis and Development Framework. Finally, the literature on human cognition and decision making under conditions of uncertainty are utilized to develop a working model of a practical decision support system, which represents the last subordinate research question of this study.

3.0 RESEARCH METHODOLOGY

This study uses a *grounded theory* approach to explore the dynamics that shape the formation, collaboration, leadership, communications, and decision making processes of unified command teams during large-scale emergency events. Using Allegheny County, Pennsylvania as the field study area, this research considers all three major aspects of public safety response; police, fire, and emergency medical services.

Grounded research seeks to understand and explain a process, or interaction between individuals, and to describe the results in detail (Miller and Salkind, 2002). While grounded methods can be used to develop theoretical concepts, this study is of an exploratory nature and does not seek to do so. Instead, this research is focused on developing an understanding of the dynamic processes at work among the members of unified command teams seeking to bring large emergency events under control. The results of this investigation derive from an iterative process of data gathering and analysis and are thus *grounded* in the phenomena under study.

Miller and Page (2007) explain that theories allow us to understand the world by making the right set of simplifications. Modeling, by contrast, functions by determining which simplifications to impose on the underlying theories and then, based on those abstractions, uncovering their implications. This study is based on a number of theoretical frames, and utilizes a comprehensive, *mixed methods* design for research.

The investigation of this study's research questions proceeds through a series of

activities: documentary analysis, semi-structured interviews, direct observation, and computer-based modeling and simulation. The mixed methods style – using the process of *triangulation* or multiple lines of sight – helps to assure an in-depth investigation of the subject matter (Berg, 2007). Mixed methods research is also an ideal vehicle for the exploration of organizational adaptation to complexity and uncertainty, which cannot easily be examined with only one research method. This study features the following primary methodologies:

- *Documentary analysis* of public and organizational records to provide background information and identify key criteria for interviews and focus groups.
- *Semi-structured interviews* of domain experts to provide the primary data, evidence, and basis for recommendations.
- *Direct observation* of unified command team activities during tabletop and actual emergency services exercises.
- *Computer modeling* and focus group follow-ups to determine the applicability of decision support systems during specialized emergency events.

3.1 SCOPE OF RESEARCH: REGIONAL UNIFIED COMMAND TEAMS

Regionally assembled unified command teams (UCTs) represent the ideal organizational structure for the study of the process and dynamics of large-scale incident management under conditions of high risk, uncertainty, stress, and time pressure. Unified command teams in the field study area coalesce quickly, usually within the first 30 minutes of a major event (Informant 19). Deriving their membership from local mutual aid networks, these teams must cohere into a collaborative problem solving contingent if they are to effectively manage a major event.

This study seeks to understand the “theories in use” of the assembled members of unified command teams; what is *actually found to be the case* in the field, as opposed to the “espoused theories” that are postulated by the formal structure of the Incident Command System or stated in organizational standard operating procedures (Argyris, 1993, p. 20, 65). To do so, the mixed methods approach gathers insight into the dynamics of UCTs: how they form; how they structure themselves as problem solving groups; how leadership emerges from within; how they obtain and utilize critical incident information; and how they make their decisions during incident operations. Both quantitative and qualitative methodology is used to explore regional UCT networks, investigate public safety organizational information, examine documents pertinent to past events, solicit the input of experienced incident commanders, and model and evaluate systems of decision support.

3.2 RESEARCH QUESTIONS

This research focuses on identifying the factors that promote or inhibit effective large-scale incident management by regional unified command teams. It assumes that regional command teams are sociotechnical, complex adaptive systems which feature a blend of human decision makers along with information and communications technologies. This research also assumes that the UCT process can be improved by developing a deep understanding of the dynamics of these small decision making groups. Accordingly, this research is summed up in the form of the following central research question:

- *What are the dynamics that lead to coordinated and effective incident management by regional unified command teams?*

This question leads logically to the following five additional inquiries:

1. *What are the impediments and facilitators of unified command team formation and collaboration?*
2. *How do leaders “emerge” from nascent unified command teams, and what are the characteristics displayed by effective team leaders?*
3. *What is the role played by systems of communications, and by information availability, assimilation, and dissemination during unified command team operations?*
4. *What processes do unified command team members utilize to make decisions during major emergency operations?*
5. *How can regional command team effectiveness be enhanced by modern systems of decision support?*

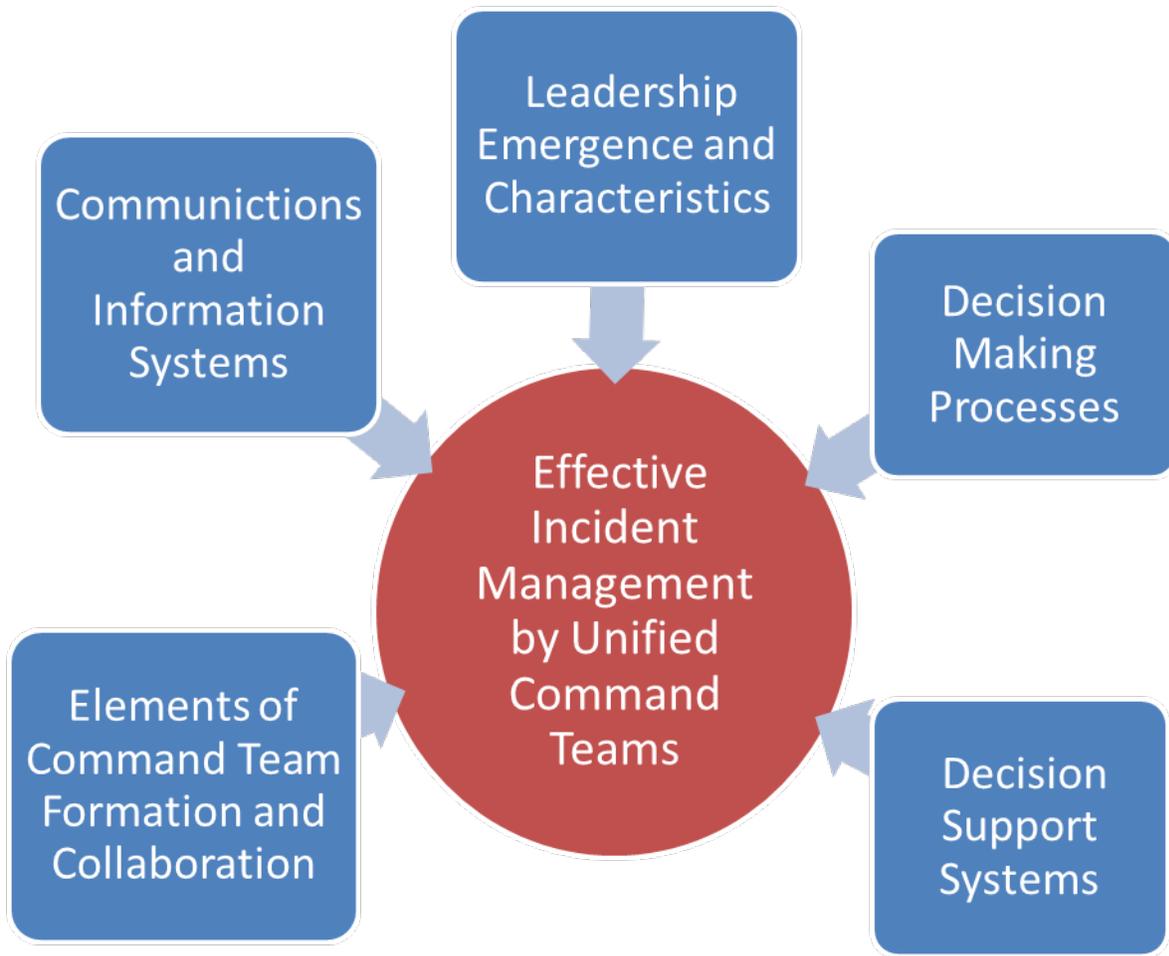


Figure 2: Factors Influencing Effective Incident Management by Unified Command Teams.

3.3 UNIT OF ANALYSIS

The unit of analysis is that of a regionally assembled unified command team (UCT) of the type that would be found at the command post of a major emergency event in a typical metropolitan region of the United States. Normally ranging in size from three to seven experienced incident commanders, these collaborative management teams may also utilize additional support staff,

depending on incident complexity.¹¹ In addition, each unified command team might require the assistance of an array of technical specialists, local and county government officials, liaison officers, safety officers, and other ancillary members. This research pays special attention to how this unit of analysis operates across multiple levels of government, across the jurisdictional boundaries of municipalities and response districts, and at different scales of incident severity.

3.4 METHODOLOGY AND DATA COLLECTION

Following the mixed methods approach of this research, several sources of data have been collected and analyzed to build a comprehensive picture of the UCT process, and to provide a basis for a practical decision support system. Four techniques to explore the research questions are utilized: documentary analysis, semi-structured interviews, direct observation, and decision support modeling. The linkage of the research sub-questions to the methodological techniques employed is detailed in Table 1.

¹¹ The Incident Command System specifies three to seven as the recommended span of control for commanders and team leaders during active incidents (FEMA, 2008).

Table 1: Linking Research Sub-Questions to Data and Methods

<i>Sub-Questions</i>	<i>Data</i>	<i>Source</i>	<i>Method</i>
1.) What are the impediments and facilitators of unified command team formation and collaboration?	Public records; Organizational and institutional documents; Semi-structured interview data	Allegheny County 911 emergency call response records; Expert interviews;	Documentary analysis; Semi-structured interviews; Direct observation
2.) How do leaders emerge from nascent unified command teams, and what are the characteristics displayed by effective team leaders?	Semi-structured interview data; Observation of command team activities	Expert interviews; Tabletop exercises; Simulations	Documentary analysis; Semi-structured interviews
3.) What is the role played by systems of communication, and by information availability, assimilation, and dissemination during unified command team operations?	Semi-structured interview data; Decision support data	Expert interviews; Tabletop and actual emergency services drills	Semi-structured interviews; Focus groups; Decision support modeling
4.) What processes do unified command team members utilize to make decisions during major emergency operations?	Semi-structured interview data; Decision support data	Expert interviews; Tabletop and actual emergency services drills; Focus groups	Semi-structured interviews; Decision support modeling
5.) How can regional command team effectiveness be enhanced by modern systems of information technology and decision support?	Open-source documents; Semi-structured interview data; Decision support data	Organizational websites; Expert interviews; Center for Disaster Management activities	Semi-structured interviews; Decision support modeling; Professional research collaboration

3.4.1 Documentary Analysis

During this research, documents from publicly accessible sources were examined to help identify the key agencies and actors that comprise Allegheny County's mutual aid system.¹² The collected information provides a basis of understanding of which agencies interact during major events, and whether this cooperation extends to other types of emergency incidents. Documentary analysis includes a recent historical examination of media reports, expert critiques, and other information relevant to major incidents that have occurred in Allegheny County during the past ten years, including the command processes used and the outcomes attained.

Documentary analysis of standard operating guidelines (SOGs) was conducted to shed light on the internal procedures and command structures of fire, police, and emergency medical services agencies. Open source documents such as *after action reports and incident critiques* helped add depth to the information obtained from standardized recording systems. The analysis of public documents was employed to examine actual historical patterns of mutual aid activities as well as to explore the espoused and in-use procedures of recent regional unified command operations.

3.4.1.1 Public Records and Documents Data Collection

A preliminary investigation revealed that many of Allegheny County's over 500 emergency services agencies utilize websites to disseminate information and to "tell their story" to their local citizenry. These sites were of immense anecdotal value while investigating incident command processes, as they often provided the size of each organization, a list of key officials,

¹² Allegheny County 911 Center operational zone maps, combined with incident reports and SOGs, will be of particular importance in identifying the mutual aid networks from which UCTs emerge.

and narrative descriptions of large-scale emergency events in which the agency has participated. Several agency websites also provided descriptions of mutual aid procedures and joint training exercises within their regions of the county. The online information of the Pennsylvania Emergency Management Agency (PEMA), the Pennsylvania State Fire Academy, and the Allegheny County Department of Emergency Services also provided relevant data.

This study also includes a media investigation of large-scale emergency activities within Allegheny County during the last ten years. A content analysis of the resulting information was conducted to provide background information for the semi-structured interviews, and is intertwined in the discussion of the county's efforts to improve coordination, which are detailed in Chapter 4.

3.4.1.2 Organizational and Institutional Data Collection

Organizational records were requested from participants in the semi-structured interviews, and proved to be quite valuable in determining the command processes used by key agencies throughout Allegheny County. The standard operating guidelines of regional emergency service entities shed light on collaborative planning and procedures. Additionally, certain agencies were asked to provide reports of major disruptive events, which they submit to FEMA using the National Fire Incident Reporting System (NFIRS).¹³ NFIRS incident reports contain a wealth of information on the resources and tactics used by responding agencies. Once collected, this data was utilized as a part of the analysis process of this study.

¹³ NFIRS uses a standardized submission process for fire and incident reports, and since these reports must be submitted to FEMA as a prerequisite for federal grants, compliance with the requirements is high.

3.4.2 Semi-Structured Interviews of Domain Experts

Miller and Salkind (2002) state that the process of conducting interviews constitutes the primary means of data collection in grounded theory research. Similarly, Geertz (1973) suggests that interviews of experts who speak to a particular topic serve as a principal source of evidence. Accordingly, the major methodological research instrument employed in this study is the series of semi-structured interviews held with 75 domain experts in Allegheny County and surrounding areas. Following the postulations by Geertz (1973) regarding “thick description,” these interviews serve as the predominant means of investigating the research questions, and also provide primary evidence for the conclusions of this study.

The informants to this research identified a variety of factors inherent in the unified command team incident management process. Yielding a rich source of insight into the decision making processes of experienced incident managers, the interviews were particularly important in the examination of the theoretical decision making models, such as the Naturalistic Decision Making style espoused by Klein (2004), and the Heuristics and Biases approach put forward by Kahneman (2002).

Interviews were conducted over a seven month period between June and December of 2014. The informants were engaged in-person, with 64 of the 75 interviews conducted using audio recordings. Immediately following the interviews, detailed field *notes* regarding the setting, the informant’s demeanor, and other important anecdotal information were recorded.

Semi-structured interview questions were open-ended and designed to elicit comprehensive explanations of the dynamics of incident command by teams brought together from many agencies. Within this context, discussions of unified command team formation and collaboration, leadership emergence, information systems, and the factors that promote or inhibit

collaborative decision making among experienced incident commanders provided considerable insight into the UCT process.

Following the Strauss and Corbin (1998) approach to grounded theory, interview data was prepared for analysis in order to address the research questions. The recorded interviews were transcribed verbatim and coded using the three-step, systematic technique of open, axial, and core codes to identify key processes of unified command team operations (Strauss and Corbin, 1998). A copy of the interview protocol is located in Appendix C.

3.4.2.1 Semi-Structured Interview Data Collection

The primary pool of interviewees consists of fire service leaders throughout Allegheny County, with a smaller sampling of police and EMS officials. Representatives of the Allegheny County Department of Emergency Services, the City of Pittsburgh Department of Public Safety, and select municipal-level emergency management coordinators also participated. Additional informants included officials from the Pennsylvania Emergency Management Agency, the Pennsylvania State Fire Commissioners Office, The Pennsylvania State Fire Academy, and the Allegheny County Fire Academy.

Informants were selected in a *purposive* manner, in which the researcher identified – based upon experience, referrals, and open-source documents – the key players among the regional unified command networks (Creswell, 2009). The objective in this process was to allow informants to “contribute direct insight into the grounded theory being generated” (Miller and Salkind, 2002). Potential informants were contacted by phone, email, or in person to solicit their participation in this research.

Most informants reside in Allegheny County, while others are very familiar with mutual

aid and command operations in the county. Paid and volunteer organizations were represented, with volunteer fire department leaders being the most prominent group among them. Regional police and EMS experts were also consulted, and many of the informants are members of more than one type of agency. These “boundary spanners” as Wukich (2011) termed them, shared unique perspectives of the unified command team process. Domain experts from the municipal level were most numerous among interviewees, but several key informants represented county, state, and federal emergency services organizations.

Criteria for selection included the preference for informants with at least ten years of active service with an emergency services agency in Allegheny County, while serving at least five of those years in a command position with the organization. Some exceptions were allowed for informants with command experience in related fields and for those who offered a specific perspective that would add to this research. An advanced level of incident command or advanced officership training was also preferred, and the pool of informants generally included chief officers, directors, and managers of their respective public safety entities. In fact, demographic information on the informants reveals a level of experience among them that far exceeds the minimum criteria set by the researcher. Although it is impossible to quantify, the 75 interviews might be considered a large-N sample of the population of experienced unified commanders in Allegheny County, and should be considered one of the fundamental strengths of this research design.

Obtaining in-depth information from experienced incident commanders was critical to the success of this study, and directly impacts its validity and reliability. Accordingly, the semi-structured interviews were conducted with a guarantee of anonymity to allow the informants to provide information without fear of being identified by members of the relatively small incident

command community in Allegheny County. The demographics of the informant pool are detailed in tables 2 and 3.

Table 2: Semi-Structured Interviews by Actual Level of Informant Experience.

Actual Level of Informant Experience (N = 75)	N	%
<i>Total Years of Emergency Services Experience</i>		
25 Years or over of Emergency Services Experience	14	18.9
20 – 24 Years of Emergency Services Experience	19	25.3
15 – 19 Years of Emergency Services Experience	23	30.6
11 – 14 Years of Emergency Services Experience	13	17.3
10 Years of Emergency Services Experience	6	8.0
<i>Total Years as a Command Officer</i>		
25 Years or over Served as a Command Officer	7	9.3
20 – 24 Years Served as a Command Officer	13	17.3
15 – 19 Years Served as a Command Officer	20	26.6
11 – 14 Years Served as a Command Officer	15	20.0
6 – 10 Years Served as a Command Officer	14	18.6
5 Years Served as a Command Officer	6	8.0
ICS Training		
Basic or Intermediate ICS Level Training only	18	24.0
Advanced ICS Level Training (ICS 300 or 400)	46	61.3
Other Advanced Officership / Command Level Training	11	14.6

Table 3: Semi-Structured Interviews by Level of Jurisdiction and Primary Discipline.

Level of Jurisdiction	Fire	Law Enforcement	EMS	Emergency Mgmt.	Other	Total
Federal	-	2	-	2	-	4
State	2	1	1	1	-	5
County	5	1	1	2	1	10
Municipal	32	5	12	3	1	53
Private / NPO	-	-	-	-	3	3
Total	39	9	14	8	5	75

3.4.3 Direct Observation of Incident Command Teams

Beginning in May of 2013 and continuing through November of 2014, direct observation of incident command activities was conducted in the western regions of Allegheny County. These activities were centered on the mutual aid training programs of the Allegheny County Airport Authority and consisted of:

- Incident Command System training courses.
- Tabletop exercises hosted by the emergency planning staff of the Pittsburgh International Airport.
- Practical field evolutions involving the mutual aid network surrounding the Pittsburgh International Airport.

Each training course and exercise included problem solving activities performed by teams of local incident commanders. Drawn from the regional mutual aid network, these emergency services officials exhibited high levels of experience, but varying levels of familiarity with one another. Further, the standard operating guidelines utilized by the assembled mutual aid agencies varied to the point of confusion during command team operations. During these activities, each team was given the freedom to organize themselves and conduct their command activities as they saw fit. Each activity provided a rich source of primary research materials.

3.4.3.1 Data Collection for Direct Observation

The behavior and activities of the members of each unified command team was carefully observed and recorded, especially with regard to team formation and collaboration, leadership emergence, information utilization, and decision making processes. Direct observation of UCT

actions during training activities has added additional depth to the data collected from the semi-structured interviews. The information garnered is included in the empirical chapters of this study, and adds important elements to the *major findings* and *recommendations* of this study.

3.4.4 Modeling of Decision Support Options

The study of complex decision making can be aided by reducing the potential decisions of a given scenario into simpler, well understood components (Druzdzel and Flynn, 2010). Computer-based modeling simplifies a complex problem by making assumptions about the variables in a particular situation and specifying the potential outcomes of decision making. Computer-based modeling, combined with real-time simulation, can explore a wide range of decision options for a particular scenario, or decision space, and evaluate the options for each (Druzdzel and Flynn, 2010). From these models, a decision support system may be constructed to aid the command team during a specific type of emergency incident.

One type of model is based on the Bayesian network, which offers a “compact representation of joint probability” and can be used as a practical decision making aid (Druzdzel and Flynn, 2010, p. 3). The Bayesian design has the potential to provide incident commanders with information that can help them select from a number of possible alternatives. It is helpful in identifying likely strategies, probabilities, and consequences for command team action, given time and resource constraints. This research includes a Bayesian network model which is used to explore decision support in a highly specified environment in order to test its ability to be of use within a unified command team environment.

The Bayesian model used in this study is based on the hazards of natural gas wells, a

timely topic in light of the advent of drilling into the Marcellus Shale¹⁴ layer of sandstone, which is located beneath much of Western Pennsylvania. The Bayesian model was designed and tested using the GeNIe 2.0 (Graphical Network Interface) computer software program, developed by Decision Systems Laboratory at the University of Pittsburgh. Interviews of domain experts were instrumental in the model design, and three emergency response teams were used to test and evaluate the model. Afterward, the evaluators were assembled to provide recommendations for model enhancement. Complete details of the design, testing, and evaluation of the Bayesian model are included in Chapter 9. The Bayesian model used in the airport simulation is located in Appendix E.

3.4.4.1 Data Collection for Decision Support Modeling

As noted, a Bayesian model of a natural gas drilling emergency on the property of the Pittsburgh International Airport was designed and utilized to investigate the possibility of using a decision support system at a specialized regional disruptive event. The knowledge base required for a meaningful design was drawn from interviews with domain experts in the gas well and gas well firefighting industries, as well as from regional emergency responders and public safety training instructors. In addition, information was gathered during three tabletop exercises held by the emergency planners at the Pittsburgh International Airport during the summer and fall of 2014. Additionally, the University of Pittsburgh's Center for Disaster Management, through its participation in FEMA's Community Resilience Innovation Challenge,¹⁵ provided invaluable assistance to the modeling process.

¹⁴ The Marcellus Formation is a sedimentary rock found in eastern North America. Named for a distinctive outcrop near the village of Marcellus, New York in the United States, it extends throughout much of the Appalachian Basin.

¹⁵ Managed by the Los Angeles Emergency Preparedness Foundation, the FEMA Community Resilience Innovation Challenge seeks innovative approaches to protect communities from natural and man-made disasters.

3.5 DATA CODING AND ANALYSIS

Once the semi-structured interviews were completed, they were transcribed verbatim by the researcher. Once transcribed, the data was scanned manually to uncover broad initial categories in the processes of command team formation, collaboration, leadership emergence and decision making, and to detect patterns of communications and information exchange. This research uses a systematic qualitative research methodology of coding trees and categories, where key points are coded and grouped into similar concepts (Oh, 2010).

Using the Atlas.ti data management software, interview transcripts were then categorized by assimilating key concepts into a series of broad, *open codes*, or the first level of abstraction, using the Strauss and Corbin (1998) approach to grounded theory. Continuing with the Atlas.ti program, the open codes were grouped into similar categories in order to associate them with the research questions.

Following the guidelines of grounded theory, the open codes were further refined by comparing the data and modifying the concepts for better classification. The resulting *axial codes* were refined once more into a series of core (also known as “selective”) codes (Strauss and Corbin, 1998).

3.6 ETHICAL ISSUES

Many of the informants of this study maintain a high profile in the State of Pennsylvania and in Allegheny County, and could be easily identified within the relatively small emergency responder community. The researcher assured informants of their *right to privacy* and

anonymity by identifying these individuals as interviewees by number, rather than name. Per current standards on ethical conduct, no identifying information was kept. Once the semi-structured interview recordings were transcribed, the audio recordings were erased.

Interviewee *right to know* was also assured by fully describing the research and discussing how the collected information would be used. Participation in the interviews was entirely voluntary and full information on the purposes of the study was disclosed. The interview design, as well as the interview protocol, was approved by the Institutional Review Board (IRB) of the University of Pittsburgh prior to the first conducted interview in June of 2014.

3.7 THREATS TO VALIDITY AND RELIABILITY

Validity is the approximate truth of an inference; the extent to which relevant evidence supports that inference (Lee, 2003). Reliability refers to the consistency and stability of the measuring instruments; are they such that the results are replicable across various field studies? In this mixed-methods design, there are a number of threats to validity and reliability. Since this research concentrates on developing a greater understanding of resource allocation and decision making, it does not attempt to test causal hypotheses. Thus, internal validity and statistical conclusion validity are not pertinent to this study. Threats to construct validity, external validity, and reliability, however, are all present and were addressed during the research.

As indicated, this work is an exploration of the factors leading to effective team management of large-scale disruptive events. Accordingly, while this research does not employ statistical means to test causal hypotheses, the researcher recognized that threats to validity and

reliability were particularly relevant to the main instrument of data collection; the semi-structured interviews. To mitigate these potential pitfalls, the research was conducted according to the tenets of good research design as they apply to threats to validity and reliability: have specific predictions in mind, collect data systematically, study more than one case of each phenomenon, and consider alternative explanations for each finding (Dunn, 2004).

3.7.1 Construct Validity

Construct validity is the extent to which the research instruments actually reflect the concepts behind the questions; they should measure what the researcher claims it does (Shaddish, Cook, and Campbell, 2002, Lee, 2003). This hazard is made worse when the theoretical concepts themselves are not properly explicated (Dunn, 2004). To assure construct validity, the researcher clearly “operationalized” and defined such key concepts as major regional event, emergence, effectiveness, and collaboration (Miller and Salkind, 2002). Operational definitions were also related to the research questions, and to observations made during the investigation itself.

The mixed methods design itself helps assure validity by using multiple research techniques in a process of *triangulation*, to avoid the “mono-operation” bias that can result from the use of only one instrument (Shaddish, et al., 2002). The coding process was also considered to be an integral part of the safeguards that assure construct validity.

3.7.1.1 Construct Validity of the Semi-Structured Interviews

In the Strauss/Corbin approach (1998), constructs are generated by the subjects themselves and identified through the coding process. Responses of subjects were examined and compared, and evidence supporting and contradicting construct definition and the expected

results of the research were made clear in this dissertation.

3.7.2 External Validity

External validity reflects the quality of a research design such that the results are generalizable to different settings. Do the findings hold across variations in persons, settings, and outcomes? The generalizability of this study – whether it is applicable to settings other than those found in Allegheny County – depend to a large measure on how specific or unusual the procedures of each unified command team turned out to be. In this study, the researcher believes UCT procedures to be similar enough throughout the county to be considered standard and generalizable.

External validity can also be challenged on the basis of using an unusual group of research subjects, limiting the research to a specific geographic region, or by confining the study to a narrow point in time. Yet the wide variety and size of the Allegheny County region, the diversity of its emergency response network, and the researcher's exploration of major incidents over a period of ten years should serve to mitigate such challenges. While generalizability is restricted due to the limits of the sample, the ability to replicate the design will be made possible by the detailed notes and descriptions, which should prove helpful to future investigators of similar phenomena (Kvale, 1996; King, Keohane, and Verba, 1994).

3.7.3 Reliability

According to Kerlinger and Lee (2000), questions about reliability consider the extent to which the methods and instruments employed by the study generate results that are dependable, lack

distortion, or are free of measurement error. They remark further that “A highly reliable measure...tells us that it is measuring something precisely or consistently.”

3.7.3.1 Reliability of the Semi-Structured Interviews

The Strauss and Corbin approach (1998) offers a replicable interview process. Using this method, the researcher used carefully worded interview questions which were open-ended and designed to obtain valid and accurate answers from the informants. This process helps to maximize the variance of the experiences and opinions of command team members (Wukich, 2011). Prior to the interviews of domain experts, the interview protocol was tested on ten emergency services officers to gauge, among other pertinent concerns, its reliability.

3.8 CONCLUSION

This research uses a mixed methods, grounded theory approach to investigate the dynamics which shape unified command team formation, collaboration, leadership, communications, and decision making processes. Additionally, simulation and modeling are utilized to explore the viability of computer-based systems of decision support.

The primary objectives of this study are to develop an in-depth understanding of the factors that promote or inhibit large-scale incident management by unified command teams, and to offer practical suggestions for the enhancement of that process. The scope of the investigation encompasses major disruptive events of a regional nature, and the unit of analysis is the typical command team of three to seven individuals, as might be found in most metropolitan areas of the United States.

The bulk of the primary evidence garnered by this study consists of 75 semi-structured interviews of experienced incident command officials from Allegheny County, Pennsylvania and surrounding areas. Selected in a purposive manner from the rolls of fire, police, EMS and other pertinent agencies, these interviews have resulted in rich and detailed descriptions that provide a comprehensive understanding of large-scale incident management.

This study also includes a documentary analysis, which is utilized to provide background information and guide the investigation of the UCT phenomena. Publicly available documents include media reports of major events in Allegheny County from 2004 through 2014, organizational records and standard operating guidelines of public safety agencies, and response network information from county's 911 dispatch center. Direct observation of incident commanders during training activities is also utilized to provide further grounding for the research, and a computer-based decision support system has been developed, tested and evaluated to gather additional data to provide answers to the research questions.

The collected information was entered into the Atlas.ti qualitative management software and categorized using the Strauss and Corbin approach to grounded theory research. The data was then refined using a series of open, axial and selective codes, which ultimately tracked with the five subordinate research questions which guide this research. A complete analysis of the information was conducted by cross-referencing and examining the details of each core code.

4.0 CONTEXT OF REGIONAL OPERATIONS IN THE FIELD STUDY AREA

Allegheny County, Pennsylvania, due to its multiple political subdivisions and its convoluted emergency response structure, is an appropriate area for research into the dynamics of large-scale incident management. The county spans 730 square miles across Southwestern Pennsylvania and has a population of 1,233,000 residents; 305,000 of whom reside within the City of Pittsburgh, according to the 2010 U.S. Census (SPC, 2015). Allegheny County's governmental landscape is made up of 130 independent municipalities, within which there exist in excess of 450 semi-autonomous emergency response agencies (Informant 19). With such a large number of public safety entities, coordination and collaboration are crucial when it comes to the management of regional disruptive events.

4.1 BACKGROUND: EMERGENCY SERVICES IN PENNSYLVANIA

According to Skertich (2008), emergency response systems in Pennsylvania are fragmented “along and within their functional lines.” While this study spans the full range of emergency services activities – fire, police, and emergency medical services (EMS) – an examination of the situation faced by Pennsylvania's fire service agencies is instructive. Public fire protection in Pennsylvania consists of a patchwork of 2,337 fire departments. Of these agencies, only 23 are staffed by full-time professionals, while 73 include a combination of career and volunteer

firefighters. The remaining 2,241 fire service agencies are operated solely by volunteers, whose organizations make up the overwhelming majority of the state's fire service agencies (PERC, 2004). It is estimated that between 50,000 and 55,000 men and women serve in the ranks of this "most critical component of the system" (SR60C, 2004).

During the 30 years between 1975 and 2005, the staffing of Pennsylvania's volunteer fire companies has fallen from about 300,000 to about 52,000 (Hampson, 2005). In spite of this precipitous drop, new responsibilities are changing departmental structures and roles in the community, and altering the demands placed on fire service personnel (SR60C, 2004). Since current requirements already place a heavy burden on the typical volunteer department in Pennsylvania, it remains to be seen if the many local volunteer agencies can thrive, or even survive the changes forecast in the next decades.

4.2 PUBLIC SAFETY IN ALLEGHENY COUNTY

Allegheny County's emergency public safety agencies feature a wide diversity of missions, capabilities, demands for service, which provides significant variability for research into cooperation and "information asymmetries" (Wukich, 2011). Additionally, the county's emergency service providers suffer from an almost across-the-board shortage of manpower, necessitating multiple agency responses and joint management of major events (Informant 19). Figure 5 displays a map of Allegheny County, showing the location of primary response station, by discipline.

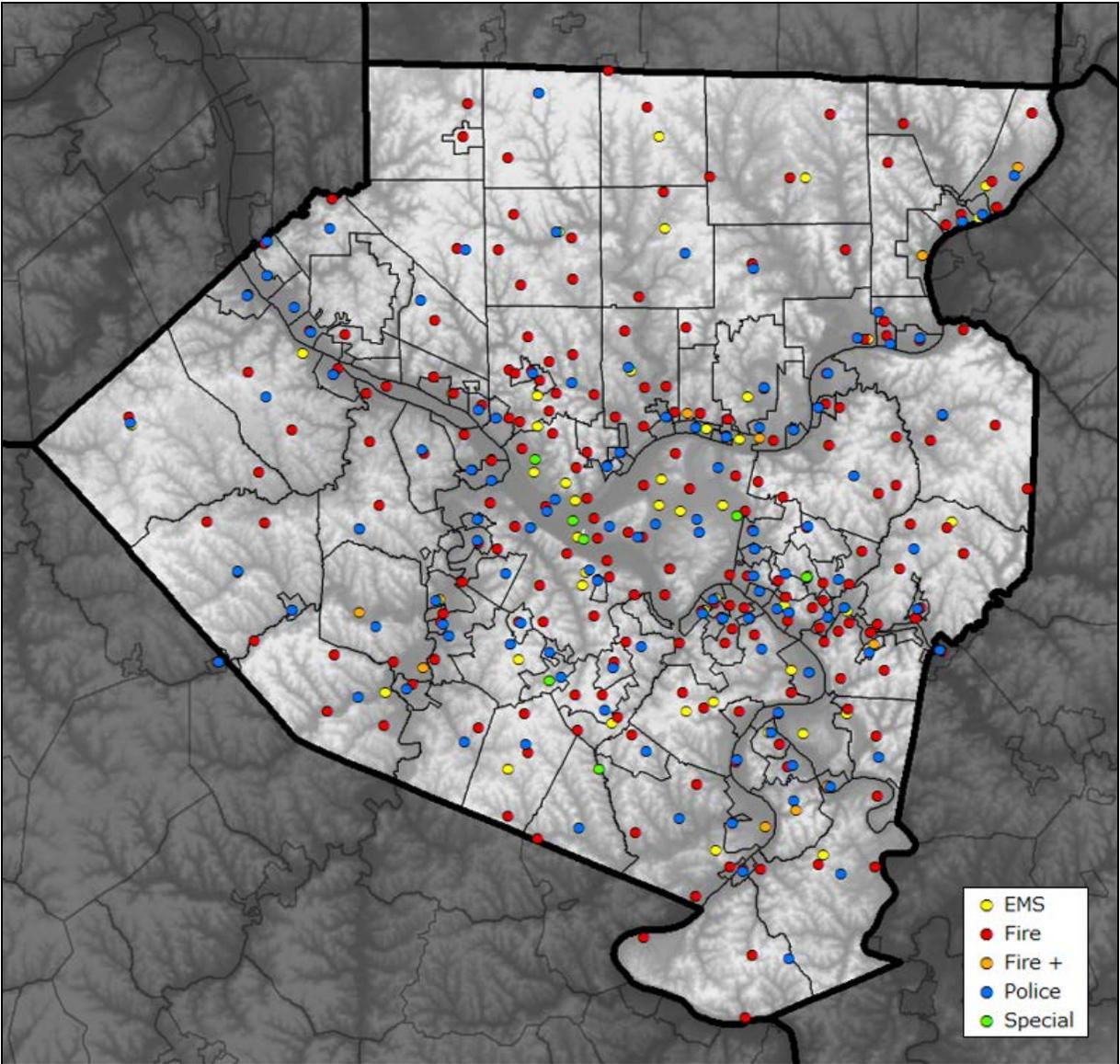


Figure 3: Map of Allegheny County Emergency Agency Stations, by Discipline.
Courtesy of Brian A. Chalfant, University of Pittsburgh.

Allegheny County, due to its complexity and diversity, is susceptible to a number of man-made and natural events of a sufficient scale to require collaborative incident management (Wukich, 2011). Threats such as flooding and hazardous materials releases abound, as do the transitory risks posed by the major transportation routes that converge and pass through the region (Wukich, 2011). The county continues to serve as a large hub of heavy industrial activity,

and includes major health care and educational facilities, all of which pose complex challenges in the event of a large-scale emergency event. Many of the region's small towns feature old and often dilapidated construction and infrastructure that make them susceptible to rapidly spreading conflagrations that can consume large swaths of local business districts (Informant 19). Additionally, a new and challenging hazard has arisen with the advent of natural gas well drilling in the Marcellus Shale layer throughout Western Pennsylvania.

4.2.1 Declining Response Capabilities

Allegheny County, Pennsylvania's second most populous, presents a microcosm of the situation faced by the state's fire service agencies. Within the county, over 450 first responder agencies struggle to provide emergency response while suffering from dwindling human resources assets (Informant 19). In this environment, an increasing number of agencies must be summoned to deal with large-scale fires and other emergencies. Consequently, a team approach to the management of large-scale incidents has become a necessity within the county's borders.

4.3 COORDINATION IN ALLEGHENY COUNTY

Allegheny County has suffered from a haphazard emergency response network for many decades, and efforts to institute a coherent emergency response system remain problematic. Wukich (2011) characterizes the system as an "integrated, interdependent system" which operates largely without an overarching hierarchical structure. An examination of recent efforts to establish countywide emergency services coordination is instructive.

4.3.1 Allegheny County Department of Emergency Services

Allegheny County's governmental structure includes the Department of Emergency Services (ACES), an agency charged with assisting and coordinating the emergency preparation and response efforts of the county's 130 municipalities. The mission of ACES is as follows:

To mitigate the potential effects of the various hazards and vulnerabilities that might impact the county, to implement measures which will preserve life and minimize damage, to respond effectively to the needs of the citizens and local jurisdictions during emergencies, and to provide a recovery system to return the county and its communities to a normal status as soon as possible from the effects of natural or man-made disasters, technological accidents, national security threats, and other disrupting incidents that may impact the area.

The ACES vision statement hints at the *voluntary* nature of cooperation between the county and its municipalities, and of the difficulties faced when trying to coordinate responses to local events – even those of large scale – from county level. It reads as follows:

The vision of ACES is a less vulnerable and more resilient Allegheny County through a comprehensive emergency management program built by fostering relationships that will be mutually beneficial without infringing upon the autonomy of each entity. It is through these relationships that we will nurture an environment of trust, respect, cooperation and coordination that will translate into success during all phases of emergency management (ACES, 2014).

4.3.2 Local Emergency Management in Allegheny County

Title 35 of Pennsylvania's Emergency Management Services Code directs and authorizes every political subdivision to have an emergency management program that includes a trained Emergency Management Coordinator (EMC), an Emergency Operations Plan (EOP), and a functioning Emergency Operations Center (EOC). The role of the Emergency Management Coordinator is to oversee planning, training, and preparation, and to act as the coordinator of the local Emergency Operations Center during large-scale emergency events (Title 35, 2013). Each

county in Pennsylvania, and each municipality of Allegheny County, appoints an EMC per state law. While the emergency management coordinator is a full-time, career position at the county level, this is rarely the case at the municipal level, where he or she may hold a part-time position, but is most likely a volunteer from the community (Informant 19).

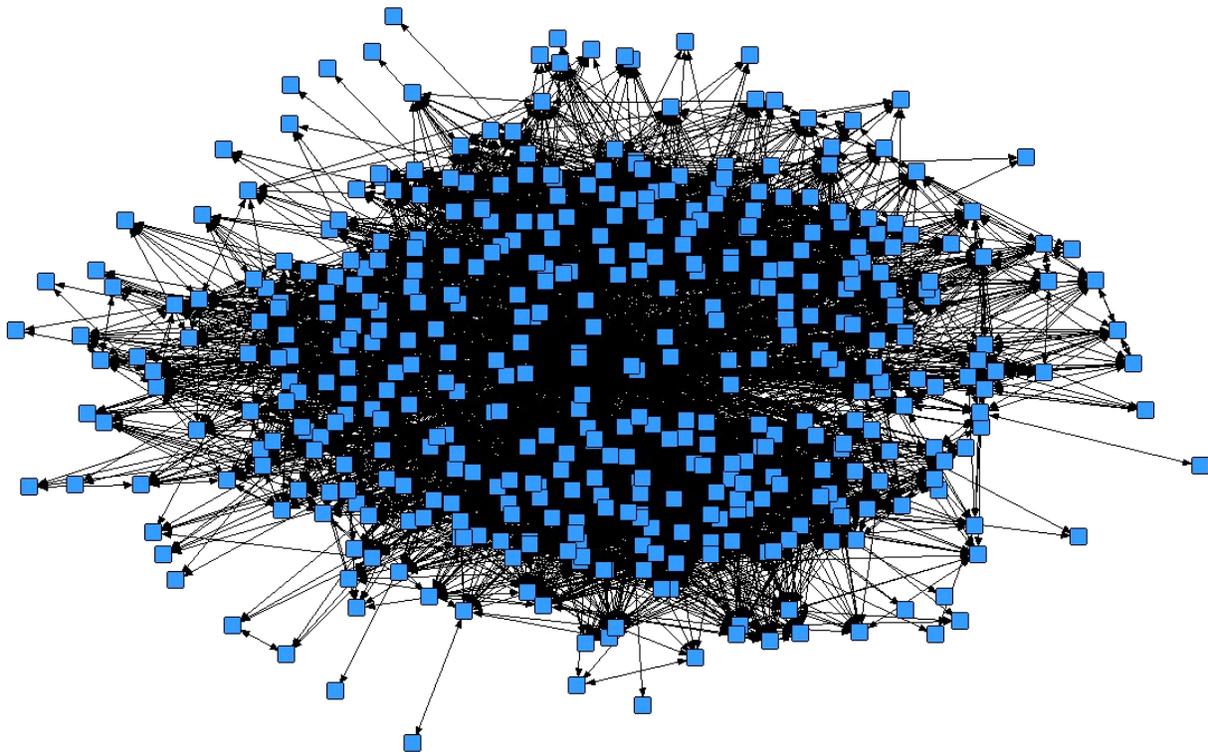
Although it is not recommended by Title 35, the EMC is often an employee of the political sub-division, usually the police chief, municipal manager, or volunteer fire chief, whose regular duties often interfere with emergency management responsibilities in times of crisis (Informant 19). Further, unless they are retired or otherwise unemployed, few volunteer emergency management coordinators have enough time to devote to the important responsibilities of the role, which include planning and training, holding major exercises, and maintaining proper documentation (Informant 19). In theory, and as intended by Pennsylvania and Allegheny County stipulations, the EMC is the focal point of large-scale emergency response. In reality, however, the burden falls to the unified command teams that assemble at the scene of the incident, often on an ad hoc basis (Informant 19).

4.4 EMERGENCY RESPONSE NETWORKS IN ALLEGHENY COUNTY

Allegheny County's emergency response system incorporates 453 public safety response agencies of varying size and make-up, mainly in the police, fire and EMS disciplines (Informant 19). While most of the county's police and EMS agencies feature full-time staffs, the fire service component presents a completely different picture, where 190 of the 207 fire departments (91.7 percent) are staffed solely by volunteers (Wukich, 2011). Since volunteer firefighter availability

is typically uncertain, it may be difficult to assemble an experienced group of officers for the unified command post, especially during weekday daylight hours.

Joint response and collaborative management during large scale incidents is also dependent on the distance separating each public safety agency within a mutual aid network. Wukich (2011) finds that the overall response structure is fairly dense in Allegheny County, and that “agencies have the ability to reach others in a limited number of steps within the network, reaffirming the system’s high level of interconnectivity.” The significance of a dense response network lies in the ability of command officers to reach the scene of a major event in a short period of time. The following figures, from the Wukich study, illustrate both the density and fragmentation of Allegheny County’s emergency response network:



**Figure 4: Diagram of Interacting Agencies, Allegheny County Pennsylvania (complete network).
Courtesy of Clayton Wukich.**

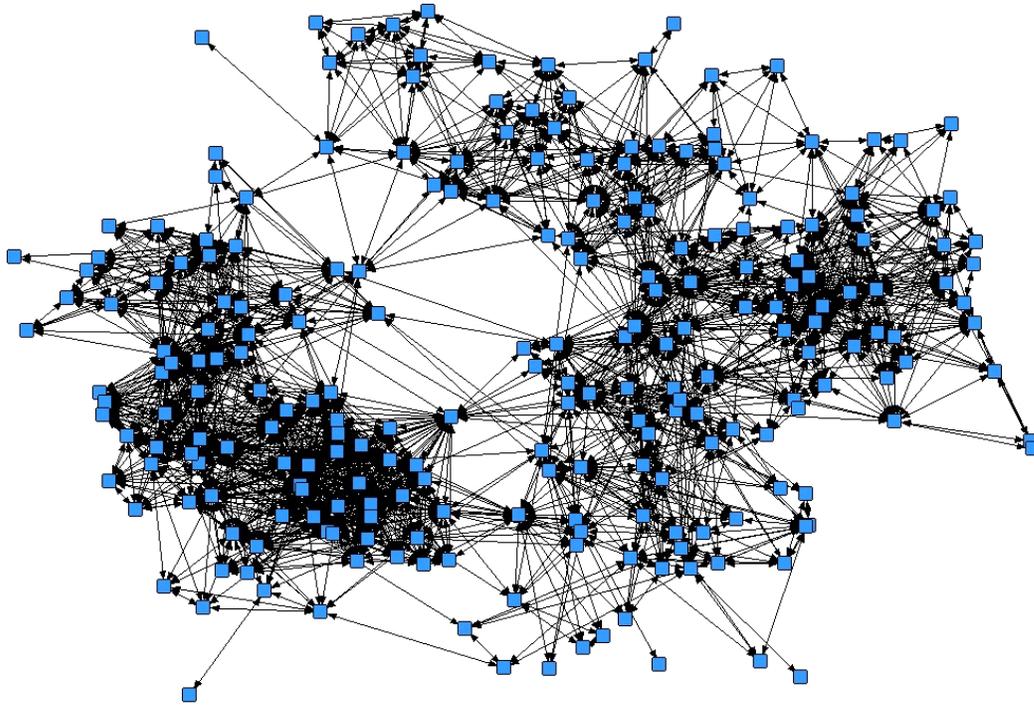


Figure 5: Diagram of Interacting Fire Departments, Allegheny County Pennsylvania.
 Courtesy of Clayton Wukich.

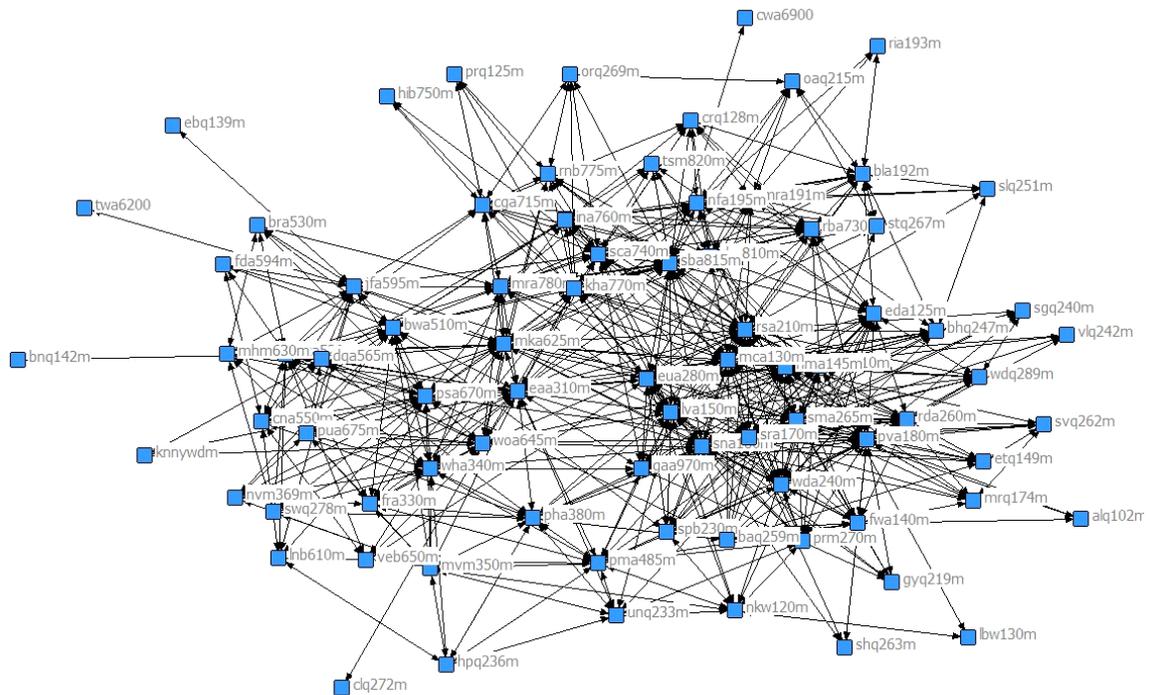


Figure 6: Diagram of Interacting EMS Agencies, Allegheny County Pennsylvania.
 Courtesy of Clayton Wukich.

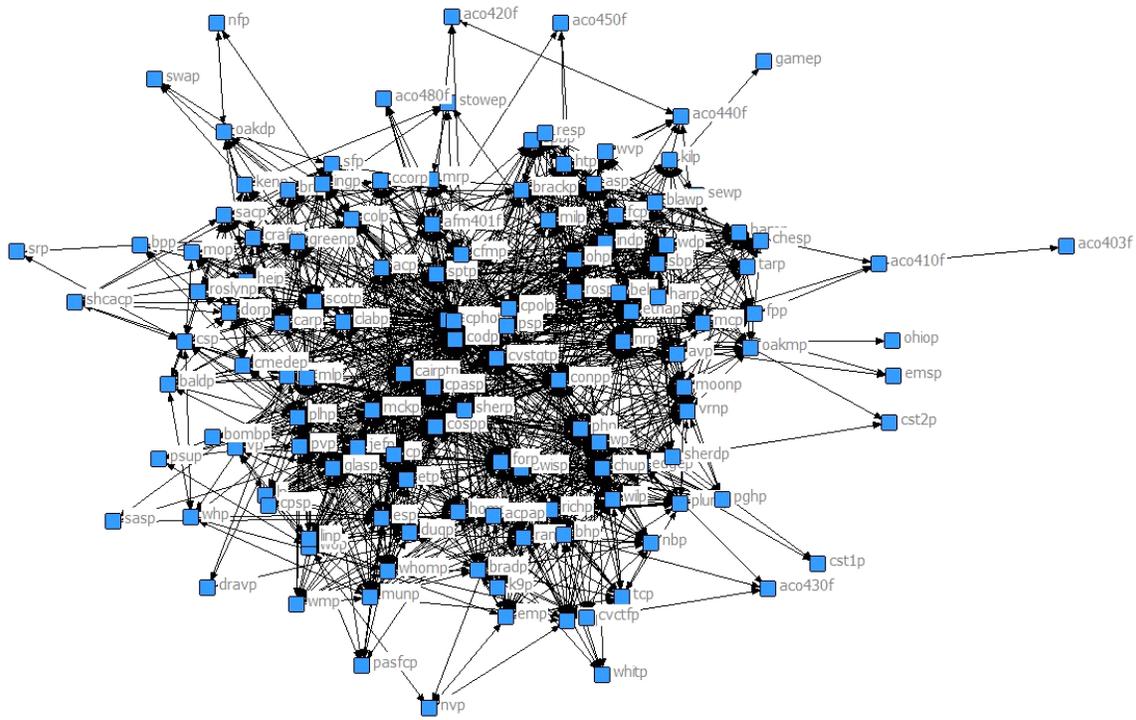


Figure 7: Diagram of Interacting Police Agencies, Allegheny County Pennsylvania.
Courtesy of Clayton Wukich.

4.5 HISTORY OF EFFORTS TO CONSOLIDATE INCIDENT COMMAND IN ALLEGHENY COUNTY

During the past three decades, numerous efforts have been undertaken to improve the management of emergency incidents in Allegheny County. Most have been met with resistance from local officials and have achieved mixed results.

4.5.1 Prior to 1996: Initial Efforts to Integrate 911 Systems

Centralized communications and dispatch services are perhaps the first manifestation of attempts at emergency services coordination. Such efforts were delayed in Allegheny County, which was

the *last* major metropolitan area in the U.S. to establish a 911 emergency number, and the last to establish a centralized telecommunications call center (CPM, 2011). Until recently, the county featured a patchwork of small, local dispatching centers scattered throughout the region.

During the early 1990s, the Commonwealth of Pennsylvania pushed for the consolidation of Public Safety Answering Points¹⁶ (PSAPs) as a way to save money and facilitate the efficient delivery of emergency services throughout the state (CPM, 2011). This process proceeded slowly in Allegheny County, as individual municipalities and small regional dispatching centers clung to their turf and as political officials argued that locally based dispatchers, with detailed knowledge of their municipalities, could best direct emergency responders to an incident scene.

It was not until 2001 that the centralized 911 process began in earnest with a consolidation in the southwestern portion of Allegheny County. This process continued – as did resistance to it – until a compromise was reached in 2005, and *five* regional PSAPs were established (CPM, 2011). As a part of an agreement with local municipalities, the five centers operated independently, each with its own policies and procedures, and with little coordination among them. While these five centers represented a major improvement from the previous arrangement, the situation was still far from ideal.

Concurrently, Allegheny County’s Emergency Services Agency established a centralized 911 Center and allowed each regional entity to “apply” for incorporation into it (CPM, 2011). One-by-one during the first decade of the twenty-first century, the regional dispatching services were merged into one all-encompassing, multidisciplinary 911 center, which included the assimilation of the City of Pittsburgh’s emergency communications system. Yet even today, many political subdivisions insist on and are granted what is known as “ring-down” status, an

¹⁶ Another designation for 911 telecommunications and dispatching centers.

arrangement where requests for assistance must be re-routed from the county 911 center to dispatchers in local municipalities, creating the potential for delays and mistakes in service delivery (Informant 19).

4.5.2 1998: Formation of the Region 13 Antiterrorism Task Force

Following the first World Trade Center attack in 1993, and the Murrah Federal Building bombing in Oklahoma City in 1995, the potential for terrorist activities within the United States came to the forefront. Emanating from discussions held by the Allegheny County Weapons of Mass Destruction (WMD) working group, the task force began its mission in 1998, three years prior to the September 11, 2001 terrorist attacks (PAR13, 2014). Task force members recognized Western Pennsylvania's vulnerability to domestic and foreign terror attacks, and sought to create an all-hazards organizational structure consisting of resources from multiple counties which could be mobilized to assist local emergency response efforts.

Sanctioned under Pennsylvania State Law Act 227, the Region 13 Task Force covers a metropolitan area of 3 million residents within a 9,550 square mile area and including 706 municipalities, 713 fire departments, 392 police departments, 203 EMS agencies, 65 hospitals, 15 hazardous materials teams, and 2 specialized explosive teams (PAR13, 2014). The task force has been recognized by FEMA as a model organization for intergovernmental cooperation and is often held up as an example of the type of collaboration that may one day be possible within Allegheny County's fragmented governmental and emergency services structure (PAR13, 2014).

The Region 13 Task Force consists of a series of mutual aid and intergovernmental agreements to respond to weapons of mass destruction (WMD) events,¹⁷ chemical emergencies, and other man-made and natural disasters. The task force features specialized resources of personnel and equipment, along with an interoperable communications system, all of which are available for regional emergency events. Region 13 also coordinates grant funding and provides numerous opportunities for networking and training that allow local responders to hone their skills (Informant 19). Figure 8 illustrates the state's regional task forces and PEMA areas.

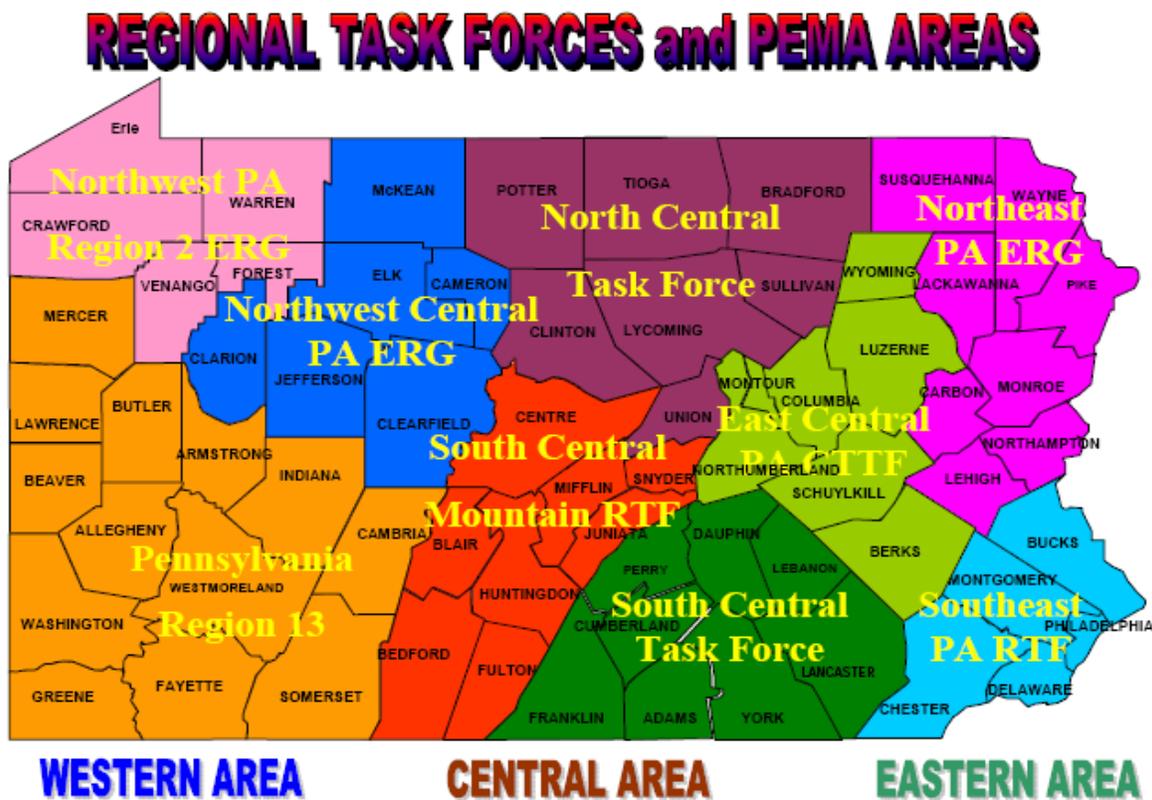


Figure 8: Pennsylvania's Regional Task Forces and PEMA Areas (PSEOP, 2012).

¹⁷ Weapons of Mass Destruction (WMD) are considered to be of a nuclear, biological, or chemical nature.

4.5.3 2001: September 11 – A Support Role for Allegheny County

The crash of United Flight 93 in rural Shanksville, Somerset County, Pennsylvania, necessitated a multijurisdictional, multiagency response which was intergovernmental in character (Grant, Hoover, Scarisbrick-Hauser and Muffet, 2003). Since the event was primarily a terrorist incident, federal and state law enforcement personnel maintained control of the scene, led by agents of the FBI. The Federal Aviation Administration (FAA) and the National Transportation Safety Board also sent investigators to the site to assist federal authorities. At the same time, the Pennsylvania Emergency Management Agency (PEMA) provided coordination for the many state, regional, and local public safety agencies.

Although the tragedy in Shanksville did not impact a populated area, Allegheny County's emergency services agencies were nevertheless called upon for a number of supporting functions, including on-scene logistics, assistance with the search for human remains, and specialized equipment that was needed to maintain 24 hour out-of-doors operations in a remote and rural area. The American Red Cross and the Salvation Army also played important roles during the sustained incident operational period of what became a long-term disaster recovery operation.

While the Shanksville incident was generally well managed, it nevertheless brought to light the need for greater coordination among law enforcement, fire, and non-governmental supporting agencies (Grant, et al., 2003). Allegheny County officials who responded to the event were able to help bring some order to the situation, yet they noted a lack of command clarity regarding the responsibilities of the individual public safety resources assembled at the scene.

The extended response to Somerset County also highlighted a need for a greater availability of funding to support training and equipment, which was found to be lacking for this

type of distant and specialized response. In particular, it was noted that agencies which hadn't trained together operated in an air of unfamiliarity that hampered the response to certain on-scene demands, while leading to a duplication of effort in others (Grant, et al., 2003).

4.5.4 2004: Tropical Storm Ivan – Coordination Improving

During the 2004 Atlantic Hurricane season, Tropical Storm Ivan swept through Allegheny County, causing widespread damage and severely taxing an emergency response network which was not accustomed to dealing with such a large-scale event. Approximately 10,000 homes and businesses were damaged during the storm, and widespread flooding occurred as heavy rains fell on a region that had already been saturated by the remnants of Hurricane Frances just 11 days earlier (ACES, 2014). Massive flooding, wind and related damage caused by the tropical storm kept emergency crews busy for over a week, straining the volunteer fire service in Allegheny County and challenging its ability to keep up with requests for service.

Ivan was yet another event during which demonstrated the importance of cooperation among public safety agencies, and on this occasion it was in evidence. Thanks to the efforts of a strong and effective leadership team, the Allegheny County Department of Emergency Services demonstrated a rapidly expanding capacity for large-scale incident management by organizing the resources and directing the efforts of hundreds of regional response organizations. It was particularly noteworthy that these new abilities had a very positive effect on the interdisciplinary elements of the response.

Still, in spite of the work of ACES, complete coordination of all public service organizations proved elusive as incident commanders struggled to deploy the county's limited resources in ways that would assure service delivery while not causing the response system itself

to collapse. This situation was due in part to the limited authority that county officials held over local agencies and also to the extreme variation in available manpower from one public safety entity to the next. As in previous incidents of a regional nature, a more robust system of interoperability and inter-agency cooperation was shown to be needed.

4.5.5 2009: Region 13 “All Hazards” Incident Command Team

In 2009, the leadership of the Region 13 Task Force developed a plan to establish a permanent unified command team. Known as the Region 13 All Hazards Incident Management Team, it was based on standards promulgated by FEMA for permanent, regional incident management teams (AHIMT, 2007). Although the team has yet to be fully trained and certified, its ideation represents the region’s first attempt to develop a group of established incident commanders who would be used as “strike teams” for deployment to large-scale emergencies throughout Western Pennsylvania (Informant 19).

4.5.6 2015: New Threats – Current Status

In 2014, natural gas exploration and drilling into the Marcellus Shale sandstone layer began in earnest at some locations in Allegheny County. This unconventional industrial process introduces new hazards to Allegheny County’s citizens and infrastructure, and presents new challenges to its already overburdened public safety agencies (Informant 19). The large and complex response to an uncontained gas release or explosion at one of the well sites will require coordinated activities that seem beyond the reach of the current capabilities of the county’s public safety agencies and responders.

One particularly problematic threat is that posed by the five natural gas drilling operations located on the property of the Pittsburgh International Airport. With up to 70 well heads¹⁸ in the planning stage, the potential exists for a major incident which could disrupt a critical piece of the region’s economic and transportation infrastructure. Figure 9 displays a map of the Marcellus shale formation in Pennsylvania, while a site plan for gas drilling at the Pittsburgh International Airport is included in Appendix D.

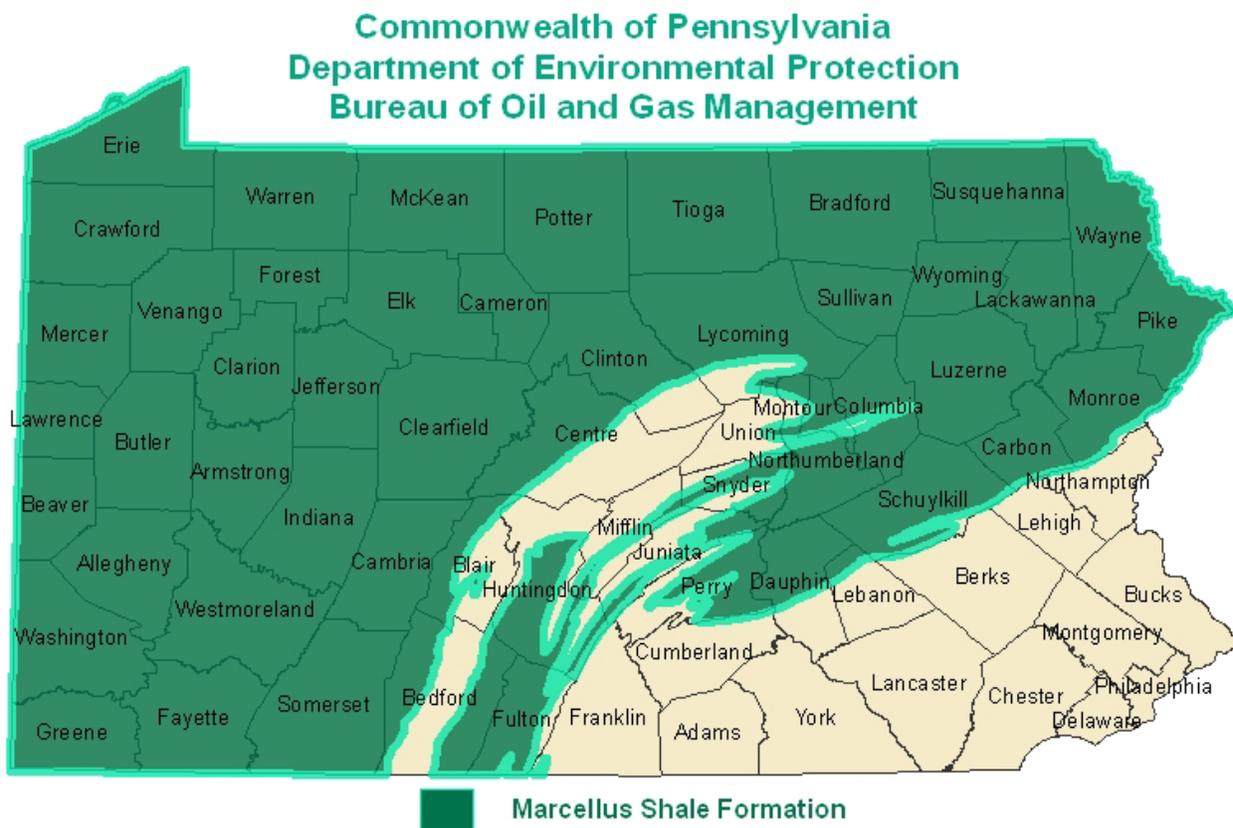


Figure 9: Marcellus Shale Formations in Pennsylvania (MCOR, 2015).

¹⁸ Each well head is a separate drilling unit.

Recent focus group sessions held by the University of Pittsburgh's Center for Disaster Management, consisting of experienced incident commanders from throughout Allegheny County, draw attention to a continuing lack of resources and coordination for the type of large-scale operations that would be necessitated by a major gas well incident, in spite of the efforts of the Region 13 task force. Local public safety professionals continue to point to the need for more funding to finance the training, manpower, and specialized equipment that would be needed to control a catastrophic well pad gas release or fire. These experts also identify another common and longstanding shortcoming – a failure to properly coordinate large-scale regional emergency events – which has plagued the region for many years.

4.6 CONCLUSION

Allegheny County, Pennsylvania is an appropriate area in which to investigate the management of large-scale disruptive events. The region's police, fire and EMS agencies are framed by their disjointed structure and uneven geographic distribution. Varying widely in their missions, capabilities and demands for service, these public safety organizations present significant variability for research. Within Allegheny County, limited resources of equipment and personnel necessitate a multiagency response which stretches well beyond the normal mutual aid networks. Multiagency response, in turn, adds complexity to the joint management of regional disruptive events.

Efforts during the last three decades to improve coordination and effectiveness among the over 450 emergency response agencies have met with uneven results, in spite of the fact that the county features old infrastructure paired with complex and growing hazards to its population.

While some efforts toward coordination have been initiated by the Allegheny County Department of Emergency Services, these actions have been inhibited by a lack of legal authority to *compel* the county's agencies to adapt modern methods of incident management.

Chapter 4 also details some of the key historical attempts to improve coordination of incident command in Allegheny County, including the centralization of emergency dispatching, the formation of the Region 13 Anti-Terrorism Task Force, and the ongoing efforts to form collaborative management teams of incident commanders. This chapter sets the stage for Chapter 5, which begins this study's empirical exploration by examining the factors that influence unified command team formation and collaboration.

5.0 UNIFIED COMMAND TEAM FORMATION AND COLLABORATION

Chapter four outlines the structure and disjointed nature of Allegheny County's emergency response network. It also describes recent efforts and opportunities to bring order and coordination to the county's public safety agencies, and how these have met with mixed results. Analysis of the semi-structured interviews conducted during this research reveals a similarly uneven record of success regarding efforts to coordinate the management of large-scale disruptive events within Allegheny County. Chapter five, using the information provided by domain experts, explores the factors that inhibit or facilitate the formation of unified command posts during large-scale disruptive events, and looks into the elements which lead to genuine collaborative synergy among team members.

According to John Cosgrave (1996), emergency response is a "collaborative effort of many actors" from a multidisciplinary network of public safety agencies. Further, he posits that effective incident management is only possible when the various agencies, along with their governing institutions, are in agreement on the need for, and the acceptance of, such collaboration (Cosgrave, 1996). From the earliest interviews, it became clear that many of the barriers to mutual aid collaboration in Allegheny County, as detailed by Wukich in his 2010 study of mutual aid networks, also plague the efforts to establish collaborative command teams which arise from these networks.

The use of unified command teams and procedures varies greatly within Allegheny County, ranging from regular use to no joint management at all, as illustrated by the following comments.

“Unified command posts are set up at each of our incidents exceeding a certain size, like when two geographic divisions or three functional sectors are needed. Certainly the type we’re talking about here” (Informant 30).

“We use joint command all the time, and we include police, fire, EMS, road department, utilities, and local political leaders” (Informant 1).

“Yes, normally all of the jurisdictional chiefs will come together to form a team type of command. The EMS and police will usually join in” (Informant 27).

“Often the neighboring chiefs collaborate, but not in any formal way” (Informant 32).

“The fire chiefs will usually coordinate among themselves, and they may or may not ask EMS to join in. The police, for the most part, will do their own thing and ignore everyone else” (Informant 24).

“Yes, unified command is set up, although we wouldn’t call it that, and we don’t always include police or EMS” (Informant 12).

“All of the mutual aid fire departments use team command concepts, and we’ll often include an EMS component, but police rarely participate, even when asked” (Informant 67).

“Most, but by no means all of our mutual aid agencies would specify a unified command team in a situation where we have multiple jurisdictional operations” (Informant 3).

“At larger incidents, we set up unified command, but it takes a while to get going. Usually all agencies and disciplines begin their own commands separately, but they eventually discover that they need to work together to accomplish anything” (Informant 11).

“Our fire companies won’t set it up in every case. We might have single command led by the host chief, with two outside-the-jurisdiction chiefs staffing operations or sector command positions” (Informant 51).

“No, not unless there is a specific issue such as a mass casualty EMS or law enforcement incident” (Informant 69).

“Our three neighboring townships use it for police, fire and EMS. But when we have to call in additional resources from other municipalities, it’s more likely than not that they won’t. It’s a crap shoot” (Informant 43).

“I think people know that it’s good for incident management to set up unified command, but I’m not sure that it would happen. And part of it is that we don’t normally plan for these types of large-scale incidents (Informant 60).

“In theory yes, and on paper yes, but when it comes to putting it in place, it’s not followed properly. It’s given more lip service than used correctly” (Informant 16).

“That would be the goal, but will it always happen? Not necessarily. It just depends on what the ultimate incident commander does. I think people know they should set up a joint command post, but there is no guarantee, given the low frequency of such large-scale calls in our area” (Informant 38).

“No, not in our part of the county. The chiefs are all stubborn and refuse to use it at all. In fact, a lot of them won’t even set up a single command. Can you believe that? They won’t use ICS at all, even in 2014, as incredible as that sounds” (Informant 40).

5.1 PREVIOUS COLLABORATION AND FAMILIARITY

“Most officers won’t come to the command post and say, ‘hey, I’m good at this,’ but through familiarity we know who is capable of doing what, and what we can assign them to” (Informant 18).

Previous exposure to regional mutual aid organizations is listed by informants as the primary factor determining whether or not a team management approach is utilized. This

reasoning extends to the selection or acceptance of a particular command level officer as a partner in the unified command process. Familiarity is most often gained through a system of regular joint responses to everyday incidents, or through a history of shared training activities, particularly where there is no formal written agreement on how to operate together.

Other scholars have identified familiarity, or the lack of it, as figuring prominently in the collaborative capacities of a command team. Danczyk (2008) emphasizes the importance of personal interactions during incident preparation, response, and command. His research finds that frequent collaboration, usually from joint training and response activities, leads to an increase in trust, stating simply, “knowing one’s colleagues is the key to making the system work” (Danczyk, 2008).

Oh (2010), suggests that a “collaborative mindset” is often lacking among those in command of an emergency scene, especially if they have not worked together previously. He goes on to say that “creative adaptation under rapidly changing conditions” is a difficult proposition among those who are unfamiliar with one another. Oh (2010) reasons that joint preparation and planning for an incident, combined with collective command experience developed over time, is one way to foster collaborative efforts.

Wukich (2011) presents the idea of “professional capital” which describes how standards of professional performance demonstrate *competence* and justify the decision of incident managers to interact. Two measures of professional capital – the ability of personnel to work well with others, and the results of past performance – are identified as crucial when considering who to include in the unified command team. Agreeing further with the findings of Wukich (2011), informants of this research identify experience, training, and the use of proper protocols as necessary prerequisites for potential command team members.

Informant 49, emphasizing that command teams are much more easily established among agencies and jurisdictions that work together on a regular basis, remarks that “it goes much smoother than if it’s the first time that they’ve been thrown into this pot together.” Other informants echo that sentiment and offer these comments about individual officers:

If you've never met or worked with a person before, or you don't know of their level of training or capability, it's difficult to put them into a trusted position in the unified command team. On the other hand, if you do know about their capabilities, you get a feel for what they know or don't know, and you know if they can be an effective member of the team (Informant 30).

Without joint response and training, you're more likely to put the distant mutual aid companies into a staging area rather than incorporating their key officers at a unified command post. Instead of knowing the people and saying ‘hey I would like your chief here,’ I may not know if their officers will provide any value at the command post. I need to surround myself with good, familiar people who will serve in the roles that I need them in (Informant 38).

If I know the people well, I know lots of their pros and cons. Who are the chief officers that would provide me value at a unified command post, versus those who I might not be sure about and who I might send into the operational roles rather than in the command role. And those departments that we don't train or respond with, we don't typically know very well (Informant 27).

Well, first of all everyone is comfortable with each other. Everyone knows each other's strengths and weaknesses. From the chiefs all the way down to the firefighters working together, everyone is comfortable, and there's often interchangeability between members of all the teams, not just with incident command but with the whole scene. It's really comforting to know each other's abilities (Informant 17).

A common theme running through the interviews with experienced incident commanders is the importance of becoming familiar with one another’s potential command post representatives prior *to* joint operations at large-scale incident scenes. When neighboring agencies work together on a regular basis, as Informant 27 remarks, “you get an idea if your

sister agencies have people who are even capable of operating as a member of a high level command team.” Informant 71 adds that first-hand experience is indispensable, “because on paper they may have all the command level certifications in the world, but in person I’ve witnessed these same individuals as utterly unable to function in the command role.” The informants list regular responses with mutual aid agencies, and training on a regular schedule as two vital ingredients in the establishment of a competent command team.

5.1.1 Established System of Joint Response

“The mutual aid departments we respond with, we know what to expect from each other. A level of trust develops that we don’t have with departments that we don’t work with on an emergency scene. And at a command post, that trust makes all the difference in the world” (Informant 63).

When asked about the most important aspect of familiarity with one’s prospective command team partners, most informants list an established history of joint response to everyday incidents as the most significant. Experienced incident commanders cite extreme difficulty in managing large events with partners with whom unfamiliarity exists. Informant 26 illustrates the impediments:

We’ve unfortunately been involved in several big incidents over the last 10 years and not one of them has gone well. Coordination was poor, use of resources was poor, and personnel were not used to the best of their abilities. Setting up a unified command post that is effective and efficient is impossible under these conditions. With no routine, day-to-day responses together, our management efforts are wasted and the scene becomes pure chaos. To me there is no excuse for this, but in our district it has been this way for many years, unfortunately.

According to the majority of informants, mutual aid responses allow for the measuring of the strengths and weaknesses of mutual aid partners, and with it the command capabilities of their officers. As stated simply by Informant 52, “I’ve got to know beforehand if they can be counted on if placed in a command position.

Command level officers become familiar with each other’s emergency scene management abilities during regular, routine responses. Those displaying such qualities are more likely to be included into the decision making aspects of a command team’s decision making activities during a major event. Further, if officers have worked together frequently, a type of *shared cognition* seems to develop among them. This phenomenon is aptly described by Informant 34:

When it comes to officers of other departments, and you work every day with them at joint responses, you know how they operate. You know their strengths and their weaknesses, and you know if they are really good at any one aspect of command. And so the tasks that need to be undertaken sometimes are implied. And between us all, we know that the needed jobs will be handled by one another. I know he’ll handle interior firefighting strategies, or I know she’ll do a good job with determining evacuation strategies. The other officers might consider me to be a good communicator, so they know I’m going to send concise and timely information to the sector leaders or the interior crews. Because she’s a capable EMS leader, the rest of us are now going to be able to make our decisions from a medical standpoint based on her information. So a lot of tasks where you have this familiarity can be understood or implied ahead of time because you assume your partners will do what they need to do without asking. No matter what the job is, we know that the officer in charge of it will get it done. That’s the ideal. And it works the other way too. With some, we have to delve into the issues more because we can't really trust what he or she says. Have they made sure all the floors in the building have been cleared? Have they coordinated a complete search? Have they checked the dangers to the personnel at the scene? With these people, nothing is implied. Knowing this is just as important, and you only learn these things by working together often.

Thus familiarity through working together is deemed critical by experienced incident officers, and it often determines whether a comprehensive unified command team is established.

5.1.1.1 Regular Mutual Aid Activities

“Training together builds good relationships, which makes it so much easier to establish joint command during major emergencies” (Informant 3).

Informants note that joint training activities provide a high level of familiarity and trust for all involved in joint command. Informant 3 elaborates on the positive effects of shared training in his area of the county.

We have a tradition of outside officers coming up to the command post and introducing themselves and telling us who they represent. But because we also have a long tradition of training with our nearby departments, we can look at them and say ‘hey chief, we need your guys to do this, or we need you to staff this command function.’ We’re just familiar with them and their background and it makes things move a lot quicker. We know their skill sets, especially with those who have specialized talents or are from other disciplines or agencies. Hazmat is a good example. So it’s only by training together that we become familiar with what they’re capable of, and that comfort level allows us to integrate them seamlessly into our command post.

5.1.1.2 Collective Mutual Aid Training

“Training with mutual aid partners gives us trust and confidence in them and a better understanding of what we can expect from their officers as incident commanders” (Informant 5).

Wukich (2011) argues that “joint activities integrate agencies into subsystems based on various goals.” Analysis of semi-structured interviews reveals this statement to hold true for the public safety entities and their commanders who come together with the goal of managing the operations of a large-scale emergency event. Classroom or practical training – which may or may not include command activities – is identified by informants as an indispensable building block toward the kind of multi-agency integration that leads to the establishment of a collaborative command team.

Informant 56 explains that training within his department's mutual aid group is an important pre-event activity, partly because "you get rid of the handshaking and the 'get to know you' rituals when you get to the command post. Since we've already met everyone, those formalities are not needed and we can get right to work." Informant 69 agrees and adds that integration with sister agencies through training "makes everything easier once we get together at the scene. No introductions are needed, and we know the fire chiefs by first name. So interaction and joint training, when it is held, is very beneficial."

Another benefit of collaborative training activities is that they provide an environment in which to learn about the personnel, equipment, and specializations of other organizations within the regional public safety network. As Informant 24 remarks, "training also lets us know what types of apparatus and equipment is available." Informant 6 lists joint training as indispensable as a vehicle for gauging the strengths and weaknesses of personnel, and that knowing their skill sets becomes "very important during the decision-making process when it comes to what we can assign them to do."

With regard to regional emergency events, such as large fires in a business or commercial district in one of Allegheny County's small municipalities, training and working together translates to the fireground and to the command post. Once you establish that rapport with other agencies and their command officers it makes it much easier to function in unified command.

A history of training, according to analysis of the semi-structured interviews, provides innumerable benefits to the collaborative command process. Informant 64 commented, "when you train with these departments you can put a face to a name, you can develop relationships over time that allow you to work well as a decision making team when the time comes." In a

similar vein, Informant 5 remarks, “we train and respond with them so much, we know their skills – what they’re capable of doing. We don’t question their command skills.”

Resource Allocation

Resource allocation is integral to the unified command process, and the benefits of mutual aid training are evident here as well. Informant 53 indicates that training “takes the guesswork” out of resource allocation. Through joint training activities, commanders become informed about the personnel and equipment throughout their response area, and need only give minimal attention to the resource allocation process. Similarly, Informants share these thoughts on the resource allocation benefits to the command team:

Training lets the incident command team focus on strategies and other higher level decisions, instead of having to worry about where to position each responding vehicle or worry about where a particular crew might be used best. Also, the officers of the incoming [apparatus] don’t need to call the command post and request instructions for every little thing during their response. Training allows us to give general instructions and them to need minimal information (Informant 38).

Mutual aid training and practice sets certain things into motion, so when all the fire companies are coming to the scene, they all don’t have to ask, over the radio, what they need to do. They assume certain roles based on the order in which they arrive, and this is based on joint training. It becomes a problem with those we don’t often work with (Informant 66).

5.1.1.3 Extended Mutual Aid Training

“We train quite often with nearby companies, and this includes ICS practice. But not so much with the ones from further out that we’d need to respond during a big incident and would need to know our command team and procedures” (Informant 14).

This study suggests that the dearth of *extended* mutual aid training presents severe implications for the establishment of a collaborative command team. “Without the experience of working and training with those departments that would be called in on a large incident, we are reluctant to include them as part of our command team” (Informant 2). The regional command officers and ICS experts interviewed for this research acknowledge the importance of collaborative training, but argue that it does not extend far enough into any particular region of Allegheny County. As a result, many public safety agencies are well-schooled in the resources and capabilities of nearby entities, but lack such knowledge about the outlying agencies that would answer any call for the type of regional event investigated by this research.

Informant 19, a public safety official who participates regularly in large incidents all over Allegheny County, characterizes the region’s extended mutual aid training system as “haphazard.” He states that “far too little extended joint training is done at all,” and when it is conducted, such training occurs on an infrequent basis and “has very little substance to it.”

Other informants agree that extended training and familiarization is rarely done, and as Informant 12 states, “it almost never includes all the departments that would respond to the big event.” Informant 6 is firm in his belief that a failure to include enough agencies in the extended mutual aid network “results in a “wildly inconsistent system” where the “players may or may not know anything about each other’s capabilities.” The result of this dynamic is a “highly inefficient management of major incidents” as various agencies struggle to learn to conduct joint operations “on the fly” (Informant 19).

When it comes to extended agency training, Allegheny County’s police and EMS agencies seem to be outpacing their fire service brethren by holding a regular series of “active

shooter”¹⁹ and terrorism related response training that includes public safety entities based far from their political sub-divisions. Informant 61, an experienced police officer and volunteer firefighter, suggests that since the police and EMS agencies in the county feature “full-time career staffs,” they are able to extend the scope of their training as a matter of routine. He contrasts this with the situation facing the county’s fire service agencies, made up largely of volunteers, by saying that “the volunteers are hard-pressed to work with the fire department next door, let alone the one that is several municipalities over.”

“You’ve got to work together with those who’ll be present at your command post, and you’ve got to get a good understanding ahead of time, or else things won’t go smoothly for the command team when the time comes and you’re faced with a major incident (Informant 67). Adding to the chorus is Informant 2, who says of the command team “if you haven’t trained together and don’t understand each other, it’s too late to try it in the middle of a big incident, so we won’t include them as anything but bystanders at our command post.”

5.1.1.4 Command Level Training

“Once a month our five closest mutual aid departments get together to practice joint operations, and that includes joint command of a simulated scenario” (Informant 6).

Danczyk (2008) emphasizes the importance of “learning from and mentoring” among colleagues during training exercises as a way to strengthen the mutual aid relationship. When asked to indicate the most important type of collective training for potential members of regional

¹⁹ According to the Department of Homeland Security (2015), active shooter training is used by law enforcement agencies to instruct their personnel on how to respond rapidly to real-time events where “an individual is actively engaged in killing or attempting to kill people in a confined and populated area.”

command teams, informants confirm Danczyk's claim by stressing the importance of practicing unified command with their mutual aid partners prior to using it during a major event. Two experienced command officers offer the following suggestions:

It's all about training to command together, as a unit. You've got to practice command techniques for large scale incidents ahead of time, or you don't have a chance of managing a big incident with any success. These activities can be as simple as stress free, periodic discussions between chief officers, or as elaborate as full scale exercises that test command skills in a real-time, pressure packed environment. But I think you've got to do something in between those two extremes at least quarterly to develop and maintain your own skills, and the knowledge of how your potential command team colleagues operate. I think the perfect vehicle for this is the tabletop exercise, using complex scenarios complete with simulated radio traffic and under time limits. This is critical to build rapport and develop trust and confidence in one another, and to assess the strengths and unique abilities of potential command team members. It is also the perfect opportunity to train young officers, as they can command parts of the tabletop under the guiding hand of more experienced, senior officers (Informant 29).

We like to train with other departments so we can learn what their capabilities are. And we like to extend this to the point of our command staff. Especially when we go into what we might call weaker districts, where we know that we need to look out for our own a little bit more. Joint training helps the command staff know this in advance, especially if they don't meet our high standards of accountability and safety. It cues us in to be a little more aware of the situation, and because of it, we'll push for a unified command team, even if the host department doesn't set one up (Informant 44).

In spite of the alleged importance of command level training, it appears from the descriptions of the informants that not much of this type of education is conducted in Allegheny County. Informant 54 offers mixed reviews about the command level training held in his part of the county. "I don't know if we actually learn to function better, but we do learn to talk to one another better." Informant 68 adds, "We also know if someone is a hothead or if a certain person handles the situation better, and we can place them accordingly. So it's better than nothing, but it should be so much more than it is now."

Informant 42, an experienced ICS instructor and chief officer of both EMS and fire agencies, expresses frustration that most collaborative training efforts involve “tactical level skills which don’t involve command procedures.” He argues that there is a great need for collaborative, leadership style educational opportunities throughout Allegheny County. He goes on to say that tabletop training scenarios would provide the perfect format to bring together regional chief officers and allow them to develop their “command level decision making” abilities. Informant 16 agrees and states “we really don't practice the tactics of getting things done, but it definitely helps knowing people when we get to the command post.” Informant 52 also takes issue with joint training that does not include command evolutions:

The problem with our mutual aid training programs is that we cover only task-related skills, and ignore the command level skills which are necessary to direct those tasks. We’re so afraid that responders from different companies won’t be able to work together on simple functional tasks that we forget about that at the command level. We don’t expect two inexperienced firefighters to come together and extend a handline into a fire, or rescue a victim from a window via ladder, yet we expect teams of incident commanders to come together on the fly, without any experience with one another, and manage a complex incident. It doesn’t work that way. It’s at this level that we need to train and practice. The lower level skills can be taught in-house. So we lack training in command level decision-making and quite frankly I have serious concerns about the educational level of high-ranking fire officers all over Allegheny County and Western Pennsylvania.

Informant 45, another EMS and fire service manager and command instructor, is strong in his belief that ICS training has little value when “done in the isolation of your own agency, without including your mutual aid command officers.” He states the case for collaborative command level training efficaciously, by citing the example of regional coordination during the planning for the 2009 G-20 Summit, which was hosted by the City of Pittsburgh:

I think that getting all the fire chiefs in the same room, discussing issues on a monthly basis, allows us to know the players. So once the big incident hits, you’re much more comfortable interacting with those players at the command post. Through discussions, we learn about each other's abilities and knowledge levels. I

then know which officers to utilize in the command post or to assign as sector commanders, and I'll know the jobs will get done. The G-20 efforts really pulled us together and got us working together. During the extensive planning process, we became comfortable with one another. We knew that we would establish unified command, we knew what our roles would be, and we rehearsed these roles. And once we arrived at the event, our team functioned flawlessly. During it all, we were not afraid to offer ideas to one another at the command post, because we knew from our previous collaboration that none of us would criticize or be offended. We knew what needed to be put in place – what needed to happen – and we didn't have to think about what the other command officers were doing, because everyone understood their roles.

5.1.1.5 Formal, Multijurisdictional Emergency Planning

Regional emergency response agencies and municipalities often conduct some form of joint planning as a hedge against response issues during a multiagency, multijurisdictional incident. To be effective, such emergency plans must “assign responsibilities” and “facilitate coordination” (McEntire, Boudrot and Webb, 2014). In such cases, which are rare in Allegheny County, the formation of a unified command team is sometimes set out in advance, and may include a multi-agency response. “In our area, it has been all mapped out. Our municipal emergency coordinators have agreed to establish unified command in any of our [four] townships” (Informant 57).

5.2 ORGANIZATIONAL POLICIES AND PROCEDURES

The policies and procedures of individual public safety agencies can impact the formation and collaborative nature of a unified command team. Analysis of the semi-structured interviews indicates that Standard Operating Guidelines, formal or informal agreements, and the arrival of county level resources tend to be facilitators of UCT formation, while regional custom most often hinders the team process.

5.2.1 Standard Operating Guidelines

While analyzing the semi-structured interviews for the use – or lack thereof – of unified command teams, Informant 42, a highly experienced fire and EMS leader, sums it up best when he relates:

At my [EMS agency] we do have unified command policies and we follow the unified command structure. And from the bottom employee all the way up to the chief we have the appropriate level of ICS and NIMS training. At [the municipality of the informant's fire department] it works a little differently in that the police department does not actively participate in the command post, although fire and EMS do. As we get into the outlying areas of my [EMS or fire] network, unified command is a hit or miss affair, unfortunately. It is not embraced in many places for a variety of reasons, including ego, "my hat is more important than yours," or from a lack of education and training in the Incident Command System, its advantages, and its procedures.

The standard operating guidelines of Allegheny County's emergency services agencies may or may not specify the use of joint command for incidents of a certain size or for those which involve a certain number of agencies or political sub-divisions. It appears most likely that while they don't preclude UCT formation, neither do they require, or even mention it. This situation seems to be a hindrance, as Informant 59 remarks. "Very often, the jurisdictional officer, no matter his or her inexperience level, will not allow joint command, and will cite the lack of direction in the company SOGs as the reason why."

Informant 3 argues that a set of uniform SOGs that would specify UCT use is needed across the county emergency services network. He goes on to say that not having county-wide standard guidelines is a shortsighted policy promoted by agency leaders "who only worry about their small slice of the county pie without thinking about the big picture." Informant 28 agrees and adds that leaders from the many small public sector agencies are also failing to consider the benefits of managing large incidents with collaborative command teams.

5.2.2 Formal or Informal Agreements or Regional Custom

Formal agreements, usually between agencies of the same type within a specified mutual aid network, or among multidisciplinary agencies of the same jurisdiction, are extremely rare, according to those interviewed during this research. Further, they do not seem to be gaining much impetus in Allegheny County, in spite of well know Incident Command System principles.

Where they do exist, as Informant 63 maintains, formal agreements do tend to specify the use of multiagency and multidisciplinary command teams for large incidents. At the very least, formal agreements serve as effective facilitators for the use of unified command. Informant 68 contends that the dearth of such agreements is a key reason for the “irregular pattern” of command team usage. In a similar vein, Informant 23 states:

The jurisdictional issues are a hindrance, while agencies from within a single jurisdiction seem to have an easier time setting up a unified command post. And in fact, most responding chiefs from other jurisdictions accept the fact that they would not expect to be invited to be part of the unified command team. This then translates into the same type of situation as when outside officers respond into [the host] jurisdictions. These outside officers readily accept the positions of operations chief, section chief, safety officer, division chief, or one of the command staff positions. And this would happen even if several fire departments from within one municipality do form a unified command post. Instead of staffing a unified command post, chiefs from outside the area are utilized in specialty positions on the fire ground (Informant 23).

Where joint command is the norm, regional custom, which can be considered a type of informal agreement, seems to be the operant factor. These norms are especially important when three or more political sub-divisions are actively involved in response to large scale events. Several informants gave detailed accounts of how these informal agreements came about and how they function. Summing up their descriptions, it can be said that long-standing

collaborations were developed and maintained by groups of forward thinking individuals and have been maintained over the years by their successors.

5.2.2.1 Pre-Planned Command Team Membership

“When we arrive on the scene of a large fire in [our area of the county], we usually know who our command team partners will be, since we’ve talked about it ahead of time” (Informant 51).

In some parts of Allegheny County, agencies from the local mutual aid network have established guidelines to determine which agencies will be represented in the command organization. According to informants, these informal agreements help alleviate the problem of having *too many officials* at the command post, and assure that the *appropriate agencies* are represented. Agencies are selected for participation based on such factors as the skill level of their personnel, the specialization of their organization, and by the level of familiarity and trust that they have attained among the mutual aid group. Informant 2 discusses one such process:

We have regular meetings with all of the area fire officers and chiefs to iron out command procedures before we get to large incidents. We determine which departments will be the incident leaders, and their chiefs will end up at the command post. We also make sure we standardize or update our ICS terminology during our discussions. It’s a verbal understanding of what we expect from each other, and it’s proven to be very helpful to our command efforts.

5.2.3 Availability of County Level Resources

The Allegheny County Department of Emergency Services (ACES) maintains an array of specialized assets which can be dispatched to assist local agencies during large-scale emergency operations. These resources include: mobile command posts with comprehensive

communications and information gathering capabilities, specialized rescue vehicles and equipment, hazardous materials decontamination facilities, portable generators and lighting plants, and foam firefighting equipment. Perhaps more importantly, ACES material resources are normally dispatched along with highly skilled and experienced human resources who are expert incident command officers in their own right.

Domain experts explain that the arrival of ACES equipment and personnel provide powerful inducements for on-scene command officers to initiate unified command team protocols. As Informant 19 relates, “When the county command post shows up, I’ve seen it cause a group of separate incident commanders and command posts to join forces around it in unified command.” Informant 6 adds that county facilities provide a “non-threatening location and venue for [the local ICs] to assemble and work together,” and county personnel provide “very valuable, but neutral, command resources.”

5.2.4 Type of Agency

The types of agencies assembled at the scene of a major event have a bearing upon how easy or difficult it is to assemble and galvanize the respective officials from each into one unified command post. Interview analysis suggests that the more homogeneous the incident scene, the more likely it is that a UCT will be set up. Conversely, during multidisciplinary incidents involving fire, police, EMS and other public service entities, heterogeneity seems to work against the establishment of collaborative command. Informant 12 offers a few insights:

For firefighters, it's easier to set up unified command because we speak the same language. Everyone understands how each other operates, and we have similar mentalities. But trying to get police to participate is often difficult. We just can't seem to get the police to switch to more of an emergency mentality and less of

that law enforcement or traffic mentality. Likewise, EMS usually wants to focus on the victims in front of them, without looking at the big picture.

In some instances the command officers from agencies of different disciplines do not begin their operations in a unified command mode, but eventually come to the realization that it makes sense to coordinate strategies and tactics using a collaborative decision making approach. Informant 38 has witnessed the slow formation of several incident command posts, and suggests that it is largely a social phenomenon:

I've seen situations where we end up with a joint command even though it didn't start out that way. Usually, officials from other agencies, like police and EMS, start coming to the fire command post with questions and problems, and possibly some suggestions. This sets the stage for good relations between everyone, and from there it naturally grows, as a social group gathers. They are just naturally pulled together that way. Sometimes all it takes is one agency, police or the medics, to move their flag to our fire command post. The other will follow pretty quickly, in my observation, and we end up with a genuine unified command post.

Informant 63 offered similar remarks:

So again it starts out as maybe three separate commands or as one command post with one type of agency staffing it, with the other two pretty much ignoring it. But if one of the other agencies sets up shop with the first, in no time there will be all three together. No one wants to miss the chance to have a say in the strategies of the incident, and they will naturally gravitate toward one another.

5.2.5 Type of Incident

Two Allegheny County officials disagreed as to which type of disruptive event is more likely to result in the establishment of a unified command team. Informant 23 asserts that his experience has shown him that unified command is more likely to result from multidisciplinary events rather than from multijurisdictional incidents. He explains that when police, fire and EMS responders have an equal stake in the outcome, they are compelled to manage the incident together. Since

each discipline might be blamed for a poor result, each wants a say in its mitigation. Yet each specialty also “understands at some basic level” that if they don’t collaborate as decision makers, then the operation will be uncoordinated and “their efforts are likely to fail.”

In contrast, Informant 22 views multidisciplinary events as less likely to result in joint command, and more likely to produce entirely separate command posts that don’t utilize collaborative decision making processes. His reasoning, based on over 20 years of direct observation, is that those responders who share a common specialty are more likely to understand and collaborate with one another; he states simply, “birds of a feather flock together.”

5.3 SITUATIONAL VARIABLES

In his research into collaboration among agencies within Allegheny County’s emergency response system, Wukich (2011) finds that “once a need for action is upon them, an agency’s decision makers decide whether to cooperate with others or rely on their agency’s internal capacity” to cope with the situation. Informants of this research allude to the same decision point regarding whether to establish a multiagency command post, and discuss how it is reached during large incident operations. Analysis of the interview data suggests that it is most likely the *situation* faced by the responders that determines whether collaborative management is utilized. The situational forces of a major disruptive event usually result in a unified command post – in fact if not in name.

5.3.1 Availability of Command Level Officers

“Experienced officers are just not always available to properly staff a good unified command post, especially during weekdays” (Informant 26).

Day of the week and time of day are both critical to command team formation, especially when the situation requires a major response from the county’s largely volunteer fire service. Major events occurring during the morning and early afternoon hours of the typical Western Pennsylvania work day are particularly problematic, and serve as a major inhibitor of properly staffed unified command posts.

The disappearance of heavy industry, with its shift work, is often mentioned as a reason for the lack of availability of daylight fire service personnel in general, and of command personnel in particular. Informant 35, a paid EMS director and volunteer fire chief who has witnessed these changes over the last several decades, cites a typical example in his area:

We work with all-volunteer fire departments, but we are a career EMS service with paid personnel, just like the area police departments are. So it depends on time of day as to how you're going to engage at the command post. At ten o'clock at night, we may have 50 to 60 firefighters with a host of experienced incident commanders who can staff command post effectively. But during the daylight hours, we may have 15 to 20 firefighters and I may be the only experienced incident commander on the scene available to staff a command post, because a veteran fire officer might have to take an inside operational role because of a lack of manpower.

5.3.2 Scope of the Incident

At times, the sheer scope and complexity of an emergency event compels the formation of a unified command team. Informant 6 has witnessed events where “unified command is

established by officials who would not normally work in a collaborative setting.” Informant 52 agrees and states that although this type of UCT formation is far from ideal, “it beats the alternative of trying to manage a big incident with one IC.”

5.3.3 Interorganizational Rivalries and Personality Issues

Semi-structured interviews reveal that interorganizational rivalries are alive and well in Allegheny County, and that they are a strong inhibitor of command team formation. These rivalries are exacerbated by the disparate nature of Allegheny County’s public safety agencies; especially the fire service, which as discussed in Section 4.2, is predominantly volunteer in its personnel make-up. As Informant 9 remarks, “a command team won’t always come together naturally, and it’s usually because the members of one volunteer agency don’t like the members of another.” Informant 39 adds that the volunteer fire service is laced with poor attitudes and competing priorities. “Some people just don’t like one another, and in the volunteer fire service, unfortunately, that translates into poor command collaboration. Their focus is on the rivalry, not on the importance of public service to the community.”

Many informants pointed out that the county’s response agencies feature many strong personalities, which further complicates the establishment of unified command teams. The issue of personalities, especially when the actors possess strong egos, is complex and may either help or hinder command team formation. Informant 30 illustrates the dynamic:

With the emergency services career field, whether you’re talking about fire, police or EMS, there’s a lot of ego and pride that goes into it. And it’s because of what we do and the way the public looks at us. So if the command team can all ‘play nice’ and get along with one another, the job gets done faster and there are no hard feelings at the end of it. That’s usually, but not always, the case in our area. But when I respond to other areas of the county, I see big egos in full bloom. I see command officers not accepting the advice of their counterparts at

the command post because they can't get past their own pride in themselves, their companies, or whatever. This creates a mutual lack of respect and a refusal to communicate.

Other informants detail situations in which lack of respect between command level officers emanates from regional organizational rivalries. Such rivalries are often exacerbated by a lack of good communications prior to joint operations, which carries over into command post functions when a large-scale emergency occurs. Informant 56 cites a "simple lack of communications" between public safety officials as a reason for a lack of professional respect between them. Informant 24 adds, "these guys are pros, but they act like amateurs, like children, as soon as they have to work together at the command post. Informant 74 believes that interagency rivalries create a "toxic atmosphere that is translated and perpetuated" throughout an organization's roster, and becomes self-sustaining as "the lower line officers buy into that nonsense." He concludes by emphasizing that unified command is unworkable unless the players have "respect for each other all up and down the line," and that rivalries between public safety operations "prevent respect from ever developing."

5.4 INFORMANT COMMENTS: EVALUATING THE EFFECTIVENESS OF UCT FORMATION AND COLLABORATION

Elinor Ostrom (2005, p. 14) defines an action arena as the "social space where participants with diverse preferences interact, solve problems, dominate one another or fight." The action arena for this study is the area of collocation for unified command team members known as the

incident command post. The following representative comments on the effectiveness of collaborative command teams are instructive:

In determining their effectiveness, I would look at the interpersonal dynamics among the command team members. Do they have good communications between themselves and the incident sectors? Are they working well together? Are their decisions making a positive impact on the incident? Are they controlling the situation and is it getting better? Are the operational teams carrying out the orders of the command post? Are the sector chiefs listening to the command team or are they being ignored? Do we have freelancing with rouge teams doing what they want? The good teams will exhibit positive behaviors (Informant 17).

First I look at the dialogue between the incident commanders and the volume level of that dialogue. If it's escalated, I know that there is some type of battle going on among the chiefs at the command post. I also try to look and see what they're trying to develop, and if they're coming up with a sensible incident action plan. Does this plan have measurable goals and objectives tied into it? And are they reviewing that plan periodically to measure those goals and objectives and whether or not they're being met? Are they taking feedback from their operational forces and adjusting their strategy accordingly? Are they really reviewing their strategy, or are they just continuing to apply the same tactics again and again, even if they're not working? Within 10 minutes, I can tell if the team will be effective or not (Informant, 19).

If they are cooperating and communicating well, and they seem to have a common understanding of the events in front of them, and of what their individual roles in the team might be, and if the command function is satisfying the goal of incident mitigation, then I judge their unified command operation to be effective (Informant 6).

I would look at how they are interacting with each other on a personal level to see if they are really able to work together. I've been in situations where we know all the players, put specific people in the command roles and we know they're all capable of doing the work well. But yet when we put them together they don't always mix well. It's like a baseball team that has a collection of star free agents who underperform. Maybe it's just that the personalities or the egos just don't work well together (Informant 67).

5.5 CONCLUSION

Howitt and Leonard (2009, p. 9) explain that “the mere existence of laws, emergency plans, or NIMS does not ensure that responsible officials will know or play their roles effectively or that conflicts will not arise.” Further, local officials in charge may find it difficult to admit that the scope of the emergency has exceeded their ability to cope, and may not be amenable to outside assistance (Howitt and Leonard, 2009).

In Allegheny County, the establishment of unified command teams to manage the operation of large-scale events, according to the experts interviewed, appears to be highly contingent upon both the *policies* of the host public safety agency, as well as the interorganizational *dynamics* at work among the mutual aid networks. This chapter explores the results of the semi-structured interviews as they relate to factors that inhibit or facilitate the formation and collaborative efforts of regional unified command teams.

The most important factors that facilitate or inhibit command team formation and collaboration, according to informants, are those related to *familiarity and trust* gained by previous association. Regular mutual aid responses, shared training activities, and collaborative incident command practice are the most important determinants of genuine unified command, while organizational policies and procedures are somewhat less predictive. Standard operating guidelines, formal or informal agreements, the availability of county-level resources, and type of agency or incident are also listed as relevant organizational elements. In addition, the unified command process seems to be heavily influenced by situational variables, including the availability of command level officers, interorganizational rivalries, and personality conflicts. Chapter 6 continues the discussion of command post structure and collaboration by extending it into the realm of leadership dynamics within the context of the decision making team.

6.0 LEADERSHIP OF A UNIFIED COMMAND TEAM

Chapter 5 details the processes that lead to the formation of collaborative unified command teams during large scale emergency events. Chapter 6 goes a step further by investigating the dynamics of leadership emergence; how one team member rises to coordinate the efforts of the decision making team. This chapter also details the characteristics displayed by effective command team leaders, as discussed by the informants of this research.

Analysis of the semi-structured interviews of domain experts indicates their agreement on the need for a “leader among equals” during unified command post operations. Respondent 59 espouses a common theme among informants by stating, “Without a firm hand on the rudder, you get command purely by committee, which is never very effective.” The interview data also makes clear that the command team leader needs a well-rounded set of abilities in order to manage the dynamics of small team collaboration and decision making. Informant 6 shares his thoughts on leadership emergence and skill:

What causes a member of the command team to rise to the top? It'll be someone who is a real leader, someone who has command presence. Someone who is calm and collected at all times, but can still think and act fast. It'll be someone who knows what they're doing. Someone with the experience and knowledge to deal with the type of incident that we're faced with, And beyond that, it'll be someone who can demonstrate to the rest of us that they are deserving of our respect and trust.

6.1 LEADERSHIP EMERGENCE

Louise Comfort, during an emergency services simulation by the University of Pittsburgh's Center for Disaster Management in 2014, observed that "Authority shifts during a disaster," as "knowledge and experience trump position." A careful review of the information garnered from semi-structured interviews suggests that Comfort's remarks also apply to emergencies of a regional nature, but that in Allegheny County the distinction is more nuanced. In fact, it appears that official command team leadership generally falls to the person with *legal authority*, while de facto leadership is granted to the individual of the highest expertise; the one most suited to facilitate the work of the team. Additionally, this research uncovers several other factors affecting leadership emergence, including strong personality types and formal or informal agreements among agencies.

6.1.1 Legal Authority arising from the Political Sub-Division

"Unless he or she is obviously incompetent, I will cede control to the person whose fire district it is" (Informant 60).

In Allegheny County, according to informants, formal authority to assume command of an emergency incident derives largely from the city, township or borough in which the event occurs. Thus it follows that when a group of officers is assembled to command a large multijurisdictional incident, the lead incident commander will be the senior official present from the host jurisdiction. Accordingly, an analysis of the semi-structured interviews shows that jurisdictional authority is most often the primary means by which a leader emerges. Informant

33 cites the typical example. “Once a unified command team is assembled, it’s assumed that the highest ranking officer from the township or borough where the incident is taking place will become the leader of the group.”

Difficulties with the jurisdictional approach arise when the senior leader lacks the experience to command a large scale event, or to coordinate the efforts of a team of incident commanders. Informant 33 has witnessed numerous instances where an inexperienced officer takes the lead not because of his or her expertise, but because “it’s my town, it’s my scene, and it’s my command.” Informant 7 relays a similar but more detailed description of this phenomenon:

I’ve seen many situations where the local individual is someone who does not have the depth and breadth of experience to handle the incident at hand. Yet he will still place his personal flag pole in the ground and leave it there in spite of all evidence to the contrary, just because it’s his jurisdiction. Then the whole command system becomes confused, without any trust or respect for that individual from the other team members. This leads to a dangerous situation where other commanders begin to freelance and take their teams in different directions.

6.1.1.1 Agency Expertise in Command of Major Events

“In our municipality, nine out of ten big incidents are fire related, so nine out of ten times the fire commander will take the lead” (Informant 33).

Another element of jurisdictional authority is the selection of *which* public safety discipline will assume the lead command role within a particular political sub-division. Analysis of the semi-structured interviews reveals a situation where the fire service agencies and their chief officers take the lead in the vast majority of events in Allegheny County. This practice results from the fire-related nature of most major emergencies, as well as from the fire service familiarity with the Incident Command System. Accordingly, fire service chief officers are those

most likely to rise to the *first among equals* position described by informants. Consider these thoughts from Informant 6:

The fire service has utilized the military styled Incident Command System since the late 1970s. Fire service leaders have become so indoctrinated with the capabilities, limitations and nuances of the Incident Command System, and so very skilled in its use, that other agencies will often times defer to them, even if it is only a marginally firefighting related incident.”

Informant 74, a Pennsylvania emergency services official, concludes that, with the exception of crowd control or minor epidemics, most police and EMS incidents are usually smaller in scope or less complex than fire related events. This leads to a situation where most agencies become subsumed within the fire service command structure. Informant 74 states that police and EMS responders “are simply minor players in a fire related scenario, and so they naturally fall under the coordination of the fire service commanders.”

Informants are in broad agreement that the county’s law enforcement agencies, in particular, have ignored the joint command concept, following instead, as Informant 55 states, a “lone ranger” approach to incident management. According to Informant 27, a Law Enforcement leader, the “old hands-off approach” has worked well in light of the “relatively small incidents police officers deal with, mostly on a one-on-one basis.” Yet with the modern concerns over mass shootings and potential incidences of terrorism, Informant 57, a regional political leader, states that police officials “are finally coming to the realization that any number of large, nightmare scenarios can happen anywhere.” He indicates that the law enforcement situation seems to be slowly changing, and lists as evidence the “active shooter” exercises and practical and tabletop style police training sessions that are “cropping up all over the county.” He cautions, however, that such training efforts represent “only a first step” by law enforcement agencies eager to learn how to lead and coordinate large regional events.

Emergency medical services agencies in many parts of the county are also beginning to close the command knowledge and abilities gap. Regional EMS providers and ambulance authorities have established command schools to hone the incident management skills of their leadership cadres. Informant 43 described a large regional command school for EMS agencies that is rapidly expanding into all areas of the county. He explains that these command schools provide an opportunity for EMS supervisors, who “were once taught to go with the flow at the command post,” to learn how to coordinate the considerable efforts of “triage, treatment, and transportation,” just as they would be required to do at a mass casualty event. The impetus for such training, in the words of Informant 58, has been “the realization that the potential exists for mass casualty incidents that have little or nothing to do with the fire service, and so we must learn to command them ourselves.”

6.1.1.2 Standard Operating Guidelines of the Lead Agency

Standard operating guidelines often refine and add weight to the jurisdictional issue by defining when it is appropriate for the fire, police, or EMS agency to take the lead role in incident management. Informant 59 explains that such guidelines are determined by consultation among political leaders, town managers, and principals from the various public service agencies. The senior officer on the scene from the lead agency is then expected to lead the efforts of the multidisciplinary command team.

6.1.2 Knowledge, Training, Expertise and Command Experience

“I’ve yet to see a major incident where the most experienced guy wasn’t in charge of the command team, in reality if not in name” (Informant 25).

A careful review of the data from 75 interviews provides strong backing for Comfort's position that "experience usually trumps position," as legal or jurisdictional authority gives way to expertise. As Informant 35 proclaims, "Knowledge and command ability are the two things that go into the equation of who will be in charge at a unified command post. Informant 25 comments that, among a group of potential command officers, "it becomes clear pretty quickly who has the skills to lead the team, and who should be nowhere near that command post." Informant 45 shares his thoughts regarding the progression of command from jurisdictional authority to experience:

The top command position will go to the person from the local township or borough where the incident is. But since we work so closely with our mutual aid departments, and because there's a core group of people that we draw from, the command post will quickly morph into a team effort. The officer who initially led the effort might easily transfer his role to another team member who he thinks is better suited to lead the group. That kind of relationship takes time to develop. In some cases it takes years to get to the point where you trust someone that much in your own town.

6.1.2.1 Length of Command Experience

"Sometimes, for better or worse, and I think mostly for worse, it comes down to 'so and so' can lead the team, he's been around longer than any of us" (Informant 25).

In this study, an incident commander's *experience level* refers to *time* served in the emergency services in a command role, combined with a high level of *training and expertise*. Years of practice alone is only one ingredient in the equation and does not presuppose *competence*.

Information gathered from the expert interviews uncovers a clear delineation between simple years of experience and true incident command expertise, which is based on a history of

ongoing training and practice. Unfortunately, according to informants, time alone is sometimes all that is used to determine who the command team leader will be.

Officials with “nothing more than a certain number of years under their belts,” with “little else to back it up,” are often regarded by their peers as “chiefs who will repeat the same mistakes at every incident they command,” without evaluating the outcomes of their actions or making necessary adjustments to their strategies (Informant 60). As Informant 42 discusses:

One of the problems with level of experience is that someone may have many years of experience, even many years of commanding different types of emergencies, but without ever having improved their skill level. And that command experience can be quite shallow, with little of it spent honing or developing their skills on the scene or through real training or education. It’s just like the situation of the firefighter who’s been in the service for 25 years but has never learned much more than he or she was taught in rookie class, and just repeats the same mistakes over and over again. Just like that firefighter, this incident commander may have commanded one scene after another over the years, doing it wrong every time, ignoring modern techniques, but never trying to correct past mistakes. Or maybe because of lack of training, never even realizing that mistakes were made in the first place. It’s so easy to absolve ourselves in the fire service, where we can say, ‘well the fire was so advanced when we got there that no one could have saved those buildings.’ So the question becomes how to measure that experience. How to tell if it’s not all just smoke and mirrors.

6.1.2.2 Situational or Specialized Experience

“In multijurisdictional command teams, the person with the most *situational experience* is the one who rises to the top and will win any debate over a course of action” (Informant 13).

Beyond the basic requirements of training and expertise, the lead position often gravitates toward the person who has seen or commanded a similar type of event in the past. This is especially true in areas of the county where good emergency management procedures predominate. Within such mutual aid networks, experienced “subject matter experts” are valued for their specialized knowledge and are “utilized to their fullest by allowing them to assume the

lead roles” (Informant 43). Informant 72 agrees and adds, “I believe it is a combination of experience, knowledge of that type of incident, knowledge of the area, and knowledge of the other departments involved and their resources.” Informant 47 cites an example:

Specialization determines who rises to the top in the command chain. We recently had a high rise fire where the command team deferred to a neighboring fire chief who had the most experience with actual high rise evacuations and fires. He became the leader among peers as he guided the rest of us in our strategies and tactics (Informant 47).

6.1.2.3 Deference to an Official of Greater Expertise

One of the surprising findings in this research is the frequency with which inexperienced incident commanders – usually the ones with legal or jurisdictional authority – defer to those who have more extensive expertise. Informants give much weight to this dynamic, and tout it, as Informant 61 expresses, as “the best way to assure that big incidents are not commanded by amateurs.” This dynamic also adds even more weight to Comfort’s postulations regarding emergency management leadership.

Analysis of expert interviews suggests that within Allegheny County’s emergency response structure, the jurisdictional incident commanders will often seek the help of more seasoned command officers from other municipalities. This deference to experience can at times lead to a complete relinquishment of the lead command position. Five informants share their thoughts:

I see this quite often, even with myself when I go into other jurisdictions where officers of not so much experience are in charge. And since I am around during daylight hours, I'm often the most experienced officer at the command post, where a lack of experience in handling big scene operations is quite common. These officers will often ask my advice when they see me, as to what they should be doing. In fact, they often ask if I would mind if they would turn over the whole incident scene to me, and I usually agree, at least until one of their more experienced people gets there. This will also happen with other officers who have a high level of experience. I know in some jurisdictions this wouldn't happen at all, but we are fortunate that we use some common sense in our area. And I tell

our junior officers the same thing. I tell them if they're uncomfortable in any situation and they see other senior officers from the area around, talk to them and if necessary let them command the incident - or let them take the lead role among the incident command team. But I have no problem with them turning the scene over. I think just because it's in our own district, there's no reason to put someone who's inexperienced or uncomfortable in charge of the scene, and put the public at risk (Informant 3).

I expect young fire officers to give command to someone more competent, and I would expect our lieutenants with less experience to let someone else call the shots, to just give them formal command. I think those are important traits of a good leader, the ability to say that something is over your head and you need help (Informant 50).

It happens a lot. With our chief officers being as experienced as they are, our mutual aid partners, who aren't staffed as well, and do not have the level of experience in their officer corps, will defer to our officers. In fact, in many cases, they will give up command and allow our officers to run it completely. In these cases they just become part of the command team. And this all goes back to the training we've done together. They have that confidence level that we know what we're doing and they let us run with it (Informant 13).

So you can say you'll maintain the top of the triangle and put people under you to help, or say that you can't even do that, that you need someone above you in this particular situation. As long as it's done for the best interests of incident management, it doesn't violate ICS (Informant 16).

I've made it very clear to my junior fire officers that if they aren't very comfortable running an incident, that they should ask one of the more experienced chiefs from another area to take over. Or just place them next to you as an advisor or as a consultant. It's not about egos. It's about putting the most qualified individuals in place to make the decisions (Informant 45).

While inexperienced local officials might relinquish their command formally and completely, informants describe these scenarios as the exceptions. More often, the local, legally authorized officers will utilize one or more command team members in an *advisory* capacity, while maintaining final decision making authority. Informant 4 relates how he will "stand beside a young officer and 'hold his hand' at the command post while decisions are made. This mentoring role appears to be quite common, as the following informants describe:

Now in our particular area, we are unlikely to try to take command from someone of the host jurisdiction. Instead, we may position ourselves at the command post so that we can just put a 'bug in their ear' and offer advice. I was able to do this very recently for someone who was obviously not equipped to handle a certain incident. I stood next to the person and pretty much ran the [incident] without assuming formal command. I merely offered suggestions, and these were readily accepted (Informant 38).

I have seen that. This doesn't always happen formally, but informally. Sometimes the junior officer will hang back and let an outside chief get to the scene first and let them take command. It's a way to defer it without embarrassing yourself or admitting you can't do it. If someone comes to my jurisdiction with a lot more experience than I have, and maybe is best suited to run that call, I will defer to them because I think that's the right call. You want the best leader to be in charge. I think that would be best done if it was a formal transfer, but I don't think it happens that way very much (Informant 62).

We've seen all scenarios where junior officers will not give command up out of pride, and will burn the building to the ground. And we've seen where they will give it up only to avoid responsibility for a bad situation that they created. But the successful scenario is the one where senior officers stand next to them, offering advice. They'll often stand next to us and ask 'what do you think about this? Am I missing anything? Is there anything else I should be doing?' This only works when you are tactful, not when you try to just take over (Informant 35).

In some situations, junior officers won't defer the command role, but they still find themselves subordinate to team members of greater experience. This process can be quite subtle, as Informant 58 relates:

When a group of officers gets together to command a big incident, something like a business district or industrial facility on fire, a junior officer, maybe from the municipality in question, might begin in command, but he won't stay there for long. That junior officer will quickly realize that they're in over their head and will ask for help. If not, the other members of the command team will recognize the situation and 'unofficially relieve' that junior person of command. The most experienced officer will soon be the one who's really in charge, and that junior guy becomes a figurehead.

6.1.2.4 General Management and Leadership Skills

Command team members may also rise to the top by virtue of their general management skills. As various informants describe, this happens most often in the volunteer fire service, when command level officers are present who also have experience as managers and leaders in other occupations. “They may be local business leaders, construction superintendents, shop foremen, or even grocery store managers, but they know how to get people to do things that they want them to do” (Informant 10). Informants explain that in these cases fire service experience takes a back seat to skills relevant in coordinating a command team.

6.1.3 Strong Personality Type

“A lot of times it’s the A type personality who will take charge when there’s no clear leader at the command post” (Informant 4).

Officials with strong personalities, according to many informants, can sometimes attain the leadership positions of joint command teams simply by force of will. This research shows that even today, with so much emphasis placed on training, skill, and experience, the charismatic leader can still rise to dominate the group, as Informant 30 explains:

The strong leader with the best training, or the senior official from the municipality in question, will typically rise to the top of the command food chain. But a moderately strong or not so strong leader, or one from the host jurisdiction, might yet demur to the guy with the stronger personality, to the loudmouth if we may call him that.

Informant 18, referring to the fact that few women have attained high rank in the county’s volunteer firefighting structure, states that “there’s always that “alpha male” who stands out in

the group and seems to end up in charge.” As Informant 6 explains, temperament is often the primary factor, especially when a “clash of weak versus strong personalities occurs at the command post.” Informant 38 explains this dynamic, and mentions a means of avoiding it:

When it comes to the team leader position at the command post, it’s difficult to beat out the strongest personality. It may be the one who talks the loudest, the one who is most intimidating. And it’s a shame because it’s often not the best qualified person for the job. Maybe that person believes he knows what he’s doing, but maybe he really doesn’t. In my experience, a command team with a history of working together doesn’t let this happen. And if they find themselves at a command post with an unfamiliar member who exhibits these characteristics, they’ll prevent such a person from rising to the top. Using their own familiarity with one another and their strength of numbers, they’ll keep him in check by allowing such a person to voice his opinions, but not to take charge.

Situations where the unified command post lacks clear jurisdictional authority also lend themselves to leadership by dominant personalities. Informant 28 describes a recurring situation where three fire chiefs from the same political subdivision would vie for leadership position at each joint incident. In almost every case, the officer with the strongest personality won out and even though he was considered a less able commander, because he “ran roughshod over the others.” This situation continued until highly trained individuals, “armed with strong personalities of their own,” became chiefs of the other two departments and asserted their own authority.

6.1.4 Formal or Informal Agreements among Organizations

“The mutual aid agencies in our area have pretty much agreed to allow the most senior incident commander to run the show when we all come together at a big fire or the like. It’s not a formal agreement or anything, just an accepted practice among us” (Respondent 5).

Just as the county’s public safety agencies lack *formal* agreements to determine whether a unified command team is formed during multiagency events, there appear to be even fewer such arrangements to guide the selection of command team leaders. Not one of the informants could cite an example of a formal process for unified command team accession.

Informal agreements dealing with leadership selection do exist, but these appear to be sporadic, and confined to certain areas of Allegheny County. Informant 25, an instructor who has served at command posts throughout the county, relates that while mutual aid departments in his area do have informal agreements that cover command team leadership selection, most other areas he has observed do not. Informant 54, for one, does not think that the dearth of formal selection procedures is a bad thing. He believes that “it’s better to allow a good leader to rise to the top naturally,” than to select one based upon “some arbitrary procedure that might produce a bad leader for incident.”

Table 4: Frequency Distribution: Primary Reasons for Leadership Emergence.

<i>Primary Reason Cited</i>	<i>N</i>	<i>%</i>
Legal / Jurisdictional Authority	27	36.0
Experience / Abilities in Joint Command	21	28.0
Strong Personality Type	14	18.6
Formal / Informal Agreement	5	6.6
Other	3	4.0
Unsure / No primary element selected	5	6.6
<i>Total</i>	75	100

6.2 EFFECTIVE COMMAND TEAM LEADERS

Danczyk (2008) asserts that effective emergency services leadership combines “knowledge, personal actions, interpersonal relations, management skills, and human characteristics.” The

informants to this study offer considerable evidence in support of Danczyk's findings, especially as they apply to the leaders of regional unified command teams. The most important leadership factors identified by domain experts include command presence, communications skills, knowledge and experience, open-mindedness, critical thinking skills, the capacity to make rapid decisions, and the ability to collaborate effectively. Informants make clear that unified command team leaders occupy the most significant, as well as the most demanding and stressful, positions on the scene. The following comments are offered as examples.

"The leader of the unified command team has got to be a good communicator, must have the proper knowledge and skill-set to match the incident, and beyond all else, has the ability to work with people and make good decisions, in a timely but not a rash way" (Informant 59).

"I like someone who can function in a 'multi-stimulus environment' with lots of noise, with many radio communications, and with lots of other command team members talking to them and asking them questions even as they try to process what they see in front of them at the scene.

"Unified command is high stress command. To survive it they need to work with their team and keep an open mind. They need to stay calm and make decisions that reflect a high level of knowledge and experience. And they must demonstrate to everyone at the scene that they are decisive and have everyone's safety in mind at all times" (Informant 39).

6.2.1 Communications and Informational Skills

“Communications skills are a paramount command tool. Know what is needed to make decisions and when to say enough information is enough” (Informant 13).

When asked to list the most important qualities of a command team leader, informants mention communications skills more often than any other attribute. Communications abilities include the ability to use communications technology to its fullest, and to get one’s message across to colleagues at the command post and to the functional units operating at the scene. The ability to receive, filter and analyze the most relevant information received at the command post is also rated high on the list of leader attributes, as is the capacity to achieve situational awareness and to disseminate a common operating picture throughout the scene. The following are typical responses from informants:

Communications is a critical part of the equation, and I think listening is the most important skill. You have to be able to receive input from other sources, especially your command post members and your operations people. You have to be willing to take feedback, and really listen to that feedback, to the reports from your troops. You have to be able to process the information that you receive quickly (Informant 13).

He or she must be a good listener, and all around good communicator, and be open-minded to alternatives and other options. So not just listening, in other words, but listening as in ‘this officer sees something that I don't, and I'd better listen.’ That leader must be able to accept advice and be willing to change course. Be willing to allow the other officers in the command post to be equal stakeholders (Informant 17).

6.2.1.1 Maintenance of the Communications Network

Communications management skills take on high importance at “the modern incident scene, which presents the IC with so much information that it can be overwhelming” (Informant 55). Informant 63, a long-time fire officer, offers the following remarks:

Twenty years ago we had information coming into the command post from a few portable radio sets, even at the big incidents. It was easy to deal with, but it was never complete, you never got the big picture. Today, we have radios, cell phones, thermal imaging cameras, and helmet cameras that go inside so that you see the same thing your people are seeing. You have helicopter feeds and even drones flying above a big incident scene. It’s really remarkable. But the bottom line is, we need to be able to handle all this information. If we can’t, it’s useless, even worse than useless because it can take our focus away from where it needs to be. And that’s where I think the Incident Command System and NIMS haven’t caught up yet. So the issue today isn’t that we can’t get enough information to base our decisions on, but that we have almost too much information and we can’t get through it fast enough to make timely decisions with.

Communications during large-scale disruptive events are almost always problematic from a technical standpoint, and challenging to keep track of because there is so much of it. Yet while the information flow is often overwhelming, informants agree that the communications network must be properly managed, and that the command team leader is responsible for assuring that it is. While offering suggestions, Informant 51 sums it up:

The team leader can’t possibly monitor or analyze even a fraction of the incoming and outgoing reports over the radio during a big incident. If he’s smart, he’ll use at least one of his co-commanders to keep track of the big picture and manage the communications net. He should also consider using one or more responders or even 911 operators on loan from the county to work with that commander and to listen for and record all important communications.

6.2.1.2 Knowledge of the Lexicon

Communications and informational skills, according to Informant 39, a long-time fire officer and fire academy instructor, include the ability to “speak a common language with all other public service agencies, especially fire, police and EMS.” He adds that knowing the

lexicon of one's sister agencies and officials "helps immensely when trying to obtain their cooperation at a busy incident scene." Informant 58 agrees that knowing the particular jargon of the public safety agencies is important, but beyond that, a good incident commander will also attach "real importance" to what is said. Fire officers, in his experience, have often listened to the concerns and advice from police and EMS officials at the command post, and then quickly disregarded it.

6.2.2 Command Presence

"Much like in the military, emergent leaders have confidence in themselves, they have patience, and they are analytical thinkers about the problems at hand. They are able to keep calm under pressure, even when others around them are nervous and uncertain. They can proceed through logical decision making steps" (Informant 11).

"I've always measured a good incident commander by how calm or excited they get on the scene. Can you, as you say, keep your head while those around you are losing theirs? If they don't get rattled, even if things are going badly, then I see a good leader" (Informant 23).

Somewhat unexpectedly, the nebulous concept of *command presence* took precedence over all factors except informational and communications skills. As informant 22 suggests, command presence involves "the manner in which the command team leader acts in front of the other members of the team." Informant 58 agrees. "It's a way of carrying yourself, a body language. It's the IC acting and looking the part of the leader." Informant 9 says that an officer

with command presence has a way of “getting everyone’s attention and reassuring everybody that they’re in good hands.” Two other informants elaborate:

Has the leader put himself in a situation where he is really in command and control? Does he have that command presence that tells everyone at the command post that he’s the one in charge? He’s got to demonstrate that he has control of himself before he can control others or lead an incident command team (Informant 62).

Demeanor is huge, since that leader sets the tone for the incident, even on the radio. If he's yelling and screaming on the radio, it just amps up everyone on the scene. But if he maintains a calm perspective and demeanor and doesn't get excited, and is able to issue coherent orders with some stability, I look at this person as a good choice to coordinate the work of the unified command team (Informant 44).

Informants use a number of adjectives to flesh out the concept of command presence, and Informant 8 comments that team leaders should be “confident, decisive, and able to express themselves naturally.” Informant 15 offers agreement when he adds that “real leaders have that ability to get their message out in the self-assured way that inspires confidence in their decisions.” Informant 6 adds that “the confident leader inspires others to action, and assures them that their decision making abilities are sound.” Informant 34 suggests that “even when they are all dressed alike, with no command vest or other identifying markings, it’s easy to spot the one with that command presence,” adding that “members of the media often go right to the person who looks like they are in charge.”

The research finds that *decisiveness* is a common element of command presence. Informant 4 explains that decisiveness is displayed both in giving commands and carrying them through, as well as by “sticking to your guns by not changing the course of action too quickly.” Informant 37 adds that “the decisive IC has an obvious confidence to lead,” tempered with “the knowledge of when to defer to others.” Command presence, as Informant 31 suggests, involves

being “calm and collected” as reflected by ones voice on the radio, thereby instilling confidence in the decisions of the command team.

Informants are quick to contrast the positive attributes of leaders who espouse command presence with those who lack strong leadership characteristics. Informant 30 is adamant in his opinion that “weak leaders vacillate; they are ‘wishy-washy.’ Their voice over the radio has elements of uncertainty that make everyone on the scene question their competence, or worse, fear for their own safety.” Informant 23, a county official with extensive command experience, elaborates:

Weak leaders, and we see them often in our travels around the county, have very little control over themselves, their command team colleagues, or the incident scene. Very little organization is in evidence and responder safety is compromised. At their worst, they permit freelancing²⁰ on the fire scene. We've brought to the attention of some of these weak leaders the unsafe practices we've noticed on the fire scene. And as shocking as it is today, we get responses that say in effect, ‘well that's the way that department, or that officer, operates, and I really can't do anything about.’ I want to shake him and say but you are in charge of the incident command team. Throw them out if you have to. Send them home. Tell them to go back out their apparatus and leave the scene.

6.2.3 Establishing a Climate of Collaboration

“An effective command team leader has the ability to build rapport with, work with, and assimilate information with unfamiliar chief officers who arrive at the command post from other departments” (Informant 28).

“You’ve got to be able to work through others, to talk through all the options for action” (Informant 73).

²⁰ Freelancing is a term for taking actions that haven’t been directed by a higher authority. It is considered a violation of the chain of command and a major safety concern.

Informant 22 posits that for collaboration to succeed, the leader must demonstrate that his or her command post colleagues have an equal say in the decision making efforts of the team, even while allowing for the fact that the leader with legal authority has additional responsibilities. He explains:

If five of us are located at the command post, and I'm the leader, it's not going to be unified command if I don't allow the other four to be equal stakeholders. That's not unified command. Instead, it's really a bastardized single command system, and I might as well not set it up at all, because I'll get no benefit from it. Unified command means that we all stand together, we succeed together as a team or we fail together. We can't do that if I start establishing some chain of command within that command post. But at the same time I also understand that since it is my community, I have the ultimate responsibility on my shoulders for the control of the incident. So at the end of the day, I know that I am the one legally on the hook for the outcome. And this in my opinion may be the biggest barrier to forming that true unified command team for most leaders.

6.2.3.1 Assessment and Assignment of Command Team Members

“The best leaders will utilize their people's strengths” (Informant 67).

According to domain experts, good leaders have the ability to recognize the unique abilities of their team members, and to divide the work of the command team accordingly.

Informant 38 remarks:

To me the ultimate command team leader is the person who can assess, quickly, the skills and abilities of the others so that they can make the proper assignments at that command level. If you have an incident commander who makes a bad assessment, or backs down from the loudmouth, or starts giving responsibilities to those at the command post who can't handle it or who won't carry through with their responsibilities, to me this person is a poor choice for team leader and their action will cause the entire incident to start breaking down.

6.2.3.2 Fostering a Collegial Environment

An examination of the semi-structured interviews verifies that an open, collaborative climate is crucial to the work of a unified command team. As informant 55 suggests, allowing

full participation is the best way to obtain buy-in from the team and to get the greatest number of ideas and options from everyone.” Informants also make frequent mention of the human relations skills needed to coordinate the efforts of a small team of decision makers. The following are examples:

They need to be cordial with others and levelheaded in their dealings with everyone at the scene. In today's world you can't just say, ‘this is my fire and this is the way we’re going to do it. Or say ‘it’s my way and I don't care what you say.’ That's not going to get it done, especially when dealing with officers from outside your immediate mutual aid network (Informant 39).

People skills are huge, because you are dealing with multiple egos and attitudes at the command post. Sometimes you don’t know the other officers at a big command post, and as the leader you need to be able to pick up quickly how they are going to react to curve balls that the incident throws their way. The leader has got to trust and understand these people to use them effectively, and can’t get upset or distracted by them (Informant 56).

The IC has got to be a people person, able to work with and manage people. Not just competent at technical skills, but competent at getting things done with other people. The selling of an idea, and giving an order without really making it seem like a command, these are the leadership traits needed by that lead incident commander (Informant 22).

Informant 71 stresses that the leader should build a collegial environment among the team members at the command post, “even though the operational segment of the incident is best managed in a hierarchical, military style fashion to assure safety and unity of purpose.” According to Informant 10, this participative atmosphere is best attained by assuring that everyone’s input and ideas are heard at the command post, with special attention paid to “bringing out the thoughts of the officers with weaker personalities.”

Informant 56 notes that command team leaders should be prepared to interface and collaborate with those outside of their “public safety comfort zones.” Accordingly, he advises the potential team leaders to “develop the skills and tact” to “collaborate on a professional level”

with utility company representatives, officials from volunteer agencies, concerned local business professionals, property owners, technical specialists from industry, local politicians, town managers, or others who might interface with the command team.

A Note on Ego and Personality

Informants offer differing opinions on the ideal personality for the team leader, but there is broad agreement that the ability to interact effectively with command post colleagues is closely tied with the ability to deal with one's own “emotions, reactions, and motivations” (Informant 55). Two other informants add:

It's important for all command team members to check your ego as you get out of your [vehicle], because having an ‘I'm in charge attitude’ might work ok with single command, but not very well with unified command. If you bring your ego to the command post, it will be difficult for you to ask for help or to accept it when you need it most. And when others know more than you do about a particular problem, your ego can have serious consequences for the incident, because they might not be in the mood to share (Informant 30).

Some ICs, to their own demise, will argue that ‘this is my sandbox and we're going to do things my way,’ despite the Incident Command System's best practices or the suggestions from more educated officers, or even in the face of an incident going rapidly downhill. These individuals should never set up a unified command team, because it is one in name only (Respondent 6).

6.2.3.3 Engendering Trust, Respect, and Integrity

“The command team leader doesn't have to be well liked, but better be respected as a person of integrity, as someone who is trustworthy” (Informant 16).

Trust, respect, and integrity were terms mentioned often by informants discussing important elements of a collaborative decision making atmosphere. Informant 62 feels strongly

that the team leader needs to command the respect of the members at the command post, the sector chiefs, and any others working on the operational end of the incident. He remarks that “The best leaders always seem to have the respect of the people around them, which makes it much easier to sell a certain strategy or tactic to them.” Informant 13 agrees and states that the person who rises to the top of the command team will almost always engender the trust of other command team officers. Informant 68 maintains that “You have to trust those around you at the command post. If you don’t, how will you be able to let them help you manage the incident?” Informant 25 adds, “Trust is a two-way street. Just as the lead guy has got to be trusted, that leader had better be able trust the other incident commanders with the work he assigns them to do.”

6.2.3.4 Remaining Receptive to Team Input and Incoming Information

“A good leader takes input from all members of the command team to formulate the incident action plan. Over the years I’ve had lots of officers who’ve made me look very good as the lead incident commander” (Informant 45).

An examination of this research suggests that the success or failure of incident management hinges on the lead incident commander’s ability and willingness to *accept information* from command team colleagues, from technical specialists, and from operational sector chiefs. Informant 5 praises team leaders who can “recognize that everyone has a say, and that their ideas may be very important.” He adds that the ability to assimilate the ideas of other on-scene leaders is “what differentiates the limiting nature of single incident command from the management possibilities of unified command.”

Informant 12, a fire service officer and private sector management trainer, provides a number of insights regarding command team input. He cites the importance of allowing each team member the opportunity to offer suggestions without fear of criticism, and stresses that all ideas must be valued and that advice must be accepted or rejected without the *biases* of the lead commander coming into play. “A leader listens to his people and implements their good ideas, even if they clash with his own.” Informant 12 warns that command post members will “know when they are being patronized, or give lip service,” and will quickly stop offering their input. In a similar vein, other informants remark:

The group leader has to be able to accept the ideas of the team, yet be ready to disregard it if it doesn't further incident goals. So it's a delicate balance of not giving 'lip service' to other team members and at the same time being tactful but decisive on the ultimate course of action (Informant 55).

Not every idea or suggestion is a good one. Or maybe the ideas are good but not appropriate to the current situation. The command team leader walks a delicate balance. He can't accept every idea, but he can't reject them all either, or the other command officers will just start to feel 'why bother' (Informant 61).

If the IC is hesitant to take advice, to take suggestions, the rest of the group will be able to tell immediately. I've been in a situation where several members of the command team have conducted a minor 'mutiny' by ignoring that IC, just like he ignored us. Then a clash of who could get their message out to the firefighters began. I realize how stupid and dangerous that was now, but at the time we were angry that he wouldn't listen to our ideas (Informant 24).

6.2.3.5 Selling the Strategy with Enthusiasm and Tact

Informants agree that consensus is the ideal situation for unified command team decision making, yet they acknowledge that complete agreement on strategies and tactics can be difficult to achieve. As Informant 75 remarks, “There comes a time, and it will come quickly at a fast moving incident, when the lead IC needs to make a decision that some of the team will disagree with.” Informant 18 discusses the importance of “salesmanship” on the part of the leader:

Unified command team leaders need to be salespeople as they propose their strategies and tactics. They need to make a strong case for what they want to do next, especially if it involves a change in operations that are already underway. If they can't, then no one at the command post will buy into it, they won't really help implement it, and this doubt will quickly spread to the sector leaders. So if team leaders really believe in what they propose, then they need to make the rest of the team believe it as well. Only then will they put their full energy into making it succeed.

6.2.4 Specific Incident Expertise

In a somewhat unexpected finding, over half of the informants think that generalized leadership and management skills are more important than specific knowledge regarding the unique properties on a large-scale emergency event. They suggest that the lead commander need only possess a *broad understanding* of incident operations. With the aid of the command team, as Informant 40 suggests, the leader should be able to “keep the entire incident in front of him,” without discerning the intricacies of every ongoing assignment. Informant 33 indicates that the leader should perceive “how the pieces fit together” to assure that everyone's efforts are moving in the same direction; toward resolution of the incident. Two comments illustrate these beliefs:

The primary skills of the incident commander at a unified command post lie in his ability to *inspire, coordinate, communicate, and keep the team on mission* [Emphasis added]. Of course he needs to be aware of the technical aspects of what the responders do, but not to any great degree. He has his whole command team for that, and if he knows what he's doing, he'll utilize their knowledge as much as possible, and concentrate on leading the way (Informant 28).

It's like an officer in charge of a military unit. He doesn't need to understand the specifics of how all the equipment works or what the common infantryman knows. He does need to know how to employ that equipment and personnel in the best way possible to get the job done (Informant 58).

In contrast, two other informants discuss the minority view:

I like somebody who's knowledgeable, because often you see people who might be good managers and can communicate well, and they may even be good leaders

who others will follow. But they don't have good knowledge of the situation, of what is required on a true emergency scene. Or they don't understand the nature of the incident, of the hazards involved. We're talking about life safety here, and I'd rather have someone who is knowledgeable, even if they're less of a leader or manager (Informant 67).

I think knowledge and experience on the part of the command team leader is one of the most important qualities, along with the trust factor that builds up over time, because of past experience and past performance in large-scale incidents. The leader should be known as someone who can be trusted to command the incident because of what he knows about the situation, and what he knows about how to deal with the problems the responders face (Informant 25).

Informant 57 cites an emblematic case involving a commercial business district fire punctuated by life safety concerns:

Since I was in charge, I had to ask myself a series of questions to determine if everything was being coordinated. How is the ventilation of the roof tied to the efforts of the fire attack crews who are advancing hoselines into the structure? Are search and rescue efforts being properly coordinated so that those attack crews protect the stairwells and any other means of egress? Are we making the critical mistake of combining an exterior with an interior fire attack? Are we staying far enough ahead of the fire so we can save as much of the businesses as possible? These are questions that ran through my mind, and that we discussed as a command team, as the fire grew in intensity. At a complicated scene like this one, it would have been easy to lose sight of our goals, or for us to issue conflicting orders that would have set our forces to working at cross purposes, with devastating results for human life and property.

6.2.5 Critical Thinking: The Appraisal of Information and Ideas

“Be wise enough to recognize what is good advice and what isn't” (Informant 38).

This study indicates that the unified command team leader needs the ability to look at everything from multiple perspectives before moving forward, but while not expending a lot of time doing so. “As [the leader] you need to filter and process information and decide what you

really need to do versus what everyone is telling you that you should do. You always get more advice than you need, and you need to determine which pieces are really important” (Informant 36). The research also suggests that it is important for the leader to properly *organize and prioritize* incident information, and to consider it with an open mind. The leader should also exhibit the “ability to give and take suggestions, and think creatively” (Informant 26).

Semi-structured interviews detail the importance of the team leader’s ability to analyze the information contained in reports from the operational sectors, as well as the ideas and suggestions from his or her colleagues collocated at the command post. Informants indicate that because of the rapidly changing nature of most large scale emergency incidents, the leader needs to “process the information quickly and decide if it’s important enough to act on” (Informant 25). Once the analysis is complete, a decision should be forthcoming. Other informants offer the following remarks on the personal make up of accomplished critical thinkers and rapid decision makers:

They must have the knowledge and skill to act and think quickly, and they must be decisive. They must be quick decision-makers. They can't be hesitant. They can't display hesitancy to their subordinates. But they can't just make their decisions without really taking a look at what's in front of them, either. They must listen to the radio, and to what people are telling them face-to-face, and to what they see in front of them with their own eyes (Informant 9).

As leaders of an experienced incident command team, the other chiefs at the command post expect and demand a lot from us. They expect us to be able to sort through a lot of information; much of it useless or not pertinent to the situation. They also expect us to carefully consider their recommendations and act on them one way or the other. Then they demand that we be decisive without being irrational or reactive in terms making those decisions. They expect us to look at all the options, all the pros and cons of the situation. And they can put a lot of pressure on us to accept a certain option over another; they'll argue for their position, as they should. Of course, unlike a nonemergency situation, we rarely have much time to do this. We don't have hours, days or weeks to make our decisions. We've got minutes or seconds, and we'd better be able to think through the situation quickly and sensibly (Informant 33).

The good leaders need to take the experiences of their entire careers and use those to make decisions. Not in a tunnel vision way, but by looking at the effects on the entire operation. The leader needs to be able to conduct a rapid intellectual analysis, using the cues and indicators that the incident is providing. But knowing what we know about Recognition Primed Decision Making, that leader might automatically assign an action to a cue based on what they've done before. We know this is an almost automatic process, and it doesn't take into account the fact that no two situations are exactly the same. So that leader has to really think, really consider the effects of the decisions the team is about to take. It can't be just automatic, and this is where the good leader uses the rest of the command team, as a check on quick – and maybe bad – decisions (Informant 72).

Informants also describe how unified command team leaders should be able to appraise the ideas of the team and have the confidence and strength of will to steer the group toward the favored course of action, with the goals of the operation always in mind. Further, when it becomes necessary to reject the recommendations of one or more team members, the leader should “be tactful, so as not to take the other officers out of the game by implying that their ideas have no merit” (Informant 14). Informant 19 agrees and adds that if the leader is not careful, “a brash or condescending attitude toward the ideas of others will quickly shut off the flow of ideas and leave that leader back, in effect, in single command.”

6.2.5.1 A Proactive Disposition

“The lead IC steers the group toward taking control of the incident, not being taken control of by it” (Informant 70).

Part of the command team leader's repertoire includes the acumen to stay ahead of incident developments. Complex emergencies are never stable, especially in the early stages, and rapid change poses serious challenges to even the most experienced command team. What sets the good IC apart in such situations is the ability to “stay several moves ahead of the fire, or

the haz-mat, or the flood, or whatever the situation might be” (Informant 61). Similarly, Informant 9 touts the “talent to think ahead” and to “urge his command team to do the same.” Informant 53 is another who argues that the lead IC “has the task of getting everyone at the command post thinking of what’s going to be needed during the next phase” of the incident. Two other informants echo these comments:

The kind of incident commander I like to work for has the ability to be proactive, to foresee future needs and not just react to what the incident does to them. Far too often we see reactionary management and reactionary tasks given. That's very frustrating as we try to catch up when we should be ahead of the incident (Informant 12).

At the fire scene, you can tell how the IC is doing by the equipment laying around and unused on the ground. Most incidents around here are monuments to failed tactics, and the evidence is in the stuff that has been tried and failed and now is discarded. So the good IC will have a minimum of equipment deployed and in use, because he planned ahead and knew what he needed. The bad one will keep trying new things as he gets further behind (Informant 70).

6.2.5.2 Receptive to Changes to the IAP

“When someone says, ‘listen, X isn’t working, so we’d better try Y,’ you’d better able to accept that” (Informant 2).

Informants stress that the members of unified command teams need the flexibility to change course when it becomes obvious that the current plan of action isn’t working well. Yet they also suggest that this is not an easy thing to do once a particular course has been set for incident operations, especially among those teams which are unaccustomed to working together.

Informant 27 says of the command team leader:

He has to be flexible; not locked into one course of action. Able to change the tactics he uses to salvage the situation. Able to change the entire incident action plan if he sees fit. Open to alternatives, both early and well into the operations.

When new information arrives, the command team should be ready, in the words of Informant 40, “to have plan B or C ready and waiting, with the resources on hand to put it into action.” Informant 19 is another expert who asserts that it is the leader’s responsibility to guide the team in the direction of change when new information makes it necessary to do so:

You need an open mind that allows you to make strategic and tactical changes to the incident action plan when things aren’t going well. This means gathering all the information you can to make an informed decision and you must be able to use your command team and your sector leaders as your eyes and ears. You must rely on them to gather that information and get it to you in an efficient manner. And you must trust their information and take it in and process it to recommend a new course of action. You must be able to listen and take advice as you make joint decisions.

6.3 INFORMANT COMMENTS: EVALUATING THE EFFECTIVENESS OF THE COMMAND TEAM LEADER

Most of the domain experts interviewed for this research have had occasion to lead a multi-agency unified command team, and they offer some comments on how they would determine leader effectiveness.

The leader of the unified command team really functions as an information conduit almost as much as a decision-maker. The decisions are probably really being made at the lower levels of the command structure. At the upper management structure-unified command team-we're trying to be like conductors of a symphony orchestra. We try to make sure that everyone is playing not just from the same sheet of music but also from the same bar of music. Rather than, you're on the same page of music but you're two bars ahead of me or behind me (Informant 49).

I equate a good incident command team leader to a very good pool player. They talk about pool players who are able to think three shots ahead. ‘This shot will be able to get the ball here, but I don't want it to be here for the shot after that, so I must take a different shot first.’ That's the kind of thing that goes through a good leader’s head as he tries to stay ahead of the situation (Informant 38).

As an effective leader, you can't be the kind of person who lets ego get in your way. It's especially important at a large incident to be able to take the opinions of others. Just telling the team what you want to do without asking their ideas isn't going to work well for you, and you can tell very quickly if this is the case at the command post (Informant 17).

They have to be people people. They must be able to work with and manage people. Not just competent at command skills, but competent at human relations skills to be able to work with command team members who come from different backgrounds and have different ideas and attitudes. They've also got to be good at selling their ideas and at giving an order without really having to give a command. Those are the key leadership traits needed for that lead incident commander (Informant 14).

It's the body language of the incident commanders. It's their personality and demeanor. Do they appear like they know what they're doing, that they understand what they're involved in? Do they want to do the job, want to lead? Do they care about their people? Are they calm and collected, or are they screaming and out of control? The commanders who don't display command presence are the ones who will be ignored by their colleagues at the command post (Informant 23).

6.4 CONCLUSION

Chapter 6 builds on the concepts discussed in Chapter 5 regarding the dynamics of unified command team formation and collaboration. It analyzes the information garnered from the 75 semi-structured interviews as it relates to the emergence of a leader from among the members of a unified command team; how one person rises to facilitate – and in certain cases to direct – the work of the team as strategies are developed and tactical decisions taken.

The most likely avenue to command team leadership during major events in Allegheny County remains largely unchanged from decades past; the legal authority emanating from the political sub-division in which the incident takes place. While this often results in less than optimal management, the informants of this study suggest that *expertise* is rapidly gaining and

may someday supplant jurisdictional authority as the primary means of leadership emergence. Organizational pathways include the type of incident (fire, police or EMS) and the existence of formal or informal agreements among the agencies within a mutual aid network. Human characteristics affecting leadership emergence include personality type, experience in a particular type of incident, and years of command experience. Another, and more recent trend described by domain experts is *deference* on the part of inexperienced officers to those of greater knowledge and expertise, in spite of jurisdictional concerns.

Chapter 6 also conveys the strong yet consistent thoughts of practiced emergency managers about the key characteristics needed by unified command team leaders. Communications skills were mentioned frequently as the most crucial leadership skill of an effective leader. Communications during large-scale events are always challenging, and a good leader is able to establish and maintain a comprehensive network while gathering and disseminating the right kind of information.

The concept of *command presence* was another frequently mentioned characteristic, and is exhibited by the leader who displays confidence, remains calm in the face of adversity, can quickly analyze a set of alternatives, and can issue decisive orders that inspire confidence throughout the operational arena. Effective command team leaders also establish a collegial and participative atmosphere within the command post, have good knowledge of incident command guidelines, can assess the abilities of colleagues, and can *sell* their strategies. The best leaders also display a proactive quality that keeps the team focused on the future.

Chapter 7 builds on Chapters 5 and 6 by considering the ways in which unified command teams utilize communications techniques to gather and process information which will is then utilized to inform their goal-setting, problem solving and decision making efforts.

7.0 INFORMATION AND THE COMMAND TEAM

“Communications is everything at a big incident, and it’s always the first thing that fails” (Informant 2).

“The command team can’t make decisions that will keep them ahead of the incident without a steady flow of good information arriving at the command post” (Informant 30).

Comfort (1999) postulates that real-time, specific information provides the assistance that incident commanders need as they formulate their incident action plan and initiate their strategies and tactics. This chapter examines the communications systems and methods utilized by Allegheny County’s regional command teams in their quest to obtain a clear understanding of the environment at the scene. First, the merits and shortcomings of the county’s incident communications and information systems are debated. Next, the actual techniques of information collection and analysis are discussed. Finally, the practical aspects of how these systems inform decision making are listed. A discussion of incomplete or fragmentary information is included in the discussion, as are the concepts of *situational awareness* and *common operating picture*.

7.1 INFORMATION AND COMMUNICATIONS SYSTEMS

“The most effective communication is face-to-face, but that’s not really practical. Portable radios are great but at big incidents there are too many radios, usually operating on the same frequency. Cell phones are good, but have severe limitations in coverage and noise” (Informant 7).

One thing the analysis of semi-structured interviews makes clear is that comprehensive communications networks, and the information they provide, are critical elements in the effective management of regional disruptive events. Just as clear are the expectations among regional experts that large-scale incident communications networks are bound to suffer serious difficulties at some point during the operation.

Richard Gasaway (2009, p. 451), in his research into situational awareness on the fireground, uncovers several elements that add complexity and have the potential to compromise emergency scene communications systems. These include:

- Missed radio communications
- Verbal versus nonverbal communications
- Incomplete communications loops
- Radio equipment malfunctions or incompatibilities
- Multiple radio channels
- Radio network overload
- Crew inability to communicate by radio
- Misinterpreted words or phrases.

Analysis of semi-structured interviews finds broad agreement with Gasaway's (2009) ideas about the difficulty of maintaining effective on-scene communications networks. Informants describe how radio systems often become congested during large-scale emergency operations, how face-to-face reporting becomes impractical, and how the use of alternative techniques – often employing new technologies – can't cope with the communications requirements or physical environment of major events.

Deficiencies in incident communications systems adversely affect team decision making by preventing critical information from being received by regional command posts. Comments from informant 12 touch on some of the main concerns about communications methods:

First I'd like to say that no type of communication is helpful if it is not clear and concise. We're supposed to have common terminology and the 'hey you it's me' clarity. But the promised clear and concise communications system is still not there in Allegheny County. So this is where face-to-face information and communications clears up a lot of misunderstandings. Face-to-face is the best without a doubt, and it's obviously a strength of the unified command concept, as the incident commanders can discuss their issues in person. But at the rest of the scene face-to-face is impractical and can even be a dangerous time waster. So the command team must conduct its large-scale communications via radio with the operational forces. But the radio has its own set of problems, since everyone has one but it's often impossible to control the transmissions because everyone feels that they have something important to report.

7.1.1 Radio Communications

“Everyone has a radio, and everyone wants to talk. So no one gets through” (Informant 64).

“Even today, radios create big headaches. They fail in cold weather, can't transmit to the outside of the structure, and confuse our firefighters with all the control knobs and buttons. Sometimes I think two soup cans and a string might work better” (Informant 5).

“Radio technology hasn’t kept up with modern incident command needs, but we have no alternative but to use them for most of what we do on the scene” (Informant 15).

Radio communications, which carries the bulk of incident information to and from the command post, becomes an essential, if problematic, tool during large-scale operations. Yet while informants are dubious of radio system shortcomings, they acknowledge that there are few viable alternatives at present. Informant 2 notes the utility and ease of radio use. “It’s instantaneous; you key the mike and talk to whoever you need to, instantly.” As informant 36 maintains, “there are too many of them anymore, but overall, when the system is working well, the radio is still the most convenient and practical way to manage a big incident.” Informant 21 remarks, “Radio communications are always going to be the primary form of communications because with so many operational teams, face-to-face contact becomes impractical.” Striking a similar chord, Informant 25 adds:

We do use the radio of course, and as long as you have people to give you what you need instead of constantly chattering, and give it to you on a timely basis, it is still very effective. On the large incident scene, and as it gets larger, the radio becomes less useful. When the fourth report comes in about the same exact thing, it starts to lose its effectiveness entirely.

7.1.1.1 Impairments in the Radio Network

While acknowledging that mobile and portable radios provide the most accessible form of communications for operations during major events, informants describe how the technology is hampered by both human and mechanical shortcomings. Informant 1, for instance, mentions “gaps and excessive static” in radio coverage in certain parts of his town which prevent the establishment of a comprehensive and effective on-scene communications network.

Informant 30 relates a radio hardware problem: “Because of the very large amount of information passing between the command post and the operational units, the radio network becomes overcrowded and the messages are clipped or not received at all.” Informant 17 discusses a human shortcoming: “Because we don’t do this every day – especially the volunteers – the anxiety level is high and adrenaline causes operator error with the radios. It’s easy to change to the wrong frequency, or turn your volume down all the way without realizing it.”

According to Oh (2010), communications at large-scale emergency events often break down due to “a lack of planning and procedures” for a collaborative communications network. Informants attest to the truth of this statement when they describe instances of chaotic communications at large-scale events in which extended mutual aid networks are engaged. Two informants discuss:

When we have really big fires, we call on departments that respond from long distances because of manpower shortages, and we hardly ever work with them. So they don’t understand or follow our radio communications procedures. In fact, many of them don’t have much radio discipline at all. So we get this constant chatter from them, and it just adds to the already overcrowded radio frequencies (Informant 60).

The police, fire, and EMS agencies in our surrounding area are all very good, very practiced at radio communications, especially in knowing when to communicate and when not to communicate by radio. The agencies we request from outside of our area – especially the rural volunteer fire companies – may or may not practice good radio protocols. As soon as they approach the scene they begin calling command for instructions and talking to each other. It doesn’t matter that they can hear ongoing transmissions from the scene. They just talk right over them. And this is in spite of the fact that we tell them to report to a staging area and stay off the air (Informant 9).

7.1.1.2 Use of Tactical Radio Channels

The use of separate frequencies, called tactical channels, is one way to overcome the radio overload factor and distribute communications along functional or geographic lines.

Informant 68, a fire chief, states that “with too many radios on the scene, I don’t want all units on the same frequency.” Informant 55 adds, “At any large incident, you must operate on tactical channels, or the radio will become overloaded and useless.” Informant 3 elaborates:

That’s why we started going to tactical channels. That way if you have the search team, the ventilation team, and the attack team on one frequency, you can put the staging area and the water supply group on another. We make sure there is one officer or member from each crew who is designated to report back to the command team. It’s really helped make the radio a friendlier tool for us, but you’ve got to be able to monitor and manage all the frequencies you’ve set up.

Yet breaking the scene into tactical channels offers no panacea, and presents an additional set of problems for the 911 center, the command post, and the functional units, as Informant 21 remarks:

Radios are a double-edged sword. You want all of your firefighters to have a radio but the problem is that everyone wants to be on the radio. We recently started using tactical channels to overcome this difficulty at any large incident. We’ll put different parts of the scene, like front or rear or east or west, or sometimes different functions, like fire attack, ventilation and search and rescue, on different frequencies. But it’s important that a member of the command staff – or someone at the command post – be monitoring all the different frequencies. They’ve got to keep track of overall communications and should take notes about what’s going on. But even this works only if the troops are properly trained in radio discipline and they’re sure which frequency they’re supposed to be on. If not, it’ll become a hindrance to effective communications and cause massive confusion, no matter what you do (Informant 21).

7.1.1.3 Training and Radio Discipline

“I tell them ‘don’t turn your radios off, but if you’re not the team leader, turn them way down.’ That’s the only way to cut down on all the radio chat” (Informant 38).

The informants of this research lament the lack of *radio discipline* among the county’s emergency responders. The manifestations of radio discipline, according to domain experts, include: speaking on the radio only when necessary, listening to the entire message, pausing to

receive an acknowledgement of one's transmission, asking questions if an order is unclear or fragmented, and remaining cognizant of important or emergency transmissions from other operational teams. Informant 30 adds:

Of course we rely tremendously on radio communications, even though the larger the incident is, the more people who are going to be on the radio because they feel that their message is important. I train my guys that unless they're in charge of the sector to turn their radios all the way down. Carry your radio in case you need to call for help or in case of other emergency, otherwise you're just going to create a radio squeal and overload the radio net.

Informant 49 mentions his fire department's efforts to train firefighters in efficient radio communications:

Now we try to instill very strong radio discipline on our people – on our officers and firefighters. We tell them to monitor the frequency, but don't talk unless they absolutely have to. We tell them that we give them all radios for that reason, to listen to the traffic to find out what's going on. But even though we practice this, it just can't be simulated during a drill. So it all works very well until we have a big incident, and the training goes out the window. Everyone talks and no one can get a word in.

7.1.2 Face-To-Face Communications

“In some cases it's better to just send a runner from the command post to deliver and obtain important information, because the radio frequencies are all tied up” (Informant 16).

“Face-to-face is the best type of communication. You're getting the best picture of what's happening, and more importantly, you're seeing how that person is acting and reacting” (Informant 2).

“When a crew comes out of a building, I like to talk to them face-to-face. There’s nothing like that first hand description of what’s going on from a team that just exited a structure. It’s much better than the short reports they could give while they’re busy working inside” (Informant 43).

While informants to this research are in broad agreement that face-to-face meetings are the most accurate and precise means of obtaining and circulating information, they admit that this method of communications is difficult during major events. As Informant 45 stresses, face-to-face meetings prevent the misunderstandings and confusion that are common when trying to communicate over congested radio airwaves. He also stresses that the ability to accurately gauge body language and facial expressions is highly worthwhile as a check on command team decisions. “It’s nice to see what the person looks like when you’re talking to them. If you suggest something and they have an absolute look of horror on their face, then maybe it’s not such a good idea.” Of course the limitation is that face-to-face communication becomes impractical as the incident grows.

7.1.2.1 In-Person Reports to the Command Team

“Face-to-face discussions give you important visual clues from sector chiefs. It’s all in their mannerisms and their manner. Their faces say it all, and I can tell how things are going before they say a word” (Informant 16).

Many experienced incident commanders prefer that one of the tactical leaders of the operation, usually a sector chief, pay a visit to the command post to brief the team. Informant 38 explains that the sector chiefs can give their message to the entire command team at once, and the team members can ask individual questions pertaining to their specialized areas of expertise.

Sector leaders are then able to return to their functional duties with clarity about the strategies of the command team. As informant 68 mentions, “Meetings at the CP clear up a lot of misunderstandings about changes in tactics and strategies, and you just can’t communicate that sort of thing accurately over the radio.”

7.1.2.2 **Representatives from the Command Post**

Busy tactical level sector chiefs can’t always break away to give briefings at the command post. In such situations, informants put forward that sending one of their *own* command team members to the operational sectors offers an acceptable alternative to radio communications. At times this method is preferable to having the officers visit the command post, as the following informants suggest:

When you go to a sector, you see firsthand what’s going on. There’s no ‘filter’ or ‘best face’ that the sector chief can give you. It’s all out there in front of you. You’re seeing firsthand how that sector chief is acting and reacting, and how the workers are responding. Their mannerisms are important clues as to how the operations in that part of the scene are going. It’s also the best way to be sure that the sector is on task (Informant 30).

At this kind of big business district fire, the command post is still fairly close to the scene, probably across the street. If we send one of our [incident commanders] to, say, the sector three side of the building, he’ll come back and explain to the rest of us what he’s seen. That face-to-face interaction is the best. Obviously we’re not going to lose anything in the radio transmission since we’ll be in direct communication. More importantly, we’re going to know this guy and we’ll know by his body language and facial expressions, and by the way he’s presenting the information to us whether he thinks the situation is getting better or worse. It’s easy to tell if he is concerned or not; we can gauge that by the way he’s presenting the information to us (Informant 43).

7.1.3 Supplemental and Specialized Communications

Oh (2010) explains the need for systems that will aid incident commanders by using advanced technologies which can “facilitate the processing, transmitting, storing, and extracting” of large-scale incident information. Analysis of the semi-structured interviews, however, indicates spotty and uneven use of such methods to supplement radio and face-to-face communications in Allegheny County. Informant 16 remarks that some newer technologies have been tried and found to be inadequate, while others have been placed into service but are now obsolete.

7.1.3.1 Mobile Phone Technology

Cellular phones have become ubiquitous in society, and the technology has readily been adapted to emergency scene operations, both in voice and text mode. Interview data reveals an increasing level of communication using text messages between command teams and sector commanders. “We use text messaging quite often, not necessarily on scene but away from the scene. We may text people for information, especially in regard to technical expertise” (Informant 45). Smart phones that are able to bypass crowded radio networks are also useful as methods of communicating privately with others on the scene, or when personal information needs to be kept confidential. Comments from informants are illustrative:

Cell phones and texting are practical for direct and private communications with the sector chiefs, as long as they’re outside the building where they can see or hear well enough to use cell phones, of course. We might also use cell phones or text messaging between the CP and other officials – like the town manager or road department superintendent – who are not on the radio net. And we can still monitor the airwaves while we have that more direct communication with other people (Informant 71).

There is tremendous value to cell phone use at these kinds of major incidents, and they’re the perfect tool for a command team. Someone at the command post can

run the cell phone communication with a list of important numbers and with specific tactical communications. Because face it, you may not have the ability to get any radio airtime to get your message out. I think this is an easy way to utilize today's technology to gain important information (Informant 38).

I've been in situations where the 911 center or someone from one of the sectors has told one or more of us to check our phones. And there we had texts of important information. In one case it was the addresses of additional businesses and residences affected by a severe storm. Radio would not be the best way to send information like this, and a secondary means such as smart phones may be better. This is also the case with sensitive information that we don't want over the radio waves. Maybe it's a person's name, or especially when it's a victim's name, that we don't want to go over the air. Or maybe it's a hazardous chemical that we don't want the media to know about yet. And the nice thing about texting is that it's there for you and you don't have to call back to get any missed information, like you do with the radio (Informant 18).

7.1.3.2 Mobile Command Posts

“Having a mobile command post with full communications capabilities is a godsend at a large incident. It lets us gather and send important incident information in a ‘place of sanity,’ without the noise and constant interruptions of being outside” (Informant 18).

Command vehicles provide important adjuncts for information gathering, analysis, and dissemination during major emergency operations. Informants laud the usefulness of these mobile units – which feature comprehensive communications capabilities – in forging collaborative decision making teams. In addition, command vehicles provide a quiet and climate controlled meeting space for the command team, telecommunications officers, and technical specialists to perform their work.

The Allegheny Department of Emergency Services maintains two mobile command posts, either of which may be utilized during significant planned or emergency events. Informant 38, a fire instructor who has delivered the county's mobile command posts to

numerous events is a proponent of their use. He remarks that the vehicles “facilitate the process of getting information to the command team, and helps the team to distribute it across the operational scene.” Several of the county’s political sub-divisions also maintain command vehicles of some type. Informant 45 explains that one fire department in his area provides its own “command bus” with a full radio and cellular set-up and its own e-mail function which can be utilized to send and receive information as needed (Informant 45).

7.1.3.3 Systems for Emergency Dispatching

“With CAD systems and MDT terminals, the future is here” (Informant 70).

Most domain experts interviewed for this research are strong proponents of modern technological advancements to supplement radio hardware and provide enhanced communications capabilities. Paired with Mobile Display Terminals²¹ (MDTs) mounted in mobile apparatus, and enhanced by Geographic Information Systems (GIS), CAD is a two-way communications technology that is highly applicable to emergency operations.

In Allegheny County, telecommunications officers utilize the CAD system to dispatch public safety responders using text format. The county’s CAD system also provides ongoing updates to mobile units, and keeps track of all emergency units responding to the scene.

Informants explain the functionality of CAD:

Having the 911 CAD system, and with the MDT terminals in our vehicles, we get the dispatch information and we can see exactly what the caller told the emergency response center. Even better, we get all the real-time updates as they come in and are entered by the 911 call takers. It’s really helpful for responding incident commanders, since it gives them so much information, even before they set up their formal command post (Informant 37).

²¹ Mobile Display Terminals are apparatus mounted computers used to communicate with dispatch agencies.

The advent of the mobile data terminal is very important in mobilizing resources and tracking resources. It also provides that common operating picture to all participating agencies and responders at the incident. And it makes radio communications much less necessary as everyone has the same understanding of what's going on and they don't have to ask so many questions (Informant 9).

CAD systems let the call taker see the status of every emergency vehicle responding to or on the scene. You can also communicate with the dispatcher with your [MDT], and that lets you be a little bit more discreet in your communications. The only problem with technology like that is the possibility that it won't work, or that it'll crash or shut down when you need it most. That's the exception anymore, though. These systems are getting better all the time (Informant 51).

7.1.3.4 Specialized Systems for Gathering Information

"I'll often use Google Earth to pull up a picture of the scene for us. I like to look at the map and see what the topography of the area is" (Informant 34).

Technology designed for other emergency operations functions can sometimes be used to supplement standard information gathering systems. "We don't use the full capabilities of the available technologies we have in hand – we need to think outside the box" (Informant 18).

Informants share some examples:

We never think about it, but our thermal imaging cameras²² can be used to send real time images back to the command post, instead of just being used by the firefighters inside the structure. Of course it has limits, but combined with other methods of information gathering, it helps present a clearer picture for the team's decision making (Informant 22).

'Go-Pros'²³ are very helpful for displaying and recording real time video of the incident. We see what our operational teams see, and that info is invaluable. You

²² Thermal imaging cameras are infrared heat sensors which can be taken into hazardous atmospheres to look for hidden traces of fire, or to help locate missing victims within structure.

²³ *Go-Pros* ARE high definition digital cameras that can be taken into hazardous situations to provide real-time video displays to the incident command post.

wear a Go-Pro on your helmet, and the commanders see what their troops are seeing. Unfortunately, it works less well when the incident grows and everyone tries to use their cell phones (Informant 35).

We like to gather information through video and photographic technology. Its cliché, but a picture is worth a thousand words. Next generation 911 will soon give us those types of capabilities, and with it a better understanding of the caller's situation (Informant 19).

We invested in lap tops and tablet computers for on-scene use. We've ordered them with an imbedded chip that allows us to see a multi-dimensional view of the scene or different floors of a building, for example. As soon as a mike is keyed by one of our responders, the display comes up (Informant 14).

A Note on Social Media

The advent of smart phones has caused an explosion of amateur reports from emergency scenes. If harnessed properly, this information can add immeasurably to the information gathering capabilities of the command team. Of course, the sheer amount of information can quickly overwhelm the team's ability to filter, analyze and utilize it. Informant 68, an active user of social media, describes how he was contacted by witnesses to a large incident covering several city blocks:

All of a sudden, my cell phone began alerting me to one text message after another. It turns out that these were bystanders, and members of my [social network] who were all around the scene. Since this was a small town and it was a Saturday, they all came out to see what was going on. Because I was so busy at the command post, I didn't have time to look at them, and I just ignored my phone after that. But when I went through the texts after the incident, I found that they had some great information that the command team could have used as we tried to figure out what to do next. But how do you wrap your head around so much information while you're trying to manage a big incident?

Other informants express hope about the potential of social media and its informational capabilities, but also puzzlement over how to harness it. Danczyk (2008) refers to this as "the

modern paradox of having access to large amounts of information but having limited time to study, analyze and use it.” His research indicates that “unstructured information” generated by new technologies is difficult to deal with because of the “type of information it creates and the volume in which it is generated” (Danczyk 2008).

7.1.4 Information Storage and Retrieval Systems

Comfort (2007) asserts that the problem solving abilities of human decision makers can be enhanced through the use of technology to create an easily accessible “knowledge base” of information. Oh (2010) concurs and adds that such systems need to include a permanent knowledge base of *past* events. Many informants agree, but are quick to echo the advice of Informant 6, who stresses that any knowledge base should be efficient, practical, and suitable to the efforts of the command team.

This study reveals a lack of use of good information storage and retrieval systems in the county, especially those which can be tied directly to regional command posts. On a positive note, several informants do indicate that local agencies are in the process of augmenting their information storage capabilities with modern software programs. These programs, which provide detailed information about specific occupancies and special hazards, are a step toward a usable regional knowledge base.

Wukich (2011) finds that public safety agencies in Allegheny County utilize the capabilities of regional dispatching centers, which serve as “repositories of available information.” Similarly, this study finds that the county’s 911 operators are particularly adept at providing specific information about mutual aid agency availability and location, as well as type and number of specialized resources on hand.

Domain experts, citing agreement with the postulations of Comfort and Oh, explain that the most practical informational systems allow incident commanders to obtain current information while at the same time retrieving stored knowledge from past events. Informant 19, a high ranking county official, indicates that the Region 13 Strike Force *Knowledge Center*²⁴ has the capabilities to provide both real-time information and archived “after action reports,” but that this system “is a bit beyond the capabilities and use of the typical unified command post.” Thus the county’s emergency services agencies continue to grapple with the establishment of an adequate storehouse of easily accessible knowledge.

7.2 INFORMATION COLLECTION AND ANALYSIS

“There will always be a lot of information directed at command. The best command teams will evaluate it and base their decisions on it. The worst will ignore it. Most CPs I’ve seen function somewhere in between” (Informant 71).

Once the communications network has been established, informants stress that the unified command team should quickly collect and organize it, scrutinize and analyze it, make decisions based upon it, and disseminate their decisions to the appropriate operational teams. Data from the semi-structured interviews reflects a strong consensus about the importance of assuring a continuous flow of appropriate incident information to the command post. To be of use in the

²⁴ The Knowledge Center is a software application used to assist incident management by providing a common operating picture and situational awareness.

decision making process, the information must be both current and accurate with regard to incident developments.

Large and complex events tend to be especially problematic with regard to the assimilation of enough information upon which to make proactive decisions. Gasaway (2009, pp. 453-456) notes that busy incident scenes have the potential for numerous communications difficulties:

- Inaccurate information
- Inability to collect useful information
- Inefficiencies in the process the information that is observed or received
- Inability to evaluate the importance of data
- Problems with the sharing of data
- Differing meanings for the same information
- Information overload.

Information collection difficulties are exacerbated by stress, workload, distractions, fatigue and interruptions (Gassaway, 2009). Additionally, emergency scene information is often limited in nature, or affected by low quality in its transmission or reception (Cosgrave, 1996). Nevertheless, a steady stream of information does arrive at the command post through a series of formal and informal reports and transmissions.

7.2.1 The Initial Report

“As the command team assembles, we need to be briefed on what the problem is, what has been done so far, and what is the predicted course that the incident will take” (Informant 72).

Once the unified command team assembles and is ready to assume control of the incident, the *initial report* is provided to them, usually by the senior officer who was present on the first arriving response vehicle. Delivered in the form of a transfer of command briefing, it forms the basis for the command team's early actions. The initial report is comprised of information that includes details of:

1. Incident *conditions upon arrival* of the first units, including the early actions taken by the first responders, along with the effects of those actions.
2. The *current situation*, including a description of how the incident has evolved, how resources are deployed and whether the tactics have been successful.
3. The *predicted near term evolution* of the incident, including advice on the need for additional resources or changed tactics.

Informant 54 sums up the information transfer expected in the initial report by explaining that once he gets to the scene, he asks the officer in charge: "What did you have when you got here? What are you doing now? What do you think is going to happen next?" While these three questions appear simplistic, the responses to them are expected to include a wealth of relevant information. When Informant 42 assumes command, he quickly determines if there is an immediate danger to life safety, and if any potential victims are unaccounted for. He also inquires about any unique or specialized hazards present on the scene. Two informants add the following comments:

I need to find out about occupancy type, nature of the incident, and hazards involved. If we are going to commit people to an interior attack, what are we sending them into? In our communities we have lots of potential hazards with chemical industries and rail traffic. So anything that might jeopardize the safety of

our personnel has to be at the top of the list as far as gathering information (Informant 45).

Generally, the information we need is the same in almost every case, with minor variations, whether it's a fire, haz-mat, or rescue situation. How big is it in size, scope and complexity? What resources are already on the scene, how many are in route, and what else do we need? Once we have these details, we can get to work (Informant 19).

Domain experts feel strongly that the information contained in the initial report is crucial for the unified command team's subsequent actions. The following questions illustrate the type of information sought by command team members as command is transferred to them.

“What other resources are needed? Where is the fire? How is it progressing? Is the structure sound?” (Informant 1).

“What did the initial crews see? Are the tactics working? Is the situation getting better, staying the same, or getting worse?” (Informant 5).

“We need to know what the situation is now, and extrapolate that into the future. Where will it be in the next fifteen minutes or the next hour?” (Informant 30).

“What are the biggest problems? What might be the next big problem? Is there a secondary hazard? Is there a structural issue or something else I can't see?” (Informant 12).

“Will we need any large-scale evacuation?” (Informant 18).

“At something specialized, like a chemical plant, I need to know what the specific hazards are, if there’s any danger to our personnel, and if technical specialists are on the way” (Informant 56).

“Is the situation under control? Or is it getting out of hand?” (Informant 60).

“What is the position of all units currently working in the hot zone?” (Informant 54).

“How are we set for the long term?” (Informant 73).

Armed with the initial report, “the team can then flesh out a course of action and request an appropriate level of personnel and equipment to manage the incident” (Informant 25). The initial report also establishes the basis for the command team’s incident action plan, which they may adjust based on the evolution the incident, as reported to the incident command team through regular progress reports.

7.2.2 Ongoing Incident Progress Updates

“Sometimes you have to pull teeth. You have to keep asking and asking over the radio for the crews to give you an update. That adds to the problem of too much radio traffic, but you need the information so there’s not much else you can do” (Informant 70).

The command team needs a constant flow of accurate incident information in order to make effective decisions. According to an analysis of the interviews, most incident information is gathered from *ongoing progress reports*, which are sent by the operational teams at the scene of the activity. As Informant 3 explains, “we rely on our crew leaders to be our eyes and ears to

tell us what's going on, and we build a picture based on these reports.” Most progress reports of this type arrive at the command post in the form of radio messages, sometimes supplemented by face-to-face contact.

Emergency responders are trained to provide their supervisors with progress reports regarding the results of their assigned tasks as the operation progresses. Using incident command principles, this information is channeled by having the members of one crew report to one supervisor, and having that supervisor report to a sector leader, and in turn to the command post. It becomes important for the UCT to focus on key information from these progress reports:

I don't think any piece of information should be ignored, but during a large scale incident it needs to be prioritized. Messages that are complete or urgent need to be addressed first, while those that are not complete or not clear need to be investigated further prior to basing decision making on them. Decisions should be based on incident goals, and on potential hazards to personnel, and we need good information about these. Unfortunately it often comes to us at the command post along with an overload of non-critical messages. How we sift through it and investigate and prioritize it is really what makes the big difference in management, but often times it is quite difficult to do (Informant 42).

As discussed in Section 7.1, the proliferation of portable radios means that almost all responders operating on the scene have one on their person. Beyond the technical difficulties of radio overload, this situation also causes *information overload*, as Informant 27 explains:

We get too many emergency workers sending messages over the radios with information they think is really important to command, but turns out to be not very important information at all, and it just clogs the airwaves and prevents the important stuff from getting to command. Worse, the information that does get through – the unimportant stuff – takes time to sort through. There's just too much of it and it slows down the command team's decision making.

To help control and limit the massive quantities of information generated by a major incident response, the scene is often organized and sub-divided into geographic or functional

sectors. Communications is collected and disseminated between the command post and the sector leaders. Informant 62 explains that sector organization is particularly helpful during major fire service operations, which would be “impossible to manage if every single crew or crew member started sending their own messages to the command post.” Informant 13 is another domain expert who feels strongly that sectored communications are superior, “because otherwise, everyone on the scene might key up their radios and start sending messages that would never be received.” Informant 15 agrees and elaborates:

When it comes to efficient fireground-wide communications, I think it's best to set up divisional or functional groups. That way we can make sure that the team leaders are the only ones talking on the radio, unless of course it's an emergency call, like a ‘mayday.’²⁵ This really cuts down on radio frequency overload and gives command an opportunity to really listen, to gather that information. And this set-up is just as efficient for sending information back out to those operational teams.

7.2.3 Maintaining Situational Awareness

“Assuming that we are bound by Recognition Primed Decision Making, we as the command element need steady streams of information to provide the cues we need to make effective decisions” (Informant 30).

Experienced incident commanders interviewed for this research stress the importance of gathering enough information to attain situation awareness on the part of the command team. The difficulty lies in maintaining that information flow. In his research, Gasaway (2009) found

²⁵ A *Mayday* is a request for help from, or on behalf of a lost, injured or otherwise incapacitated emergency responder.

that SA is the key to effective decision making, especially under conditions of uncertainty and stress.

Initial and ongoing incident reports are methods of achieving and maintaining good situational awareness, as officials strive to understand what has occurred previously, what is occurring now, and what might occur in the near term. Informant 19 suggests that situational awareness is best maintained by focusing the command team's attention: "The crews operating closest to the fire get first priority on the radio from the incident commanders, both in us listening to them and giving them the most critical information first."

Wukich (2011) argues that maintaining operations on the same frequency helps create situational awareness through a more comprehensive sharing of information. Informant 43 agrees and provides a practical example of how to obtain information from sector officers:

It's very important to utilize sector officers to gather accurate and timely situational information. In fact we'll take those active sectors and put them on different frequencies. The command team still monitors the main frequency, but at least the fire ground activities are on a separate channel. We can then assign certain command team members, all experienced officers, to assure that we're monitoring all of the tactical channels closely. That way we can control and manage some of that excessive radio traffic, which gives us a big advantage as we try to maintain situational awareness in real time (Informant 43).

Yet in spite of the NIMS requirement for interoperability between radio systems, many agencies in Allegheny County continue to operate with incompatible frequencies and operating systems. Informant 30, recognizing this fact, opts instead for a face-to-face approach to SA.

I don't trust different frequencies. There's too much potential for confusion and missed messages. To get the information I need, I send 'runners' to the rear and sides of the structure to see what is going on out of the view of our command team. I also have these runners speak to the sector chiefs and any team leaders they encounter. It's always surprising to me to see how much good information you get this way, and it's instructive when you realize how much important information is never transmitted over the radio net to the command team (Informant 30).

7.2.4 Incomplete Information

“You’re going to have multiple communications at a major incident scene, and the same groups are going to be calling you again and again over the radio to make sure they get their message through. They step all over each other, and incomplete information to the command post is the inevitable result” (Informant 30).

“Sometimes you have to pull teeth to get the complete picture. You’ve got to keep asking the crew leaders what is going on inside. That causes even more radio congestion, but you need the information to make decisions” (Informant 16).

Semi-structured interviews clearly demonstrate that the most effective incident command teams require – and utilize – accurate and timely information upon which to base their decisions. These interviews also testify to the fact that information received at the command post is rarely complete or comprehensive. Informant 42, an experienced fire and EMS chief officer, offers an example of the hazards of incomplete information:

During the hurricane Ivan flooding, the command team was trying to compile a list of residences in danger of flooding people in those residences. One address kept coming up and we thought that we had searched it and cleared it. We asked ourselves, why does this address keep coming up? As it turns out, we found that this was a double lot which included a designation of ½ at the end of the house number. So this was a house behind another that we missed completely. Given the same situation again I would investigate it a little more closely once I received the clue that one address came up twice.

Informant 17 hints to the fact that incomplete information is analogous to the phenomenon of “too much radio traffic – too much chatter.” He adds that all too often, “one team begins a report before another finishes theirs.” In a confused environment like this, incident

commanders must try alternative methods of building the incident picture they need to take actions that influence the course of affairs on the scene. Informant 56 remarks that he uses “runners” to and from the command post to get an idea of “what is going on” with the tactical units. Informant 15 also feels that using runners is the best alternative to a congested radio, as a way to complete the informational picture.

Informant 3 remarks that if he has not received adequate replies to his queries, “I’ll be much more direct when asking for a report on the second try, because it might be that I haven’t given precise instructions, or haven’t made it seem important enough to the busy teams working inside.” Informant 61 states, “If I don’t get what I need from the first team, I’ll call another team to find out if the first crew is okay, and to see if they can give me what I need.” Other informants have similar views:

If I’m getting a partial message, I’m going to make sure that I get the complete picture. If I have an able-bodied person with me to send out for a ‘face-to-face’ with the team leader or to act as liaison, I will take the time to do that. It may be the case where I need to send one of the command team members to get that face-to-face contact and of course come back to consult the rest of us (Informant 6).

Members of the command team should take turns doing a ‘360’²⁶ of the building or the scene. If the scene is too big to do a 360, someone from the command post should be dispatched to cover the opposite side of the incident, preferably an aide to the command team. This person should operate on a separate channel with a direct line to the command post to give the team that second set of eyes (Informant 58).

It’s a matter of deploying eyes and ears – whether it’s one or two physical bodies out there doing a reconnaissance or communicating face-to-face if necessary. They may need to be put onto a separate radio channel to report directly back to the command. Or do a reverse 360 of the scene and report back to the command post. We can’t always rely on the radio, though. Face-to-face is still good form of

²⁶ A 360 is a procedure where a command team member circles the incident, taking note of the conditions on each side.

communication on the scene. The alternative is not getting information (Informant 19).

Informants stress that complete and prioritized messages should be addressed immediately, while those which are incomplete or unclear need to be investigated further prior to basing any decisions on them. Additionally, Informant 42 notes that the more meticulous the command team is in “sifting through the information overload” and prioritizing its attention based on that investigation, the more likely it is that they can complete the picture. Yet he also acknowledges that at a busy command post such careful sorting of data becomes extremely difficult because of its volume.

7.2.4.1 The Role of the 911 Center

Informants speak to the need for the Allegheny County 911 Center to actively monitor all emergency communications to assure that the incident commanders don’t miss any critical information:

It's important for the dispatchers at the 911 center - and Allegheny County's operators are very good, for the most part - to listen to the radio for ongoing reports from the scene. Good telecommunications officers are more than just people who dispatch a response and forget about it. They can pick up reports that incident commanders miss and relay those messages to command. They may be able to hear garbled, incomplete, or missed communications. That second set of ears helps so much. But it takes a good dispatcher. And sometimes, when we request – and they give us – a tactical fire frequency to switch over to, we lose that advantage as the 911 operators can’t always monitor these tactical frequencies (Informant 18).

Telecommunications officers working at the 911 center need to stay on the line and listen for reports. And they need to listen to all of the fireground frequencies, or they can miss critical information, such as a crew calling for help. You see these tragic incidents all over the country. But it takes a good dispatcher to monitor the main and tactical frequencies. If not, we lose them since they don’t monitor it (Informant 1).

A few months ago County 911 heard our water supply group say that they'd run out of water due to a malfunctioning fire hydrant, and that the crews inside would soon be out of water. Incident command missed the message, but the 911 dispatchers took it upon themselves to announce this and tell all teams to evacuate the structure. Now some chiefs might disagree with their action, but I say that those were well trained dispatchers who were paying attention and were concerned for responder safety (Informant 2).

7.2.5 Analyzing Information for Key Intelligence

“One of the problems I see with young ICs is that they don't utilize information to assess conditions at the incident scene” (Informant 19).

As information arrives at the command post, it is scrutinized for details that can aid the problem solving and decision making efforts of the team. Informants discuss the need for the command team to analyze key parts of the information they receive in order to make prompt and accurate decisions. Two informants elaborate:

The most critical information is something that's going to prompt me or the command post to take some type of immediate action, whether it means changing strategy, or moving on to a further point in our current strategy. Anything that prompts some type of action by command is needed and should be sent to command in the most current manner - as it's going on. And for the most part it does, although crews can be very busy and you may have to prompt them. So if they can't tell me that they've started the fire attack, I expect them to at least tell me when the fire is knocked down (Informant 2).

As an incident commander, I'm looking for benchmarks. I don't need to know every little thing that's occurring. I need to know that entry is made, the fire has been found, the attack has been started. I need to know the effects of the suppression, ventilation, or rescue operations - that type of pertinent information. 'Division one is clear,' or 'fire attack is not making progress and it's getting hotter,' or 'we found the victim,' or 'ventilation is complete.' These benchmarks allow me to track actual results of our decisions; whether the plan is moving forward. It's also important that it's not delayed information or secondhand information that's been filtered (Informant 2).

Toward those ends, Endsley (2001, p. 4) suggests the use of “cognitive task analysis,” a process of determining which aspects of the incoming data are more important by focusing on the *goals* of the operation. Applying Endsley’s theory to the emergency scene, the command team’s informational use should revolve around the three most common incident priorities:

1. Life Safety
2. Incident Stabilization
3. Property Conservation.

Using these three incident priorities as focal points, command team members can classify information according to its relevance, and give salient data special attention as it arrives at the command post. Even so, the many radio, face-to-face, smart phone and other incoming reports can quickly overwhelm the command team’s ability to evaluate it. Selecting the “right information,” from among so much incoming traffic, “becomes almost impossible as you try to sort through all the ‘noise’ to get to what’s really important – the information we need to make decisions that can make or break our operation (Informant 13).

7.3 APPROACHES TO INFORMATION DISSEMINATION

“I’ve personally been at command posts where the chiefs are working very well together and coming up with great tactics. The only problem is they don’t get their message out” (Informant 20).

“It’s just as important that the tactical sectors receive information from the command post, especially when it could impact their safety” (Informant 55).

Once mission critical intelligence has been received and analyzed, it is incumbent on the command team to pass along tactical instructions, safety information, and other key data to the operational sections arrayed at the scene. Domain experts express much concern about this phase of the communications process, as all efforts at data collection will have been wasted if the communications cycle is not completed by proper dissemination of information.

7.3.1 Processes of Information Dissemination

Informants describe a number of factors which can prevent the proper circulation of information throughout the scene of a large emergency event. The same barriers that plague information collection – notably overloaded radio networks – are also at work while the command team tries to disseminate its message. “Transmitting information from the command post is challenging when every firefighter has a radio that they want to use” (Informant 18). In addition, experienced incident commanders caution that instructions should be well thought out and messages prepared prior to transmission.

Overcoming dissemination shortcomings, according to informants, is a matter of collaborating on sensible decisions and transmitting clear, concise radio messages and following up with sector leaders to assure that instructions have been received and understood. Informants offer suggestions for successful information distribution:

First, the command team must speak with ‘one voice’ from the command post. They must be in unison about their decision and their radio transmissions – their orders – must reflect that agreement. Any uncertainty on the part of the

commanders will be reflected in how that information is received and acted on by the operations units (Informant 38).

Hasty messages are the ruin of many command teams. The pressures of incident command are powerful and can cause the command post to issue premature decisions and incomplete messages. But crews are savvy, and they can usually tell immediately if they're getting 'fly by night' orders that haven't been well thought out. Contradictory messages are another problem. If the command team sends out one message and quickly countermands it with another, it's a sign of confusion. Again, it shows that they're not thinking before they transmit their messages (Informant 6).

Clarity is the suggestion I would give to any young incident commander. The fireground is a noisy, stressful, and confusing place. Send out short messages that are to the point. Don't use codes and don't get cute by trying to talk too much or use big ICS terms that you learned in a classroom. Tell them what you want them to do and give them any safety warnings you have. Then shut up and wait for them to acknowledge your message (Informant 5).

At the other end of the command post's transmissions, the tactical units need to receive the messages in order to act upon them. Those operational teams should be alert for incoming radio traffic, as Informant 1 remarks. "Everyone operating at the scene has a radio. The command team provides the information they need and it's their responsibility to listen for it" (Informant 1).

Distributing information to the tactical operations sectors is most often undertaken over the radio, and through the same sectored structure that is used to collect information. Informant 69 explains:

I think it's dependent on how many people are operating at the scene. If I have critical information at the command post and I want to disseminate it, the fastest and most efficient way is by radio, as long as we have clear open channels to communicate. But the information must be disseminated to the sector commanders first. They will then disseminate it by radio or face-to-face to the crews working under them.

Finally, the Allegheny County 911 Center can be utilized for the dissemination of urgent messages, as informants describe:

If it's a critical piece of life safety information I believe it needs to go out to the County 911 center preceded by an alert tone - "everybody clear the air." And unfortunately it all depends who is working at the Center on any particular day. In [our area of the county] the ranks of the 911 dispatchers include a number of firefighters and having them working your scene is very comforting (Informant 18).

We may have to say something like, 'all units from command, clear the air, attack team one - go ahead with your message,' or, 'search team two – give us a situation report.' If we can't obtain a clear picture of where our units are operating, what they're doing, or how much progress they're making, the 911 dispatcher can echo the command message of a request for a situation report. If we've received an incomplete message that indicates one of our teams is in trouble, we can have the 911 center announce, "All units, report PAR."²⁷ So if used properly, the 911 center can be a tremendous asset in completing our informational picture, especially when it comes to safety (Informant 45).

7.3.2 Common Operating Picture

"We as incident commanders have what is called situational awareness – knowledge of what is going on throughout the scene. But we must transmit this information to the crews to assure they understand the overall plan – that's how we create a common operating picture" (Informant 13).

Akin to situation awareness, which provides the unified command team with an understanding of the incident, the concept of common operating picture (COP) assures that this knowledge is circulated throughout the incident scene, and that all agencies and operational units share the same knowledge of equipment distribution, location of personnel, and incident management strategies (AHIMT, 2007).

²⁷ A PAR is a personal accountability report, which is used to assure that each crew is still intact, and is in at least visual contact with one another.

Experts, such as Informant 3, speak to the difficulty of maintaining a common operating picture when the airwaves are crowded with transmissions: “It’s a lot of work, with all the radios and all the frequencies and all the agencies involved in a big incident. It’s hard to get everyone on the same page.” Informant 23, a longtime incident commander and fire instructor, explained the difficulty of maintaining a COP at large multiple jurisdictional incident scenes:

The common operating picture is very difficult to get out to everyone and I don't know if I know the complete answer to it. One of the problems is that most fire departments don't operate at large incidents in a unified command post every day. They're used operating in a small single command, day in and day out. Everyone on the scene understands that. Now we add a number of other titles that go along with unified command in addition to the general confusing nature of a large incident and it's easy to see why not everyone understands the big picture. The lower officers often don't understand the entire flow of the strategy and tactics. Because quite often they're used to *one* unit officer calling command for orders, and now there's someone up above that level or someone in between. And after the switch, they may not know who to call to disseminate their information or to make some kind of request. For instance, the group leader is used to talking to the incident commander, and doesn't understand that he or she must now talk to an operations section chief. They are used to the single incident commander being that go to guy for everything - for all requests for answers. The typical firefighting team is not used to going up the ladder very far, and so the common operating picture suffers.

While assuring a common operating picture is difficult, it is not impossible. The following informants, both of whom are highly experienced fire chiefs, offer their solutions for maintaining COP for all responders:

Since the incident commanders are together, we have a constant relay of information among one another, so that's how we maintain that common operating picture among ourselves. This picture is not as easy to share with all of the sectors, especially at large and confusing incident scenes. So when there is a break in the action or when we are pausing to switch gears, we regroup and have the briefing. At that point we can bring in sector commanders and whoever else needs to know the information that we need to get to them. To assure we've transmitted a common operating picture throughout the scene, we update these sector leaders by briefing them and keeping them apprised on the overall progress of the situation. We'll explain how our action plan is working, and what is going on in the other sectors – that's the big picture. Next we'll get their input, their

suggestions. We also make sure they know how their sector – their part of the operation – fits in to our overall strategy. As they return to their sectors, they'll brief their troops as necessary. This helps to build both a common operating picture for everyone at the scene, and also increases our situational awareness of sector activities (Informant 44).

Personally, I will temporarily transfer my lead role at the CP and travel through my sectors and talk to the sector chiefs and ask, 'Okay, what's going on? What do you need? Do you understand what we're trying to accomplish?' I can tell by their facial expressions if they get the picture. I can also detail a trusted member of my command team to do the same, but whatever the case, there's no better way to get our message out than in person (Informant 49).

When crews are coming out, it's important to get their information and then recycle it by disseminating it to the crews going in or other crews that may still be working in the structure or at the incident. The difficulty is that not every crew is going to come out and check in with the command post. Hopefully at least the team leader or representative will do so before they go into rehabilitation. Sometimes we can hold the crew leader for a minute and have him brief the crew that's about to enter. That way there's no second hand information passed, and they know exactly what's going on and what they're getting into (Informant 52).

7.4 INFORMANT COMMENTS: EVALUATING THE EFFECTIVENESS OF UCT COMMUNICATIONS AND INFORMATION PRACTICES

Informants offer a wealth of opinions about evaluating the effectiveness of the command team's communications and information processes. The following comments are typical examples:

Communications up and down the line is the best measure of command team effectiveness. Is the command team really listening? Are they absorbing the information that they are receiving from their troops? They can't be so hell-bent on their own course of action that they disregard reports that suggest their strategy isn't working. They have to be able to accept information that tells them that they need to change their tactics (Informant 53).

I can't stress enough that communications is key to joint incident command. How are they communicating? What are they communicating? You have to be able to communicate not just with each other but with the functional groups and divisions

that are doing the work on the scene. They have to be able to give and receive information, and I look at if they're really doing this (Informant 48).

I take it one step further and listen for radio feedback. If they have a strike team or a task force doing something and the tone of their voice changes drastically upon being given the task from the command team. That tells me that the crews are in disagreement, and that maybe the command team isn't paying attention to their progress reports. So if I see frustration directed at the command post, and the command team doesn't react to it, that tells me that the team needs to reevaluate their communications, because it's obviously one way only (Informant 9).

7.5 CONCLUSION

Chapter 7 considers the use of systems of communications and information by UCTs in Allegheny County. Informants describe how comprehensive communications is a vital, but difficult to attain, piece of the incident command puzzle. Hardware shortcomings, along with human anxieties, often prevent the command team from achieving the situational awareness they need to decide upon and carry out the best decision options. Similarly, systems of information gathering and retrieval have not yet become prevalent during the management of large-scale events in the county, and this adds to the challenges of accurate decision making.

The chapter opens by describing commonly used techniques of information collection and analysis, and the advantages and shortcomings of each. Radio communications are by far the most prevalent method of communications during major regional events, and few practical alternatives to it exist. Yet the fact that most, if not all, responders are equipped with their own portable radios leads to a situation of radio frequency overload that prevents the proper transmission or acknowledgement of critical incident communications. The use of additional – or tactical – frequencies is complicated by the dilemma of monitoring multiple channels in a

chaotic environment and the associated danger to responder safety arising from missed requests for assistance or calls for help from lost or injured responders.

Face-to-face contact was ranked as the best form of on-scene communication, as well as the least likely to be misinterpreted. Yet as an incident grows in size, in-person contact becomes less practical, and the command team will often request a direct face-to-face report from a sector chief. If conditions preclude such a meeting, a member of the command team can be dispatched to investigate the situation in person. Specialized technologies are becoming more commonplace, but have not yet displaced the more common forms of incident communications.

Information flows into the command post as a series of initial and ongoing incident reports that the UCT must sort through and analyze. To deal with the often overwhelming amount of information, a UCT leader will often task one or more members of the team to gather, filter, and process it. As the team grapples with the problem of attaining situational awareness of the environment, it must often deal with information of an inadequate or incomplete nature.

Information storage and retrieval systems are available, but these have not found their way into the typical unified command post in Allegheny County. Instead, informants suggest that command team members rely on each other's knowledge and experience as a kind of knowledge repository, supplemented by the assistance garnered from the county's 911 center.

Chapter 7 concludes by considering processes of information dissemination, which are plagued by the same hardware and human difficulties as information assimilation. It also describes efforts by the command team to disseminate a common operating picture across all operational sectors at the incident scene. In the next chapter, the research findings of chapters 5 through 7 are utilized in an effort to understand the collaborative decision making processes of command team members.

8.0 DECISION MAKING BY UNIFIED COMMAND TEAMS

“At the joint command post we bounce ideas off of each other. All command team members are receiving the same information, and everyone is processing it at the same time” (Informant 5).

“While I’ve never seen formal votes taken, the actual decision making process is most often a case of majority rule, with the occasional vocal disagreement” (Informant 41).

Chapters 5, 6 and 7 describe the means by which collaborative command teams are formed, how leaders rise to the lead roles, and how incident communications systems are utilized to gather, analyze and disseminate information. Chapter 8 proceeds to the most significant sub-question of this inquiry by investigating the actual decision making processes employed by unified command teams. In this chapter, informants discuss how command teams consider options and make decisions regarding incident goals, strategies, and tactics. This chapter also includes an exploration of single versus joint command, the incident action plan, the facilitators and inhibitors of collaborative decision making, the use of incomplete information by command team members, the role of technical specialists, and an introduction to decision making aids.

8.1 ELEMENTS OF SINGLE AND UNIFIED COMMAND

An analysis of semi-structured interviews confirms this study's assumption that the decision making process of the single incident commander varies significantly from the small group problem solving dynamics at work during unified command operations. Yet no matter which method is utilized, decision making at the emergency scene is often problematic, and negative outcomes may be reinforced as positive ones:

In the fire service we often have a wide range of education and experience and training levels. As commanders, everything we've done in the past melds together to determine what we're going to do now – how we're going to make decisions as a team. And even among the group, it's often a gut reaction based on what we've seen or done in the past, very similar to what the single IC does. This is true whether or not what we've done in the past has been correct. In the fire service this phenomenon will take place even if we've done things wrong – even if our tactics have been terrible and we've lost a building. And this may lead to reinforcement of incorrect decision-making procedures and incorrect decisions being made at a large incident. We will often go back to the fire station and congratulate ourselves on our ingenuity, while all we really have done is to repeat past mistakes - things that have gone wrong before that we have now internalized as successful operations. We didn't get fired, no one got hurt, and eventually the fire went out. At the end of the day all fires go out no matter what we do (Informant 13).

8.1.1 Attributes of Single Command

“Using single command, decisions can be made quickly, since resources and personnel are limited, and since the incident is usually small and fairly simple to deal with” (Informant 66).

Informants' Analysis of semi-structured interviews advance the notion that decision making by single incident commanders is often more intuitive; based mostly on training and previous experience. As postulated by Klein's Recognition Primed Decision Making model,

incident commanders, when faced with familiar situations, will usually apply tactics that have worked in the past. As Informant 18 describes:

The single incident commander uses instinct and gut reaction to make decisions based on experience. He has seen a similar scenario or has tried similar tactics and they have worked in the past. This will continue from one action to another, one emergency scenario to another, since he feels it is a safe bet that the same actions and orders will work again. And he won't change direction or try something new until the old tried and true tactics don't work anymore.

The single IC can make decisions more rapidly, since there is no need to collaborate with anyone else. Yet while quick decisions made by one person might be the correct ones, Informant 9 suggests that solitary decisions cannot be taken with the confidence level obtained by group problem solving efforts:

As a single commander I might say 'this is something I've seen or tried before and I'll try it again,' and while that's a fast process, I tend to second-guess myself. I very quickly wonder if I've overlooked something important. With a team around me, I can feel confident that someone will point out any errors in judgment before they're translated into bad orders.

Informant 30 cites Recognition-Primed Decision Making as a limitation on the single IC model of command when he posits that large incidents often present problems that have not been seen before. Since the single IC has no experience with the matter at hand, he or she will not recognize the cues that would lead to the application of some previously tried strategy or tactic. This informant also puts forward the prospect of information overload as an even more basic difficulty as the single commander grapples with a rapidly escalating incident:

You could have all kinds of information coming in over the radio and in face-to-face reports, or even from drones flying overhead that provide you with live video feeds. But if you can't keep up with all of it, it becomes worse than useless since it will only confuse you and make you hesitate to make any decisions, and cause you to second guess the decisions you do make. This is a major weakness of single command during major operations.

8.1.2 Attributes of Joint Command

“It's not really a long drawn out process. Unified command lets us identify problems, propose solutions, and debate alternatives very quickly. The team approach lets us gather information quickly and move to a decision quickly (Informant 64).

Unified command transforms single command into a group process where stakeholders from multiple agencies and political sub-divisions share the decision making authority (Danczyk, 2008). Unified command “blurs the lines of responsibility” for agencies with different geographic, legal or functional responsibilities, and allows them to collaborate on a “common set of incident strategies and objectives,” under a single incident action plan (Danczyk, 2008). As Informant 51 remarks, “Unified command gets everyone on the same sheet of music.”

Domain experts agree that both single and team management of an emergency event have their place, depending on incident size and complexity. Accordingly, the interviewees are in broad agreement that during the type of regional emergency considered by this study, unified command teams offer the most effective incident management structure.

The single incident commander uses his experience to make decisions, using visual clues and the reports that he receives. With one person, there isn't much time to think about too many options, so the decisions come quickly. Where there is a group of commanders, they usually attack the problem more comprehensively, usually from several different angles, based not only on the things they see and the information they receive, but also by talking it over with their colleagues at the command post” (Informant 14).

Danczyk (2008) postulates three of the most important advantages of unified command: one set of [incident] objectives, a collective decision making approach, and an improved

information flow. The informants to this research help to bear out Danczyk's claims, as the following comments illustrate:

One set of Objectives

The incident may have started with three agencies, or three fire departments, all setting up their own operations, doing their own things, what they think is best, but working at cross purposes. Unified command brings all these folks together under one tent and forces them to come up with one plan that they can all work toward. Instead of wasting resources by duplicating efforts or working against each other, they can now coordinate the efforts of everyone on scene (Informant 27).

A Collective Decision Making Approach

When you get into a real unified command post and you have these other very skilled individuals in there with you, you can now start thinking about many different options, really exploring them. Now you have four or five others helping you with your strategies and with the logistics of a major incident scene, things that would overwhelm the single IC. With the group behind him throwing out different ideas and pointing out important incident needs, the command of the incident truly becomes efficient and the commanders can cover a lot more ground, and quickly (Informant 19).

Improved Information Flow

Three or four incident commanders, located at the same place, with all the radios nearby, is a magnet for all the reports coming in from the operations sectors or from anywhere else on the scene. Everyone knows where they are and how to get in touch with them and the team doesn't miss the information, or get it second hand like they would if one person at one location had to relay it somewhere else. It also prevents different officers from sending out their own orders from different locations without coordinating with each other. And the last thing is that they can all look at the reports together and talk to each other about it before they make any decisions (Informant 18).

The evolution of a single incident command operation to a group process is not always an easy one. The command of an incident normally begins with the highest ranking officer of the first arriving response units, and may remain with one person as chief officers of progressively higher rank reach the scene and assume command. Once unified command is initiated, the single incident commander becomes a part of a team and must be able to work with other officers in a

collaborative way; a situation that he or she might not find easy to accept. Informant 6 illustrates this difficulty with a historical analogy:

I liken it to the bomber pilots you read about in World War II whose planes were severely shot up over Germany. Even after it became obvious that there was almost no chance of making it back to England, these pilots refused to admit that they couldn't bring their aircraft home. Sometimes they would even have their crews bail out but they themselves would stay with the aircraft, never admitting that the enemy had gotten the best of them. Sometimes they made it back, but often they didn't. Incident commanders can be like that. They are in charge of an incident, say the type of business district fire we've been talking about. And just like the aircraft where systems are damaged and a series of cascading failures occurs, this fire grows beyond their capability to control it. Yet they try to continue to maintain control of the responders and all the resources by themselves, not admitting that they can't do it alone. Sometimes it works, but usually it doesn't and the incident, like that damaged bomber, goes down in flames, literally.

While the collocation of experienced incident commanders has many advantages, it offers no magic elixir for successful decision making. As Oh (2010) concludes, even collaborative teams are challenged by rapidly changing situations, and must learn from incident developments; "evolving in resilient ways" and becoming adaptive to future events. The literature and the semi-structured interview data suggest that such a transformation is highly dependent on whether the team has worked together in the past. Informant 68 discusses the situation among mutual aid groups in his area of the county:

I've been very fortunate to work with some of the best, some of the most experienced fire chiefs around. And I've worked with them for years. When we're faced with a problem, we have a system where we think about where we've been before, what we've done before, and what's worked and what hasn't. If one of us wants to try something that hasn't worked out in the past, another one will remind him. It's almost like we're brothers, like we share some bond. And I guess we do. And we only got there by working together for such a long time. I don't think you would ever see that with a bunch of officers that you just put together today.

The benefit of assembling a team of experienced officers who have worked together previously is a common theme among informants. Informant 49 proclaims, “We know each other, and we know if our solution doesn't work we need to ask ‘okay what's our next option’ and move on.” Time and again during the semi-structured interviews, informants trumpet the ability of long established teams to “learn from past mistakes and know not to repeat them when we get to the next big scene” (Informant 13).

The work of a unified command team can be more cumbersome when compared to the relatively simple decision making process used by the single IC.

Group decision making is a little bit slower, since it takes a group a bit more time to pick the best option. But at least we know that it's been discussed somewhat and people have confidence in the resulting decision. This of course assumes that we don't come to consensus too quickly and that we've discussed a lot of options” (Informant 35).

Other informants are even less sanguine. Discussing the speed of the process, Informant 38 warns that command team collaboration can result in decisions that unfold *too* slowly and that keep the team “behind the power curve,” in a hopeless effort to play “catch-up with the incident.” Informant 6 adds that a group of strong personalities, assembled in a team, might not be too quick to agree on the best course of action:

Remember, these are all experienced, self-confident commanders, with strong personalities. Disagreements in strategy and tactics are bound to occur, and while this is often a good thing, since many options end up on the table, these disagreements can easily degenerate into hostility or anger among the team members, which is counterproductive (Informant 6).

8.1.2.1 Formal and Informal Decision Making

“Typically it's an informal process, especially if the command team members have a history of well established relationships with one another” (Informant 30).

Informants describe a decision making process that is, for the most part, informal, with the group leader facilitating a participative process. In this environment consensus is usually achieved and formal votes rarely need to be taken. Of course there are instances where the group leader exerts his or her authority and makes the final decision for the group. Interesting comments from domain experts follow.

I've never seen a formal democratic vote among the command staff. I've seen ideas be accepted, but the lead incident commander almost always makes the ultimate decision" (Informant 71).

I think there is both formal and informal decision making going on. And I often relate it to the tactics that are being tried. If the tactics are working, the situation among the command team members is very informal, while on the other hand if the tactics are not working and the situation is getting worse, it becomes much more of a formal decision making process. Then we might even have to sit down and start planning two and three hours from now in a more formal way. The more complex the situation, the more involved the decision is, and the more formal the decision-making process has to be. In these cases you must have much more input from your command team (Informant 45).

8.1.3 Incident Action Plan

During day-to-day emergencies of a routine nature, it is accepted practice that a single incident commander can manage the situation without resorting to a formal action plan. The time frame is usually short and the resources are typically manageable using an unofficial, unwritten plan of attack. The picture changes considerably, however, once an incident escalates beyond the ability of a single individual to coordinate, or where resources and incident complexity converge with a substantial information and communications load.

Once the incident grows in size and requires regional resources to control, the informants of this study agree on the need for an explicit, written incident action plan, per the guidelines of the Incident Command System. As detailed in section 1.24, the formal incident action plan

describes how resources will be utilized, and includes mechanisms for setting incident priorities, integrating responder functions, establishing relationships between operating agencies, and ensuring that systems put in place support all incident management activities (FEMA, 2008).

Informants did agree that while the plan should be *written*, it should not be so detailed or rigid as to “handcuff the command team,” by limiting their freedom to consider alternatives, delay the decisions they make, or “cause needless ‘busy work’ by filling out forms” (Informant 21). Three informants share thoughts which are typical of those interviewed on the question of what a realistic IAP should look like:

With the size incident we’re talking about, the big downtown fire, for example, the command team would probably not be sitting down and writing out an incident action plan from the beginning of the operation. The things they need to do initially – directing the teams, calling for more resources – would be carried out verbally during the early stages. They wouldn’t be sitting at a table at some distant EOC drawing up plans like we would be at a full-scale disaster. And sure, a written plan will be necessary, but it can be a more informal thing. They can use a dry erase board for a good while, and if they can’t get a handle on the situation, it can become more elaborate (Informant 43).

The plan for an incident like this develops over time, usually after the initial stage of the incident has passed, and the resources are in place and additional mutual aid has been called for. Then the plan can grow as the team talks things over collaborates. As they discuss what has gone right and wrong so far, and what they’d like to see in the near future (Informant 19).

You’ve got to remember that this event will take at most a day, and probably really not more than five or six hours of real effort before winding down. The team needs a document to help them make decisions. Most people forget that. They try to come up with a plan that is nothing more than a record of what happened, not a device they can use to plan and carry out their incident strategies (Informant 58).

Many experts, such as Informant 12, stress that the incident action plan should be a fairly simple document which sets out “key goals, with a list of broad strategies and tactics.” Informants expressed a general disdain for what they consider the rigid procedures required by

the formal Incident Command System and the National Incident Management System. Informant 6 speaks for a majority when he says that “ICS forms and rules, beyond the very basic ones, were not designed with [regional disruptive events] in mind. They were designed for national disasters and should be used only at such incidents. At our local level, they only put us into a ‘strategic straightjacket.’”

8.1.3.1 Incident Benchmarks

“If you don’t have markers it’s like driving across the country with a map, but with no idea how long it should take you, or where you should stop for the night” (Informant 3).

Included in a well thought out and developed incident action plan are a set a measurable *incident benchmarks* for each goal, along with a matching set of strategies and tactics used to achieve those objectives. Informant 38 stresses the importance of tying strategies and tactics to *incident benchmarks* to assure that all operational activities are “still headed in the right direction and working toward the objectives of the plan.” Benchmarks represent important points at which the UCT can objectively assess the success or failure of their decisions, and evaluate the need to change their strategic or tactical options.

The domain experts interviewed for this research add support to the importance of benchmarks, and to the part they play in the overall decision making process. Three informants share their thoughts:

For us, a benchmark tells us two things. First, whether the work needed to complete it is done. Each benchmark is checked off as it is completed. Second, whether those efforts are having the desired effect. The benchmark for moving attack lines into a certain part of the building might be receiving a report from the interior that the fire is out. If that message doesn’t come, then something is wrong. Each [benchmark] gives us a chance to reevaluate our plan. Are the

tactics working? Do we need to change them? Benchmarks keep us from being blind to the obvious as we make our decisions (Informant 64).

If you don't use benchmarks, you won't really know where you are in the incident and if your decisions need to be changed. By keeping them always in mind, or looking at them on a written plan, you can see if the crews' work is being completed and if it has been successful or not. If it's not, then it tells you that it's time to change what you're doing (Informant 15).

I can describe many instances of tactics that were applied long after the need for them had passed, or after they were made largely irrelevant by the progress of the incident itself. I remember one command team that insisted on ventilating the roof with chain saws to make the structure tenable by interior attack crews, even after the bulk of the fire was out. If the team had used benchmarks, they would have known that the situation had passed the need for vertical ventilation, and that the remaining products of combustion could have easily been removed with smoke ejectors placed in existing horizontal openings (Informant 27).

8.2 FACILITATORS OF EFFECTIVE COMMAND TEAM DECISIONS

When asked to consider the factors that bolster the decision making processes of unified command teams, domain experts in Allegheny County allude to a strong positive relationship between the assurance of a free-flow of ideas and a willingness to vary from the guidelines of the incident action plan. An examination of the semi-structured interviews uncovers streams of thought among the informants which closely parallel the postulations of scholars who study small group dynamics and decision making under uncertainty.

8.2.1 A Flexible and Proactive Mindset

“If we've been trying the same things for a while and things are getting worse, then that better be a wake-up call for us. Let's try something different, folks” (Informant 71).

“If your team can anticipate where the incident is headed, then you have a much better chance of making decisions that prevent things from getting worse” (Informant 24).

The “balance between structure and flexibility” determines the ability of a response system to carry out its work in an uncertain and dynamic environment (Comfort, 1999). Accordingly, it has been suggested that there is a “false dichotomy” between the notion that plans must be followed to the letter, and the view that “plans cannot...account for all eventualities,” and should only be used as general guidelines to action (McEntire, et al., 2014). An analysis of the semi-structured interviews reveals considerable agreement with the latter.

Informants make clear the command team has a better chance of being successful if they use the incident action plan as a malleable *guide* to facilitate decision making, instead of a set of rigid procedures that constrain it. “You can't just say this is the plan and it's written in stone and we can't change it. If you start down one path and realize that it is not leading you where you thought it would, then you need to shift over onto a different path” (Informant 8). “You must be open-minded enough to adjust, and you should be able to do this by anticipation, before you get to a crisis or turning point in the operation” (Informant 52).

Haase (2009) asserts that a rigid set of standard operating guidelines is not appropriate for the rapidly changing environments posed by the “dynamic and non-linear nature of disruptive events.” He adds that “operational flexibility” is needed to “identify and implement creative solutions” in such environments, especially where communications systems do not provide the information necessary for SOG based decision making. Similarly, the Incident Action Plan, which may be based upon prior planning, assumptions, or the generalities of similar situations, cannot be expected to hold up unchanged in the face of incident growth.

Rather than using the IAP as a strait jacket, domain experts point to the need for the command team to be open to other alternatives as dictated by the situation. Informant 43, a chief fire officer, remarks that [the UCT] “must realize that their initial plans and strategies don’t always work out and that they must be able to regroup, to come back together and have a discussion of what is and isn’t working, and why. Informant 26 elaborates on the importance of flexibility during plan development and implementation:

When I think about the type of incident we’re discussing, the team must first of all establish an incident action plan. Now this may have started with the thoughts of a single incident commander, but it grows into a written document as the command team assembles and talks to one another. Once they come up with a plan, they must be able to put the plan into operation with the resources they have at hand. But they must realize that this plan is not written in stone, and no plan is perfect. They’ve got to be able to make changes and deviate from the initial plan as the incident develops, and this is the strength of the best command teams. It’s where they excel (Informant 26).

8.2.1.1 Anticipation of the Need for Alternative Strategies

“Always be ready to go to plan B, and fast” (Informant 10).

According to many of the informants, effective team decision making is facilitated by a proactive inclination. Semi-structured interview data illustrates the necessity for the command team to think about the future; to plan ahead from the earliest stages of the incident. Informants speak of the need for the command team to have options available that will keep their decision making “three steps ahead of the curve” (Informant 38). “Being prepared to change strategies quickly is the only way to stay ahead of the game; with a ‘plan B’ ready, you can adjust your actions before things get really bad, instead of letting incident developments dictate your actions (Informant 75). Two additional experts share similar thoughts:

Command teams often think about option A and B, but how often do they take that out to option C or beyond? When you’re dealing with an entire business

district on fire, like we're talking about today, or some similar big incident, you better be prepared for any contingency. And you'd better implement your new actions at the first sign of trouble, or that fire will pass you by very quickly (Informant 53).

Part of being proactive is to see what our back-ups are in terms of equipment and human resources, since equipment breaks down and humans can only be expected to operate in these hostile environments for a short time before relief is needed. Once you look at things this way, it forces you to call for additional resources at the outset. If you don't look at things ahead of time, by the time you realize that you need more people, apparatus, or some specialized piece of equipment, it'll be too late (Informant 34).

8.2.2 Free Flow of Ideas among Command Team Members

"I've been a part of dozens of unified command posts over the years, and there's not a doubt in my mind that the best decisions come out of the ones where everybody is comfortable enough with each other to speak their minds" (Informant 50).

Closely related to the idea that the incident action plan should be open to change is the feeling among informants that such changes are only possible if the free flow of ideas is encouraged among command team members. Informant 19, in his visits to command posts throughout Allegheny County, has witnessed this dynamic firsthand:

When I arrive at a command post, I can tell right away if they're using the advantages of teamwork. If they're bouncing ideas off of one another, if the leader is encouraging the team to come up with options, if there's no criticism of ideas and everyone is comfortable in expressing their ideas and opinions, then I see a truly collaborative team in action. Everyone gets involved. Everyone has an important part of it. And it's reflected in their ability to make good, solid decisions, even under the most challenging incident conditions.

8.2.2.1 Channeling of Disagreement

The free flow of ideas is implicit among teams of highly experienced professionals, and when this occurs among unified command teams, it is a given that some discord about strategy and tactics is inevitable. Most domain experts, in fact, feel that some conflict is a necessary part of the creative process and that it actually *enhances* the team's decision making abilities, as long as that free flow of ideas is maintained. "The good teams I've seen, for the most part, have been able to talk through any disagreements and use those disagreements to come up with new options, selecting the best ones and ignoring the worst" (Informant 62).

Conflict, according to Informant 13, is inevitable when you have an assembled group of strong personalities who are "all focused on the problem and are under a lot of stress." But he also maintains that team members "can use that conflict to bring up uncomfortable issues, like the notion that their plans may not be working very well" (Informant 13). He adds, "They disagree, but [command team members] don't attack each other. They focus on commanding the scene as well as they can and making sure that everybody goes home" (Informant 26). Informant 37 sums it up when he describes how an effective command team channels its differences into positive action:

Officers at the command post can disagree on almost every decision. I've seen it happen. But if they have respect for each other, for each other's skills and abilities, they disagree in a very professional way. At this kind of command post, there isn't any open hostility, even when they're facing a very difficult problem. They argue back and forth, making points about what they think the team should do next, and sometimes they raise their voices and almost shout at one another. Remember that these are talented people with strong opinions. But it's never personal. Once a decision is made, they move onto the next problem; never being angry that they didn't get their way, or holding a grudge against someone who argued against their plans.

8.2.3 Creativity

“If [the command team] has seen something before, it’s easy to come up with a plan of attack. But if that mental picture isn’t there, they’ve got to be able to figure out some new strategy” (Informant 4).

Haase (2009) explains that the interactions between participants engaged in decision making activities should facilitate the development of new strategies for action. This study confirms that in the face of the unexpected or unusual, novel approaches must often be formulated, and untried tactics applied. It is during the call for new alternatives, according to many of the most experienced informants, that the strengths of the unified command teams manifest themselves.

When a new or unexpected development calls for an unusual solution, the emergency management team must be able to “develop new procedures to address the challenges confronting them” (McEntire, et al., 2014). While a proactive inclination and an atmosphere that encourages the free-flow of ideas are both important, informants suggest that to achieve the highest level of effective incident management, the command team needs to use these elements as a basis for *creative decision making*.

Most day-to-day emergency responses in Allegheny County bear a strong similarity to each other in scope and in the level of difficulty of the problems presented. In fact, the resemblance of one incident to another allows for the enactment of a streamlined management approach for many public safety agencies, as manifested in the promulgation of organizational standard operating guidelines. Yet when discussing the challenges presented by major regional emergency events, informants paint a much different picture. While they acknowledge certain

similarities, especially at the outset, most agree with Informant 6 as he describes incidents of this size as “being unique in some way in the experience of most responders” and of “presenting as many uncommon problems as common ones.”

Interviews suggest that large regional events present unusual or unexpected eventualities which can prove quite challenging, even for a group of experienced incident commanders. Informant 39 explains that “just when you think you have [the situation] figured out, it throws you a completely unexpected curve ball and we ask ourselves, ‘where did that come from and what do we do now?’” Illustrating this dynamic, Informant 69 describes an industrial fire that seemed to be nearly extinguished when crews encountered combustible metals which reacted violently with water. “All of a sudden we heard explosions and half of the plant erupted in flames. We had to scramble to get the guys out and to figure out how to save the structures next door.”

Informant 30 praises the creative synergies of joint command when he remarks, “A group has a greater comfort level and is more willing to try new ideas and tactics, and are more receptive to new ideas, not just from each other but from the operational sections.” Informant 15 describes command team creativity as an iterative process where one officer suggests a course of action and the others discuss whether they’ve tried similar solutions in other situations, and what the outcomes were. The process continues in this manner, refining the alternatives until a novel solution is chosen. Informant 5 adds:

You ask about creativity at the command post, and to me it revolves around a team, sitting together, bouncing ideas off of each other. When I find myself as the sole IC, I don’t have time to be creative, to ‘think outside the box’ as the cliché goes. I have to make decisions based on what I’ve seen before, and I haven’t seen it all. No one has. But when I’m a part of a team, we all add our ideas and talk about what all of us have seen. We add it all together and we try something new. Things that we could never have thought up on our own, we come up with

together. When I look at it afterwards, it blows me away. The things a group of old hands can come up with when we get together, it's really amazing.

8.2.3.1 Brainstorming

“If the command team doesn't utilize brainstorming, they are missing out on the team's best characteristic, its real strength” (Informant 44).

An important adjunct to the creative decision making process, according to many of the informants, is the process of brainstorming among team members. Many of those interviewed share the feelings of Informant 30. “When I'm in command of a big operation, I always encourage my command team partners to offer an opposing set of ideas, or to hold a quick brainstorming session where we bounce ideas off of one another.” Informant 16 stresses the importance of a “value-free and criticism-free” environment in which to share ideas in an “open and honest way” with one another. Informant 42 agrees and suggests that focus be maintained:

For brainstorming to work it really must be judgment free, and no one's ideas should be rejected out of hand. But more than that, it can't be a shotgun approach to problem solving. Brainstorming has to be restricted to the parameters of the critical decisions at hand. If everyone is allowed to stray too far, too many opinions and options will be put on the table, most of them won't have any bearing on the real problem, and the hoped for solution will never materialize.

While the command team usually has the time to explore options, this is not to say that they have it in abundance. The incident is assumed to be growing in size and complexity as the team undertakes its work, a fact that is not lost on those interviewed. “Brainstorming must be done ‘rapid-fire,’ because the situation is probably getting worse all the time and it demands quick action” (Informant 9). Several informants allude to the time pressures which necessitate an abbreviated search for new or alternative solutions, and emphasize that on-scene developments often permit only a few moments of fast-paced discussion of those options.

Finally, informants point out the importance of open-minded *leadership* when conducting the search for novel solutions to vexing problems. Informant 17 states “Yes, brainstorming will work, but only as long as that lead IC listens to the group. Once he stops listening, the group stops brainstorming.” Informant 54 goes one step further: “The team leader has to do more than listen. He has to encourage everyone to speak up, and he’s got to head off criticism of people’s suggestions and prevent the strongest personalities from dominating the conversation.

8.2.4 Technical Specialists at the Command Post

“You’ve got to rely on your subject matter experts, your technical specialists. These people bring a particular talent or skill to the table, and they must be utilized if the team is to achieve its maximum capabilities” (Informant 49).

Technical specialists, who often serve as expert advisors at unified command posts, hail from utility companies, educational institutions, hospitals, local and state agencies, and private sector industries, to name just a few. Structural engineers and business owners are of particular import during operations involving fires in large commercial districts. Industrial hygienists, chemical engineers, metallurgists, environmental professionals, and hazardous materials specialists are similarly useful during large-scale emergency operations at Allegheny County’s many industrial facilities.

Anyone with a specialized type of knowledge might prove useful to a unified command team as they struggle with complex problems. Informant 49 describes a hazardous materials incident that proved to be beyond the scope of the command team’s expertise. The UCT, following the general guidelines of an emergency response guidebook, was about to initiate mass

evacuation of a densely populated area, along with complex containment and decontamination procedures. At that point a technical specialist reached the CP, considered the chemicals in question, and recommended a much simpler and faster method of incident control. The suggested alternative, which was accepted by the command team, provided an appropriate level of protection to those nearby, while saving much effort, time and money in the process.

In spite of the expertise and potential benefits they can offer to the management of complex events, interviews reveal an uncertain, sometimes indifferent attitude toward technical specialists. Informant 9 states that, “Sometimes they’re just there because someone is checking off a box on an ICS form. We get them to the command post, and they kind of stand to the side, not being used.” One example illustrates this mindset:

When the technical specialist arrived, the lead IC told him, ‘You’re only here because my municipality’s emergency plan says that you’re supposed to be here, and because my township manager says the same thing. I really don’t want you here, and I can take care of the situation myself, with my own people, so please don’t get in the way.’ Needless to say, his expertise was wasted (Informant 11).

In other instances, an entirely opposite attitude holds:

Our area had a major chlorine car train derailment. Several railroad technical specialists were called to the scene and the incident commander actually tried to turn the entire scene over to them. The technical specialists had to say ‘no, this may be our railroad, but it is your scene and we can’t tell your responders what to do.’ They had to explain that it was the IC’s show and that they were simply there as advisers to help mitigate the situation (Informant 9).

Not only do we use them, but we try to incorporate them into our training program, especially those from nearby chemical plants and steel mills. We rely heavily on them and make them an integral part of the command team and the decision making process (Informant 18).

Domain experts, while noting the reluctance of many command teams to utilize expert opinion properly, are unambiguous in their support for the technical specialist position, and the

value it brings to the command post as an aid to decision making. Informant 1 suggests that “If the command team doesn’t use [technical specialists], then that’s just foolish. I have shale gas wells in my area and I’ll be damned sure to call them if anything happens on one of those well pads.” Informant 3 states that “specialists are most often used at haz-mat incidents, but they should be used much more often than that.”

Informant 19 mentions that “As the fire officer I can still coordinate the scene, but I’ll often defer to their expertise on tactics.” Informant 6 strikes a balance between the two extremes by explaining how most command teams should be open to the ideas of the technical specialists by considering carefully what they suggest. Yet he also issues a caveat. “They operate in a very narrow area of understanding of our scene. So we have to temper what they advise about their specific field in light of the entire operation, which they might not fully comprehend.

8.3 BREAKDOWNS IN THE COLLABORATIVE EFFORT

As in the case of facilitators, an examination of the data from the semi-structured interviews also uncovers the main inhibitors of effective incident management by unified command teams in Allegheny County. According to domain experts in the field study area, these impediments include: lack of previous association among command level officers, rigid adherence to formal ICS procedures, failure to provide or accept input within the team setting, and the effects of the groupthink phenomenon.

8.3.1 Lack of Previous Collaboration with Command Team Members

“If we respond to a big fire in another town, and we’ve never worked with their chief officers before, it’s foolish to think that we can form an effective command team” (Informant 39).

“To make good decisions, the officers in the team have to have experience with each other. If they don’t, it might as well remain single command with a bunch of advisors” (Informant 66).

In Allegheny County, most command teams come together on an ad hoc basis, and although a few long-standing networks of incident commanders do exist, these appear to be rare. One possible reason for this lack of continuity, as Informant 43 mentions, is that most large events in the region are of a fire related nature, while the county’s fire departments consist of volunteers who have separate full time occupations. Thus even where an established command network exists, it is rare to have the same set of officers – those familiar with one another’s command abilities – available to staff unified command posts from one incident to another.

The lack of established command teams has serious implications for effective decision making during large-scale events. Danczyk suggests that the lack of an established collaborative network with “personal connections” can impede effective incident management, as “too much time and energy is spent on understanding neighboring partners’ strengths, limitations, and their willingness to make decisions” (Danczyk, 2008). Confirming Danczyk’s postulation, the informants of this research list the lack of familiarity among officials as the most significant impediment to effective team decision making, just as they mention it as a barrier to unified command team formation, as detailed in Section 5.1 of this study.

8.3.2 Rigid Adherence to Formal Incident Command Procedures

“Following ICS guidelines to the letter is counterproductive. It defeats the strength of small group dynamics; the ability to think creatively and come up with new ideas” (Informant 29).

Once an emergency event reaches a certain size, or becomes multi-jurisdictional in scope, the Incident Command System imposes requirements for written reports, regular briefings, and specified functional and staff roles. An analysis of the transcribed interviews demonstrates – in principle – strong agreement regarding the benefits of the Incident Command System and the National Incident Management System. Yet their collective attestation of ICS and NIMS support begins to waver when informants discuss the written documentation, strict procedures, and rigid time frames imposed by these systems.

While agreeing that formal procedures are a necessary part of managing the imposing problems posed by a genuine national disaster, informants express much dissatisfaction with the inflexible application of ICS and NIMS guidelines during regional events in Allegheny County. Many echo the comments of Informant 68, who believes that excessive procedural formality is not necessary during the type of regional event examined in this study.

Even when regional events are very large, as Informant 41 relates, the command team remains at a “first hand, intimate level” where they are still very close to the operation and their personnel. Other domain experts agree and explain that in contrast to a full-scale disaster scenario, the command team members can usually see and hear everything that is taking place in front of them, which lessens the need for formal reporting procedures. Informant 74 adds that while there should be some incident organization, “all of these ICS forms are not the solution at

this level of incident command.” Two fire chiefs, each with over 20 years of command experience, express their thoughts:

Incident command at this level is still intuitive. We don’t need to go to the level of a disaster where we have to fill out lots of ICS forms and put ourselves in a straitjacket. That’s not to say that someone shouldn’t be at the command post as a recording specialist, but it shouldn’t bog down the command team. I’ve seen medium sized to large regional incidents where command team leaders do nothing but fill out ICS forms, and because of it they don’t actually observe the operation, or pay much attention to their personnel at work (Informant 36).

I struggled with a lot of this. Being able to do as we’re taught in the command classes, with those identifiable goals and a good incident action plan. But going back to all those ICS 200 forms, the 201, 202, 203 and whatever, that we’re supposed to fill out at the bigger incidents. I think it hurts team decision making by keeping us focused on forms and not on thinking about whether we are setting proper goals and meeting them (Informant 13).

Domain experts express concern that strict adherence to formal ICS procedures hamper the decision making process by suppressing the command team’s problem solving abilities. Informant 46 comments that unified command team members operate more effectively as “free thinkers” when they do not have to continually “go back to the forms to see what they have or haven’t done, what box they forget to check off.” Other informants offer similar sentiments regarding the ways in which strict ICS requirements stymie group problem solving by diverting team attention from critical elements like the evolution of the incident, the progress of the implemented tactical operations, or the safety of everyone at the scene. Informant 6 speaks for the majority:

I’ve served as an incident commander and an instructor of the Incident Command System for many years, and I am very familiar with its benefits. But I think that these ICS forms and procedures and requirements, especially at the level of incident we’re talking about, impedes the creative process of the team, and takes their minds off of the information arriving at the command post. So it weakens the team decision making process by shifting their focus to the time tables, to the

formal positions and facilities that are supposed to be set up, and to all the detailed forms (Informant 6).

8.3.3 Failure to Accept Input

“The command post can become a ‘sound proof room,’ with no information allowed in from the outside” (Informant 73).

“If the ideas of the command team members aren’t being listened to, that person or those people won’t talk anymore. They’ll just shut up and let the top incident commander do whatever he wants to do, since it’s obvious that he’s going to do that anyway” (Informant 15).

While *incomplete* information is largely the result of an inadequate communications system, the *failure to accept input* occurs when the unified command team *disregards* information that *is* available to them. Often resulting from becoming too focused on their own ideas, the members of the command team don’t give enough credence to reports from the operational sector chiefs and crew leaders. Domain experts are adamant in their belief that maintaining such narrow focus is a perilous error on the part of the team, and that it seriously impairs their decision making abilities.

Informant 16 cites an example of a fire captain – serving as a sector chief – who thought the strategy and tactics as directed by the command team were seriously flawed. He proceeded to the command post and gave a face-to-face report, along with suggestions for changes, to the officials present. He was promptly informed that [the UCT] was “running the show” and that he should “return to his assigned tasks” as his input was not needed.

In other instances, the command team leader may not give due consideration to the ideas of one or more team members at the command post. Informants are clear in their belief that disregarding the thoughts of even one individual poses serious obstacles to effective decision making. “You can only hit your head against the wall so many times before you stop making suggestions. If your ideas aren’t going to be listened to, you’ll soon stop offering anything at all” (Informant 23). Informant 38 puts it simply. “When one member is not taken seriously or is given ‘lip service,’ that team member is not likely to participate further in the decisions of the group in any meaningful way.”

8.3.4 Hesitance to Offer Input

“I often feel pressure to back off and not make suggestions so that I don’t insult the fire commander. It depends on whether life safety is involved or not” (Informant 35).

Unlike the willful disregard of offered information, another decision making inhibitor arises when one or more command team members do not express their opinions at all. A frequently mentioned reason for such hesitancy is the fear of offending the lead incident commander, especially when he or she has a strong personality or a history of personal conflicts with colleagues. Consider these comments:

There’s a lot of ego at work at the command post, especially in the mind of the leader of the group. And if that person doesn’t ‘play well with others,’ the rest of the group won’t be too forthcoming with their ideas, either. Some chiefs are just too easily offended, and will raise their voices and argue with you over everything you say. These chiefs don’t get much input, to put it mildly (Informant 51).

With some lead ICs, if you’re not careful, they will take your suggestions the wrong way and shut down and completely stop listening to anything new you say.

This can have serious implications for incident management and safety, so I choose what I say carefully. It's risk versus benefit. I won't let anyone put our people's lives in jeopardy, but it's not worth the fight if it won't change anything, or if the incident is almost over anyway (Informant 35).

Jurisdictional issues can shape the communications pattern at a unified command post, and may make team members reluctant to offer input. Informant 31 commented that commanders from outside the jurisdiction will sometimes "keep quiet" rather than offer suggestions, even when they feel strongly about an action, because they strive to "keep the peace" between them and their sister agency. Informant 62 maintains that he often feels that it is not his place to offer too much advice in someone else's municipality. Informant 49 agrees, but maintains that this acquiescence to jurisdictional boundaries will hold only if the "safety of everyone on the scene is not compromised."

8.3.5 Pressure to Conform to the Majority Decision

"Just like with the juries in court cases you see on TV, the holdout at the command post has a lot of pressure on him to change his mind" (Informant 26).

A somewhat less important, but still relevant breakdown in good team decision making practices is the pressure placed on one or more command team members to accede to the will of the majority. Informant 5, who has experienced this situation, sums it up:

Group pressure can be very real, very hard to get around. If you want to do one thing and the rest of the chiefs want to do something else, there's only so long that you can hold out. I seem to have different ideas than others do, so I've been there. One by one they work on you to change your mind and go along with them. And in the back of your mind, you think, 'I'm not going to win, and it's just going to make them ignore any other ideas I come up with.' So I'm not proud to say it, but usually I'll just go along.

Sometimes it's not the majority, but only one strong willed lead commander who pressures several or all of the other team members to acquiesce to his or her will. Informant 26 illustrates the dynamic, and the danger, of this phenomenon:

Quite often I've seen [the situation] where the team of commanders were all 'yes men' and were all trying to be pleasing to that lead; usually because they know the personality of the incident commander. And if that leader is forceful, they would rather not confront or cause friction. So whatever he or she says goes. Not only does that shut off the creativity, but it becomes very dangerous for responders on the fire ground since the leaders decisions might be completely unsound.

While many informants speak of how they will continue to make their case when they feel strongly about a course of action, the interviews reveal only one universal exception in the face of pressure to conform; when an imminent threat to life safety is involved. The opinion of domain experts is aptly put forward by Informant 16, who declares:

When it comes to making decisions that impact the immediate safety of my firefighters, or the police, paramedics, or anyone else's lives on the scene, I will not go along with the incident commander, or the rest of the team put together. I won't allow anyone's life to be compromised, and it doesn't matter if I'm in my own fire district or not.

8.3.6 Groupthink

When considering the dynamics of small group decision making, the concept of groupthink is well known. According to Janis (1982), groupthink is a defective decision making process where loyalty or perceived group norms take precedence over independent, critical judgment. Groupthink can originate from pressure to conform applied by members of the group, or from time pressures which cause group members to withhold divergent opinions in order to reach fast decisions (Janis, 1982).

In *The Dynamics of Small Groups*, Cecilia Ridgeway (1983) discusses how small, cohesive groups will often develop a sense of self confidence and loyalty which impairs their ability to conduct a critical evaluation of the alternatives. Ridgeway (1983) also asserts that groupthink is very common during crisis situations, and that it undermines the team's willingness to explore unconventional alternatives and makes its members too sanguine about the risks involved in any particular choice.

Groupthink as a concept is mentioned by name by only one informant, but many others allude to its negative effects on command team decision making. Informant 53 relates how his command post colleagues, seasoned by years of working together at significant emergency events in the region, are sometimes too quick to agree to a course of action even when they know better. "The desire to agree with the guys I've worked with for so long stops me from questioning the decisions we're making." Informant 14 is a little blunter when he admits, "Sometimes [the members of the command team] are so sure of ourselves – so full of ourselves you might say – that we don't have any doubt that we're making the right calls."

8.4 DECISION MAKING WITH INSUFFICIENT INFORMATION

"Sometimes you have to "make your best guess, but always keeping in mind to err on the side of caution" (Informant 39).

Communications shortcomings and complications such as overloaded radio networks and fragmentary messages, combined with the speed and complexity of rapidly developing incidents, conspire to prevent unified command teams from obtaining real-time information. Accordingly,

command team members rarely have all the information they need for a complete examination of the alternatives available to them. As Informant 6 remarks, “The command post never has all the facts about what is going on, and this causes them to lack confidence in their decisions.” Yet when it becomes obvious that strategies need to be changed or tactics need to be adjusted, the team can’t let incomplete information prevent them from taking action.

An examination of informant responses demonstrates the lengths to which a command team will go to build an adequate picture of what is occurring in the operational arena, so that they may make the best possible decision. At the same time, however, informants admit that obtaining complete information is rarely possible, and explain that decisions must be made in spite of this fact. Informant 9 illustrates the process:

If communications becomes incomplete for whatever reason, then we gather the command team members and try to "fill in the blanks." So for instance, we may know that search crews were on the fourth floor of a ten story high-rise when we heard from them last, so maybe now we guess that they've made progress and are on the sixth floor. So let's give them an order to search the sixth floor and see if we get a reply, see if they're where we think they are, or if they're still in the same situation. It's a safe decision to make, at least until we get more information.

Informant 11 also speaks to how the command team will make their “best educated and experienced guess” based on what they assume the incident and the interior crews to be doing and on the team’s estimated progress up to that time. Informant 32 agrees that decisions taken with incomplete information should be based on the direction that the incident seems to be taking. During an evolving business district fire, he continues, the team might query each other about “whether the fire is spreading, and if so, what they think the predicted [fire spread] direction and severity will be.” Likewise, Informant 75 indicates that the team will “help each other to construct” an accurate prediction of incident evolution. These techniques help the

members of the team to build the most complete picture possible prior to making a decision.

Informant 31, an experienced command decision maker adds:

Our command team may have to build our own picture of what might be occurring inside. We'll have to make assumptions and act accordingly. That may mean adjusting our tactics and moving on to the next task, but we can't do nothing. The incident won't wait for us.

Command teams that have worked together in the past often become adept at watching and listening for clues as to how the situation is proceeding, even in the face of incomplete information. Informant 9 explains that an experienced group of chiefs, all accustomed to working with one another, "will pay close attention to the radio, will send one of their own members on a reconnaissance" to the operational area, or will query the working crews as they "come out of the hot zone."²⁸ Informant 58 agrees and adds that "runners" will often be sent to the operational areas by well-practiced command teams without waiting for the information flow to diminish. In extreme cases, the lead IC, along with one or two members of the command team, may transfer command to another team member and visit the operation directly, where they can observe and speak face-to-face with sector commanders. As Informant 6 comments, such actions can only take place "if the team members have a lot of trust and respect for each other's abilities."

Regardless of the level of experience and history of prior collaboration among members of a UCT, making strategic and tactical decisions without good information, according to informant 38, is still a calculated risk:

So if we don't have all the information and still need to make a decision I think the command team makes a cost-benefit analysis and decides. One of the team members might say something like, "I heard this much of what they were telling

²⁸ The hot zone is the area of the incident scene that is considered to be the most dangerous to life and health, and it is also where most of the incident control operations take place.

me and I think it was pretty important, and I can't get them to repeat it because they're apparently too busy. But I think they need us to do this or that." So we make the call. Yet we remain aware of the fact that something we missed in the transmission might affect someone's safety. But even so, we still make that call.

Informant 42 shares the following thoughts about the necessity to make decisions on a rapidly changing emergency scene, even without a complete picture of the environment:

We have to make critical decisions based on imperfect, incomplete, or even incorrect information all the time. I think it still comes down to organization, using the benefits of group dynamics to ascertain what it is that we don't know yet. And you must be proactive enough to solicit the missing pieces. It's just like putting a jigsaw puzzle together. You have missing pieces and you need to go after that information. If you lead a reactive incident command team, very often the information that you get is too late to make a difference. You're not staying ahead, and if you wait too long for the sectors to give you complete information, then you'll be perpetually behind. Don't let the incident dictate your actions; stay ahead of it. The only way to do this is to make reasonable decisions based on the information you do have, and on your extrapolation of what the missing pieces are, or even on what the incorrect information might be.

As mentioned time and again by the domain experts interviewed for this research, safety is paramount during incident operations, and the semi-structured interviews reveal broad agreement that it is not worth taking too many risks with incomplete information, especially when the decision is not regarded as critical. Informant 44 elaborates:

Obviously safety is paramount. Let's say we decide to do an aggressive interior attack and we're not happy with the information that we're getting from the attack teams, and we're not totally comfortable with putting more people in the building. We may decide to back them out and go defensive until we can get the information we need. But if that information isn't what we want to hear then we're not going to put our people in harm's way until we get better information. We won't jeopardize safety.

Informant 45 emphasizes the importance of considering whether a decision might be delayed without adversely impacting tactical operations. He advises that "if you can wait, then you should wait" until better information is available. He also suggests that the lead commander

pose a question to the team: “What are the ramifications of making a decision now, with the sketchy information we have, versus waiting for more information later? He stresses that, “the decision to take some action, without all the facts,” should be based on how important the action is to incident operations “right now.”

Informant 49, a fire official with over 30 years of experience and training, adds a final, intuitive comment regarding decision making with imperfect information:

Well, not making a decision is still making a decision, so if we fail to make a decision because of inadequate information, we still made a decision; the decision not to act. But in reality, you take the information that you have, and make the best possible decision that you can on the information that you have. Sometimes that will be wrong, and as new information comes to light you have to be willing to try to change your operational plan. But you still make a decision.

8.5 INFORMANT COMMENTS: EVALUATING THE EFFECTIVENESS OF UCT DECISION MAKING

Domain experts shared a series of observations as to how they determine if a collaborative incident command team has really developed into an effective decision making body. Several informative comments follow.

I would be observing to see if the ICs are trying to stay a few steps ahead of the incident, or are they merely reacting to events? This of course is not easy, and is one of the strengths of a well drilled command team. In the classic incident command process, there never seems to be anyone assigned as the *future person* [emphasis added], no one looking three steps ahead. As a result, we always seem to be behind. Nobody's thinking about the next five things that need to be done, or the things that need to be done to stay three steps ahead (Informant 38).

Are the strategies and tactics given enough time to succeed? Or is there rapid switching or “flip-flopping” between tactics? Does the command team exhibit strong decision making while at the same time not changing direction on a whim?

Are they functioning at a strategic level, or are they getting *tangled in the weeds* [emphasis added] by injecting themselves into the tactical operations of the incident (Informant 24).

If I was one of the leaders at the command post, I would ask, if we're setting realistic goals. Are these goals that we can achieve with the resources at hand? Are we asking for the resources we need? If I see those things in a leadership team I would feel comfortable with that but if I see 'fly by the seat of your pants' decision making, then I would be very concerned (Informant 42).

I would look at their body language. Does it look like they're thinking their decisions through? Or are they just shooting from the hip? And what about the overall picture of the command team's work? Does it look like they're successful? Is the fire going out? Have any victims been removed from the structure? So, basically, is their decision making working? If it's not, they need to change things up quickly (Informant 71).

I have seen many examples of good and poor incident command decision making, and both have to do with accepting feedback. In the first situation, a commercial structure fire at a large strip mall, the command team was trying to decide if they should write off certain parts of the structure. By making a trench cut ventilation opening, they could save at least a part of it, but if they didn't, the fire was so advanced that the entire building would probably be lost. Which stores were they going to sacrifice? They determined where to place the opening and were about to order the roof ventilated. But they first decided to get feedback from the rear sector of the structure, and the officer there told them that the fire was already past the point in question. They then quickly changed their strategy and moved the ventilation opening further down the line. In the second situation a series of residences – row houses – were on fire. The same type of feedback was received from the sector officers, who advised that part of the structure was showing signs of collapse. The unified command team disregarded this information and sent more firefighters into the structure. And firefighters literally 'rode the ladders down,' barely escaping as the building collapsed (Informant 19).

Are the team's decisions meeting the goals they've set for the operation? This is one indication of effectiveness. But even so, they can make all the right decisions and the situation could still get worse. Or they can make all the wrong decisions and the situation could get better. It just happens that way sometimes when you're dealing with very unstable and unpredictable situations (Informant 6).

I think we measure the effectiveness of our incident command post by what happens; if the smoke is less or we see less fire, or at hazmat if everyone is working and it's four hours down the line and the hazmat team is still not controlling the product. So we get these pictures of whether or not we're being effective (Informant 59).

Is responder safety assured? Are we maintaining unity of command and span of control? Has freelancing been prevented. Are resources properly deployed for their own safety? That's how I determine effectiveness (Informant 22).

I think the poorest indicator is whether the fire goes out. The incident command system is not designed to extinguish a fire. It is designed to allow people to go home. It is designed for the safety of the responders. We can make all the best decisions in the world, and the scene will still go to crap. It's more about keeping the troops safe and following the procedures that will guarantee their safety. Now don't get me wrong, because I do believe that ICS is a system that lets us operate very efficiently at the scene by coordinating everyone's efforts (Informant 22).

I look to see how quickly and efficiently the tasks are being completed by the crews on the scene. How long does it takes from the issuing of the order to the command being carried out? How quickly are things getting done? So I think the ultimate evaluation is - what did the command post want to do, and were they able to make it happen? (Informant 38).

8.6 CONCLUSION

The dynamics of incident management during large-scale regional events lies at the heart of this study, and Chapter 8 uses the theoretical framework developed in Chapter 2 to assess the empirical information presented in Chapters 5, 6 and 7 explore the actual decision making methods utilized by unified command teams. The chapter begins with a discussion of single versus joint command, and looks at how an assembled team formulates the strategies and tactics which are utilized to control the incident. Using information gathered from domain experts, the

discussion moves to an investigation of the facilitators and inhibitors of unified command team decision making, with an eye toward how these operations might be improved.

Domain experts agree that three of the most important facilitators of the unified approach to decision making are: a single set of objectives, a collective decision making approach, and an improved information flow. While joint decision making is considered to be somewhat slower and less intuitive than that of a single incident commander, it has the advantage of creating a greater range of decision options along with conducting a more critical examination of those options.

Good command team decision making is also facilitated by a flexible and proactive mindset among the team, along with a thoughtful incident action plan that is used as a *guide* rather than a set of strict procedural rules. Informants maintain that this balance between structure and flexibility is a hallmark of effective UCTs, and it is a phenomenon which takes time, experience and practice to develop. Accordingly, command teams that are assembled in an ad hoc manner, with little or no previous collaborative experience, are a major impediment to good incident decision making, according to informants.

Decision making by unified command teams is largely an informal affair, and the most effective teams, according to informants, arrive at their strategies by *consensus* among the members, rather than by pronouncement from the team leader. Likewise, a command team that follows rigid ICS protocols will often find that its creative abilities have been derailed by strict adherence to formality and process.

Chapter 8 also examines the utilization of *information* by command teams, with particular emphasis on decision making with inadequate information. Good teams, according to informants, are able to piece together enough incomplete information to make *educated guesses*

based on their prior education and experience. To aid this process, well-established teams often become adept at watching and listening for clues as to how the situation is proceeding, while those assembled quickly from individuals who are unfamiliar with one another are rarely able to conduct this process effectively, according to domain experts. Technical specialists and others offering expertise can also be utilized to provide knowledge that is missing from the command team's repertoire, as long as these individuals are allowed to have a genuine voice at the command post.

While the inadequacies of most large-scale incident communications networks assure that incomplete information is an often unavoidable inhibitor to effective decision making, a team's refusal to accept input from each member, or from the operational sector chiefs, presents an entirely *avoidable* impediment. Similarly, subtle or overt pressure to conform to the majority view will often cause team members to keep their dissenting opinions to themselves, while loyalty to the group may produce *groupthink*, in which critical judgment is suborned by loyalty to the group. Finally, cohesive groups – whose members have worked together often – may be prone to overconfidence in their ability to make decisions under uncertainty, and might take more risks as a result.

Disagreement and minor conflict regarding the incident action plan can actually facilitate the decision making process by promoting a critical examination of a full range of options, as long as the debate does not degenerate into personal attacks on team members. Taking into consideration this chapter's examination of the decision making process, Chapter 9 explores the potential of providing assistance to the command team with computer-based systems of decision support.

9.0 THE USE OF DECISION MODELING AND SUPPORT SYSTEMS TO ENHANCE UNIFIED COMMAND TEAM EFFECTIVENESS

The management of complex, large-scale emergency events presents significant challenges to those officials charged with bringing them under control. Decision making under conditions of high stress, physical danger, time pressure, and extreme uncertainty can overwhelm human cognitive abilities, even when incident commanders are arrayed in problem solving teams. In order to aid decision makers as they attempt to cope with complex environments, scholars suggest that it is possible to augment human intuition and judgment with computer-based systems of decision support (Druzdzel and Flynn, 2010).

Chapter 9, building on theories of decision making under uncertainty, and informed by the information garnered from the domain experts consulted for this research, explores the potential of using *decision support systems* (DSS) to assist incident commanders as they grapple with highly complex and specialized emergency scenarios. This chapter includes an examination of decision analysis and decision support models, and describes the construction, testing and evaluation of an actual decision support system.

9.1 SYSTEMS OF DECISION SUPPORT

Decision support systems are computer-based resources which are intended to augment the

limited cognitive capacities of human problem solvers by providing better data, quicker access, and more powerful solutions (Druzdzel, 2014). When combined with situational modeling, systems of decision support help to predict how an emergency scenario will develop, so that incident commanders can stay one step ahead of the problem (Southerly, 2006).

Human judgment is often based on intuitive perceptions, which helps to ease the burden of dealing with large amounts of information, but also reduces the *quality* of the decisions made (Druzdzel and Flynn, 2010). In addition, human intuitive abilities can be far from optimal, especially when the situation presents many variables, each with its own subtle interdependencies (Clemen, 1996). Further, during uncertain situations, humans often become unrealistically confident about predicting the future, adding to the inaccuracy of their decisions (Bell and Schleifer, 1995). As a result, making accurate assessments of the present and future state of a complex and unpredictable situation – a vital ability for an incident commander team – becomes extremely difficult.

Recent research, using Gary A. Klein’s recognition-primed decision making theory as a foundation, has determined that the process of selecting the best course of action in a complex situation moves “directly from situational awareness to the decision, with little intermediate deliberation” (Drury, G. L. Klein, and Pfaff (2011). Still, situational awareness, while essential, does not always provide sufficient background or guidance for decision teams, and thus RPD may fail during situations that are highly uncertain, extremely complex or unfamiliar (Comfort, Colella, Voortman, Connelly, Drury, G. L. Klein, and Wukich, 2013).

Drury and colleagues (2011) explain that during rapidly developing emergency situations, the outcome is highly dependent upon external events which are not under the control of decision-makers. They also posit that limited cognitive abilities prevent human decision

makers from examining enough options to adequately encompass these exogenous variables (Drury, et al., 2011). Correspondingly, Comfort (1994b) argues that human decision makers, faced with uncertainty and dynamic incident conditions, are hard pressed to make correct decisions without the support of some type of external decision support system (Comfort, 1994b).

9.1.1 Decision Analysis

According to Druzdzel (2014), any attempt to improve human decision making begins by understanding the decision process itself. *Decision theory* is a mathematical approach to decision making, based on the idea that uncertainty and preferences can be combined into mathematical probabilities (Druzdzel, 2014). *Decision analysis* takes the concept a step further; it is the “art and science” of applying decision theory in practice in order to provide insight into a specific situation (Druzdzel and Flynn, 2010).

Decision analysis is based on the assumption that humans can understand the elements of a problem and the probabilities of action, but aren't good at *combining* these elements into effective decisions (Druzdzel, 2014). It also assumes that “subjective judgments of uncertainty can be made in terms of probability,” usually by domain experts (Clemen, 1996, p. 265). Decision analysis provides a systematic approach for organizing and analyzing complex problems (Clemen, 1996). According to Bell and Schleifer (1995), decision analysis is a logical and systematic approach for analyzing decision problems, and encompasses the following steps:

1. Identifying the criteria for choosing among alternatives.
2. Structuring the decision problem by listing the alternatives and uncertain events.
3. Assessing the likelihood of various events and assigning values to possible outcomes.

4. Analyzing the information provided in the first three steps to select the best option.
5. Determining if the decision is sensitive to changes in the probabilities or assumptions that have been made.

9.1.2 Decision Modeling

Beach (1997) explains that decision makers can select a course of action in one of three ways:

1. By *recognition*, if the situation is similar to one experienced previously.
2. By *inference*, if the scenario is familiar enough to allow for an “educated guess.”
3. By exploring options and making a *choice*, if the situation is unique and no frame of reference exists in the decision makers mind (this option lends itself to decision support).

Druzdzal and Flynn (2010) posit that computer-based systems, especially those of a “decision-analytic” nature, hold the promise of aiding human decision making by decomposing complex situations into simpler, more understandable component parts, and “re-formalizing” them into decision models that include:

1. Preferences for the outcomes of a particular decision situation.
2. Possible decision options or actions which can be taken.
3. Measures of uncertainty present in the decision situation.

“Decision-analytic” support systems incorporate information storage and retrieval functions, along with the capabilities to perform “model-based reasoning” (Druzdzal and Flynn, 2010). Decision models, which combine mathematical and graphical properties, are often used for the types of highly consequential decisions made in strategic business planning or during

critical military operations (Clemen, 1996). It follows that such models are equally suitable for command activities undertaken during large and complex emergency incidents.

9.1.3 Objectives of a Decision Support System

Decision support systems represent an innovative approach toward *identifying interactive conditions* that evolve during large scale emergency events, and providing a series of decision options to manage those conditions (CDM, 2014). According to Comfort (2013), computational modeling holds the potential to inform decision makers about the “interactions among physical conditions, technical support, organizational structure, and individual conditions.” Such systems offer a true sociotechnical approach, combining human cognitive capabilities with computerized support systems to aid the decision making process (Comfort, 2001).

9.1.3.1 Option Awareness

The concept of option awareness is based on G. A. Klein’s recognition primed decision making research. Theories of option awareness suggest that there is a gap between human perception of the environment, or the *situation space*, and the comprehension of possible consequences of various options, or the *decision space* (Drury, G. L. Klein, Pfaff and More, 2009).

An understanding of the situation space provides a unified command team with situational awareness, while knowledge of the decision space creates option awareness. Option awareness, in turn, affords incident commanders an understanding of the consequences of their actions (Comfort, et al., 2013). Decision makers often lack such an understanding, and thus have

little ability to compare the desirability of one possible option with another in a complex situation (Comfort, et al., 2013).

9.1.4 Features of Decision Support Systems

Decision support systems are interactive, computer based tools designed to help select the best course of action in a given situation. They combine elements of information science, cognitive psychology, and artificial intelligence to augment human decision making (Druzdzal, 2014). Their ability to support human decision making depends on problem complexity, the skill of the decision maker, the power of the software solution, and the organizational context of the problem. Using computer-based simulations, these systems can inform decisions that are made in situations of high uncertainty by examining and displaying the implications of particular options (Lempert, Groves, Popper, and Bankes, 2006). Lee (1991) lists three primary characteristics of decision support systems:

1. They incorporate data and models, and utilize an interactive interface.
2. They are designed to assist decision makers solve semi-structured or unstructured problems.
3. They incorporate human judgment to improve decision making quality.

Computer literacy and user-friendly technology have combined with designs centered on the end user to make systems of decision support a practical option for a variety of problem situations (Lee, 2001). Decision support systems incorporate expert opinion into their construction to provide accurate probability assessments of the uncertainties present in the

decision environment (Clemen, 1996). Bell and Schleifer (1995) list the key *inputs* provided by domain experts during the design of a DSS:

- The *strategy*, which is a decision, or sequence of contingent decisions laying out in advance what the decision makers can do in various circumstances.
- A *list of uncertainties*, which describes possible outcomes that might result from pursuing any of the strategies associated with each uncertainty.
- A *scenario*, which is a single resolution of the list of uncertainties; it describes one possible version of the future of the decision problem.

A decision support system's design utilizes a set of assumptions – also ideated by domain experts – to assign an effectiveness score to the *outputs*, which reflect the cost of action, injuries, property damage, and lost opportunities in each of the plausible futures (Comfort, et al., 2013).

A *trial* is the simulation of one scenario to evaluate one strategy, and is another key component of a DSS. Based on recognition primed decision making, each trial uses the decision space to address more options than humans can simulate (Comfort, et al., 2013). The result is a decision support system that offers a *graphic display* of the decision space for incident command teams operating at complex large-scale events. The use of decision space in combination with the more traditional situation space produces more accurate decision choices under complex conditions (Pfaff, Klein, Drury, Moon, Liu and Enterzari, 2012).

9.2 THE BAYESIAN NETWORK SYSTEM OF DECISION SUPPORT

Probabilistic decision support systems, based on graphical representations of problem structure, and incorporating probability theory, decision theory and expert opinion, are capable of modeling real world problems (DSL, 2015). The Bayesian network model is one type of decision support system, and is said to be an appropriate choice where causality plays a role, and where complexity prevents a complete understanding of the situation (Charniak, 1991). In such cases, events must be described in *probabilistic* terms. Further, the Bayesian model's user-friendly features and specifications make it ideal for use at an incident command post where the individuals involved are unfamiliar with complex technology. In this study, the Bayesian network is applied to a highly specialized and complex scenario involving the shale gas energy exploration process.

9.2.1 Bayes Theorem

Riskiness, doubt, and uncertainty are captured by *probability*. Probability theory is a mathematical system of rules for assigning numbers to sets of hypothetical outcomes. Traditional tools for decision analysis are based on situations that follow the laws of probability theory, but these do not work well in cases of high uncertainty, or when several decision options exist (Druzdel, 2014). A *conditional* event is one in which the probability of one occurrence is modified by the fact that some other event has already occurred. For example, at the scene of an aircraft emergency, the probability of a flammable liquid fire rises if jet fuel is leaking, and increases again if an ignition source is introduced into the situation.

During the eighteenth century, Reverend Thomas Bayes postulated a theorem which flows directly from the definition of conditional probability, and describes relationships within them (Druzdzal, 2014). Of particular interest to this research, Bayes Theorem explains how the probability of one occurrence is affected by another, and it can be used to adjust a probability value based on additional evidence. Thus it allows for revising current predictions in light of relevant new evidence (Druzdzal, 2014).

9.2.1.1 Bayes Rule

Information is not always provided in the format needed to explore a set of decision options. For example, incident commanders may intuitively suspect the probability of successfully evacuating a large area or extinguishing a major fire, but what they really need to know is the probability that these strategies will actually control the situation and protect lives (Drury, et al., 2011).

Using Bayesian networks, conditional probabilities can be calculated as a result of assigning values to them (Druzdzal, 2014). These values can be obtained from existing data, or from domain experts who examine a range of potential scenarios and estimate the possibilities for success of each. This research utilizes shale gas drilling experts to provide the values used in the construction of a Bayesian network model.

9.2.2 Robust Decision Making

While Bayesian networks can be used to determine *exact* solutions, the limitations inherent in unified command team work calls instead for a series of approximate solutions (Charniak, 1991). Correspondingly, the construction, testing and evaluation of a decision support system in this

study is designed to provide unified command teams with the option awareness they need in order to conduct *robust decision making*. Robust decision making focuses on finding the *best* strategy from among a multitude of possible options, while taking uncertainty into account (ISCRAM, 2013).

Robust decisions are those that may not be ideal in every case, but are considered *good enough* for most of the situations that an incident command team is likely to face (G. L. Klein, Drury and Pfaff, 2011). By contrast, a search for *optimal* decisions can be counterproductive, as these can be adversely affected by small changes in the dynamic environment of a major disruptive event (ISCRAM, 2013). Decision support systems such as the Bayesian network aid in robust decision making by providing scenario simulations combined with historical data to project a variety of potential outcomes.

Under the parameters of robust decision making, expert observations are *input* into the DSS model, and repeated computer simulations are conducted to identify optimal strategies (Lempert, Groves, Popper, and Bankes, 2006). During each simulation, the model *calculates* what would happen if a certain option is chosen; varying the pattern with each iteration. The DSS utilizes a set of assumptions – as ideated by domain experts – to assign an effectiveness score to the *outputs*, which reflect the cost of action, injuries, property damage, and lost opportunities in each of the plausible futures (Comfort, et al., 2014).

9.2.3 The Bayesian Network Model

During highly specialized emergency scenarios, standard operating guidelines rarely provide decision makers with sufficient guidance in controlling the scene. Nor can SOGs address situations where, as Beach (1997) describes the connection between the probabilities

is unclear because of the unusual nature of the scenario. In such cases, analytic tools based on Bayesian decision analysis help select robust decisions under conditions of complexity and uncertainty (Lempert, Groves, Popper, and Bankes, 2006). Modeling can be used to assist the problem solving teams by building decision spaces for events of high uncertainty (Bankes, 1992).

A Bayesian model, also referred to as a *belief network*, offers a “prescriptive, systematic, and quantitative approach” for option selection (Lempert, Groves, Popper, and Bankes, 2006, p. 515). Bayesian modeling is particularly appropriate for dynamic situations that feature varying operational risks or changes that occur over time (Barua, Gao and Mannan, 2012). In the model, each uncertainty is programmed as a probability which represents the likelihood of a potential occurrence. If the event is impossible, the probability is set at zero; if certain, the probability is set to one (DSL, 2015). The set of variables and their conditional dependencies are represented by an *acyclic directed graph* (DAG) which includes:

1. A *qualitative* component that encodes variables and the probabilistic influences between them.
2. A *quantitative* component that encodes the joint probability distribution over the entire set of variables.

9.2.3.1 Visual Decision Space: The Bayesian Influence Diagram

When the situation is complex, as at the scene of a major disruptive event, “it is insightful for the decision makers to see how the system variables are interrelated” (Druzdzal and Flynn, 2010, p. 3). Inherent in the design of modern decision support systems is a *computer-generated decision space*. This decision space provides a visual display of the range of projected outcomes for various alternatives, “enabling fast visual comparison between options,” and creating “option

awareness” that augments the mental simulation of RPD, allowing faster and more “robust decisions” (G. L. Klein, et al., 2011). The Bayesian network is a graphical model which depicts influences among significant variables by providing decision makers with a visual display of the interactions that it models (Barua, Gao, and Mannan, 2012).

Using the Bayesian directed acyclic graph (DAG), a computer generated decision space – the influence diagram – is projected onto a viewing screen (Klein, Drury and Pfaff (2008). The Bayesian influence diagram creates an easy to understand representation of the decision problem by presenting a visual display of the decision space (Clemen, 1996).

Due to the uncertainty in complex decision problems, influence diagrams are not sequential; thus they are different from flowcharts that follow a linear progression (Druzdzel and Flynn, 2010). Instead, by displaying the relationships between the elements of the model, they offer a series of snapshots of the decision options (Clemen, 1996). Influence diagrams are revised by the model as new information is input into the DSS, providing continuously updated decision making advice.

9.2.3.2 The Decision Space: Chance, Decision, and Utility Nodes

In the Bayesian model’s display area, random variables are depicted by a series of oval shaped *chance nodes*, which represent the uncertainty between elements in the scenario. Chance nodes model the uncertainty in the situation; the probability that one event might be caused by another that affects it in some way. A Bayesian model’s display area also includes a set of square *decision nodes* which indicate potential actions, known as decision options. Additionally, a series of octagonal *utility nodes*, also referred to as value nodes, indicate the specified values assigned to various outcomes (DSL, 2015). Finally, influences between the chance nodes are

represented by a series of lines and arrows, or directed *arcs*, where “certain independence assumptions hold” as Charniak (1991, p. 51) explains:

The arcs in a Bayesian network represent independence assumptions that must hold between the random variables. These independence assumptions determine what probability information is required to specify the probability distribution among the random variables in the network.

Figure 10 illustrates a portion of the typical layout of an influence diagram.

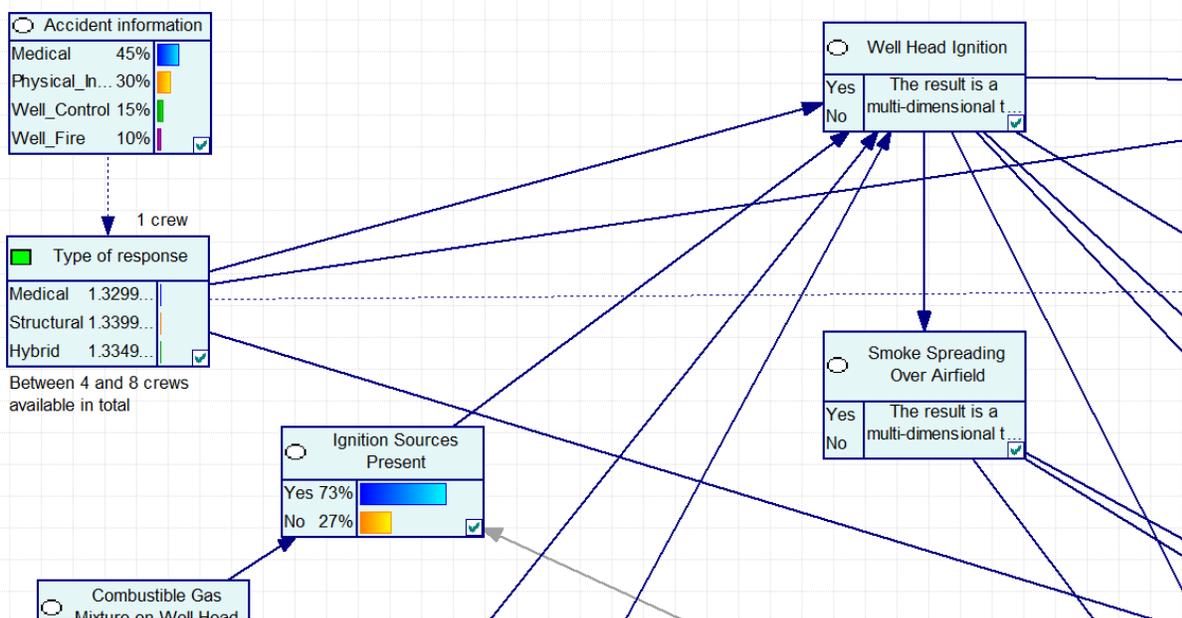


Figure 10: Cutaway of a Bayesian Influence Diagram

To achieve *usability*, a Bayesian network features a user friendly, flexible and adaptive design, with an easy to understand viewer (Lee, 2001). To assure *utility*, the Bayesian model includes a set of joint probability distributions which are input with weighted variables for each decision option (Druzdzal and Flynn, 2010). These numerical probabilities, garnered from the literature, existing databases, or from expert interviews, are encoded as user preferences for various outcomes (Druzdzal and Flynn, 2010).

This study’s Bayesian model uses interviews of domain experts to estimate the values of the model’s chance nodes, the influence arcs between them and the probabilities of event occurrence. The model utilizes a set of assumptions – also ideated by domain experts – to assign an effectiveness score to the *outputs*, which reflect the cost of action, injuries, property damage, and lost opportunities in each of the plausible futures (Comfort, et al., 2013).

Another style of Bayesian influence decision nodes, chance nodes, utility nodes and arcs is shown in Figure 11.

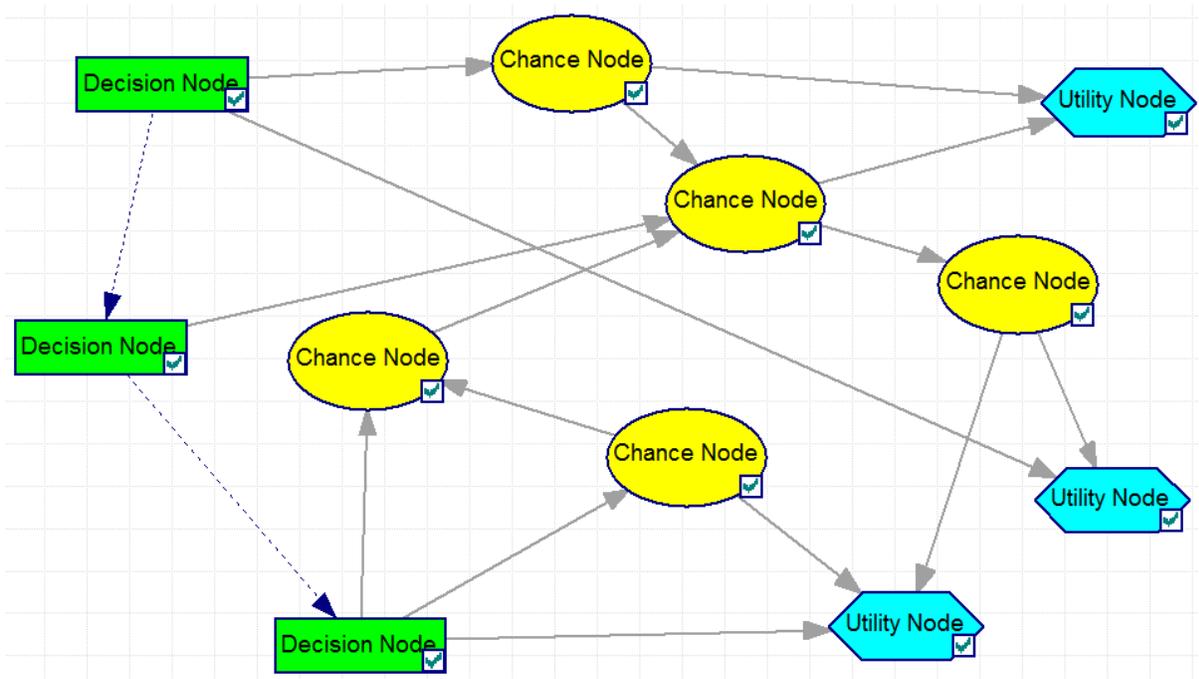


Figure 11: Bayesian Model: Decision Nodes, Chance Nodes, Utility Nodes, and Arcs.

9.2.3.3 Real-Time Updates to the Bayesian Model

Robust strategies and tactics often evolve over time as new information arrives at the command post from operational units located throughout the scene of a major incident. The Bayesian network model can accommodate this process by providing dynamic decision support

that reflects up-to-the minute incident conditions. Using the model, incident commanders can update the parameters of the situation to reflect a changed environment (Druzdzal, 2014).

A feature of the gas well simulation designed for the airport is a *point and click* user interface which allows incident commanders to adjust the conditional probabilities of the chance nodes based on new or updated information. If the command team wants to attempt a new option, the user interface allows them to do so and test it against options that are generated by the model (Comfort, et al., 2013).

Once the command team changes the values to indicate a different course of action, they can re-run the simulation and the model will recalculate each node's conditional probability; given the most current observations (Druzdzal and Flynn, 2010). The model will display the *probability of success* of the command team's proposed change in tactics, permitting a direct comparison against the options generated by the model (Comfort, et al., 2013).

9.2.3.4 DSS Testing at the Center for Disaster Management

In 2012, a research team from the Center for Disaster Management at the University of Pittsburgh designed a rudimentary Bayesian network model. This model included a prototype graphical user interface (GUI) which was used to generate the decision space and to provide incident commanders with enhanced option awareness (Comfort, et al., 2013). The model was built, tested, and evaluated in collaboration with the staff of the Fire Rescue Section of the Pittsburgh International Airport.

The airport scenario consisted of a fuel leak and possible aircraft fire on the ramp next to the airside terminal. This test was conducted to explore the ability of a decision support system to provide option awareness and alternative strategies for action in real time (Comfort, et al., 2013). While the results of the test were generally positive, the outcome presented opportunities

for further investigation. These preliminary steps toward building, testing, and evaluating a Bayesian network for Allegheny County responders set the stage for the specialized shale gas drilling scenario designed for this study.

9.3 A BAYESIAN NETWORK MODEL DECISION SUPPORT SYSTEM FOR SHALE GAS DRILLING EMERGENCIES

Natural gas exploration and well drilling into the Marcellus Shale rock formation is a recent phenomenon in Western Pennsylvania, and numerous wells have been established in Allegheny County since 2012. In February of 2013, The Pittsburgh International Airport, located in Western Allegheny County, reached an agreement with a natural gas company to lease approximately 9,000 acres of land for shale gas exploration. Site preparation began in August of 2014, and the initial well pads were completed in January and February of 2015 (Listed on the Allegheny County Airport Authority website at www.flypittsburgh.com).

Marcellus Shale exploration brings with it the potential for significant large-scale emergency events, the most serious of which include a catastrophic failure, or “blowout” of a gas well head, possibly resulting in an uncontrolled release of natural gas or to an explosion and fire (Smith-Bingham, 2013). The potential for serious consequences at the Pittsburgh International Airport include injuries to gas well employees, property damage to airport facilities, and the possible disruption of the region’s major transportation hub. Since gas well drilling incidents at the airport are highly complex and specialized in nature, and have the potential to escalate into large-scale emergencies if not controlled quickly, they present the ideal subject matter for the development of a Bayesian network.

9.3.1 Marcellus Shale Exploration

The Marcellus Shale is a sedimentary rock formation which is located under much of the Appalachian Region of the Eastern United States, and contains vast amounts of untapped natural gas reserves (MCOR, 2015). The natural gas is trapped in low permeability shale which requires an extraction technique known as *hydraulic fracturing*²⁹ to allow it to be released and be directed to the surface into a series of individual *well heads*. Recent technological advancements have permitted the exploration of this deep shale layer in a cost effective manner (MCOR, 2015).

Marcellus exploration begins with the drilling of a vertical well which extends 5,000 to 9,000 feet below the surface. Once the appropriate depth is reached, the well is redirected into horizontal drilling configuration, which typically extends from 3,000 to 10,000 feet from the vertical well (MCOR, 2015). The gas company lease agreement with the Allegheny County Airport Authority allows for the establishment of up to 60 well heads on six individual well pads which are distributed throughout airport property. All are expected to achieve production mode by 2018. A site map of the gas well plan for the Pittsburgh International Airport is located in Appendix D.

9.3.2 Objectives of the Gas Well Modeling Process

The Bayesian model of gas well emergencies used in this research is designed to provide a practical examination of the *usability and utility* of a decision support system in conjunction with

²⁹ *Hydraulic fracturing* is a gas exploration process where rock is fractured by a hydraulically pressurized liquid made of water, sand, and chemicals.

a potential major disruptive event in Allegheny County. The objectives of model construction, testing, and evaluation in relation to this study are as follows:

1. To model the major hazards of gas well drilling at the Pittsburgh International Airport.
2. To provide an exploratory decision support system for use by the incident commanders who would be charged with bringing a major well site emergency under control.
3. To assess the user-friendliness of the Bayesian model design for incident commanders who have been given a basic level of training in the system.
4. To assess the applicability of using a DSS to *increase the option awareness* of unified command team decision makers during an actual gas well incident on airport property.
5. To gauge the possibility of using decision support systems in conjunction with regional training exercises.
6. To help validate the findings of this study in regard to the small group dynamics and decision making processes of unified command teams.

9.3.3 Use of Simulation / Selected Software

This study's Bayesian model has been developed under the assumption that command team decision making during shale gas drilling emergencies can be artificially *simulated*. The model includes the following components, which are needed for an effective simulation, according to Bell and Schleifer (1995):

1. A list of strategies to be evaluated.
2. A list of uncertainties and associated probabilities that impact the evaluation of strategies.
3. A system for generating scenarios.
4. An evaluation procedure for each strategy and scenario.

The Bayesian model utilized in this research uses the GeNie 2.0 (Graphical Network Interface) decision analysis software program, developed by the Decisions Systems Laboratory at the University of Pittsburgh. GeNie, along with its reasoning engine, SMILE (Structural Modeling, Inference, and Learning Engine), provide the tools needed to analyze data, discover causal patterns, and build practical models of decision support (Druzdzel, 2014).

To provide the evaluative command teams with realistic incident conditions and decision options, the gas well scenario incorporates specific information about the resources and response activities peculiar to the Pittsburgh International Airport and the hazards associated with gas drilling within its boundaries. The airport model is designed to identify the likely consequences of each action in relation to assumed incident conditions. Accordingly, weights were given to each outcome, “based on a utility function of perceived effectiveness” in controlling the incident with minimal loss (Comfort, et al., 2013).

9.3.4 Designing the Gas Well Scenario

To determine a proper scenario for testing, experts in shale gas drilling operations, along with regional emergency services planners and chief officers, were asked to participate in the design of the Bayesian model. Initial consultations were conducted by phone to explain the purpose of the research and to gauge the expertise of the potential informants. Next, in-person meetings were held with each domain expert to determine the most realistic, yet challenging emergencies that decision makers might face when responding to the well pads located at the Pittsburgh International Airport.

To provide an adequate test for the Bayesian network model, the incident had to pose a severe risk not only to gas well operations and employees, but to the airport itself, and to the

surrounding populated areas. In addition, the incident had to be one that could quickly escalate in size and complexity if not controlled quickly. The validity of these interviews to determine a realistic model design rests with the expertise of the individuals consulted for advice.

Domain experts who participated in scenario development represent an accurate cross section of expertise in gas drilling operations and emergency response. The interdisciplinary team of domain experts consulted for scenario development included:

- Two gas well safety experts.
- One gas well operations manager.
- Two airport fire chiefs.
- One airport emergency planner.
- Three fire chiefs from areas of the county with existing gas well operations.
- Two representatives of the Allegheny County Fire Academy.
- One shale gas specialist from the Pennsylvania State Fire Academy.
- Two representatives of the Allegheny County Department of Emergency Services.
- One field specialist / trainer from a gas well control and firefighting organization.

In addition to providing a list of possible emergency events, the shale gas experts also provided a series of “threshold decision points” at which the command team would choose an option to try to prevent incident escalation (Comfort, et al., 2013). At each threshold point, the informants listed a range of available options for action, as well as their opinion on the probable consequences of each action. Particular attention was paid to the potential danger to life and property in the surrounding area, as well as to possible disruptions to airport operations.

9.3.4.1 Scenario Selection

Using the information provided by shale gas specialists, a multi-faceted emergency event was developed and used as a basis for design, testing, and evaluation of the Bayesian model. The selected scenario consists of a minor physical accident which evolves into a catastrophic failure of one of the well heads.

The simulation begins on Well Pad 4, which is located nearest to the airport's southern runway (Runway 28 Left). There, a construction vehicle collides with one of the eight well heads arrayed along the pad, and damages a safety valve known as a *blow-out preventer*³⁰. The situation escalates through a series of chance occurrences and command team decisions. Depending upon the actions of the command team, the situation could be controlled, or might evolve into a worst case scenario, with an uncontrolled gas release, combined with an explosion and fire that threatens to ignite some or all of the adjacent well heads.

Well Pad 4 encompasses eight individual well heads, and includes living quarters for gas drilling employees. It is situated approximately 1,300 feet south (1/4 mile) from Runway 28 Left, and 1,700 feet (1/3 mile) from several airport structures, including two large hangars. Additionally, Well Pad 4 lies within 2,600 feet (approximately 1/2 mile) from an Air National Guard installation, the FAA control tower, and the airport's airside terminal. The area around the airport is heavily populated with commercial and residential occupancies, some of which are located as little as one mile from the well pad in question.

To assure a challenging test of the Bayesian network decision support system, this study assumes *worst case timing* for a well pad event; a weekend occurrence when shale gas industry

³⁰ The *blow-out preventer* is designed as a fail-safe device to prevent a catastrophic loss of well control.

experts, fire department chief officers and other highly experienced technical experts and emergency planners would be unavailable for at least 45 minutes into the incident.

9.3.4.2 The Evaluative Team

Decision making teams were drawn from each of the fire-rescue department's three *platoons*.³¹ These responders accurately represent the make-up of the incident command team which would oversee the initial response to a weekend gas well event. The three command teams, from A, B, and C platoon, featured the same blend of personnel:

- One senior fire lieutenant
- One junior fire lieutenant
- One fire officer in training
- Two senior firefighters.

As an additional measure to assure unbiased testing, the platoon members were not involved in the design of the model and were only provided with basic instructions on its use prior to the first iteration of the actual demonstration.

9.3.5 Elements of the Gas Well Scenario included in the Bayesian Influence Diagram

Data from domain experts was utilized to construct a Bayesian influence diagram of the decision space. To provide maximum option awareness, a comprehensive set of 6 decision nodes, 13 chance nodes, and 5 utility nodes was incorporated into the diagram. These nodes and their

³¹ A *platoon* consists of 8 to 16 firefighters who work one 24 hour shift every three days.

connecting arcs represent the most likely occurrences and alternatives for action during a major well pad emergency. Taken together, these nodes allow the model to determine the probabilities of successful command team decision making.

9.3.5.1 Decision Nodes

Decision nodes list the key options available to incident commanders, given a set of real-time observations (Comfort, et al., 2013). Decision nodes pertinent to the airport scenario include: the type of response to be sent to the well pad, whether an uncontrolled escape of gas has occurred or is probable, if a fire is present or imminent, or if well employees, airport employees, or nearby residents need to be evacuated. In addition, the major tactical decisions of closing a portion of the airfield or beginning major fire attack operations are also included. The following is a list of the decision nodes in the gas well scenario:

1. Determine the type of response – Medical, Structural, or Hybrid.
2. Assist well pad employees in controlling the release of gas.
3. Evacuate the gas well employees.
4. Evacuate the area of the well pad and nearby airport structures.
5. Close a portion of the airfield.
6. Apply large volumes of water to contain the well head fire.

9.3.5.2 Chance Nodes

The *chance nodes* model the uncertainty embedded in the airport scenario; they list variables that *could* occur, such as the ignition of a combustible gas mixture, given an ignition source in close proximity (Comfort, et al., 2013). Based on the observations and actions of gas

well personnel or first responding fire officers, the potential for fire is adjusted as necessary.

Chance nodes in the gas well scenario consist of:

1. Initial accident information.
2. Combustible vapor mix present on the well pad.
3. Ignition sources present.
4. Vehicle collision with the well head.
5. Blow-out preventer valve damaged.
6. Gas vapor spreading to the airfield.
7. Wind speed and direction.
8. Gas well employees in danger.
9. Airport employees in danger.
10. Gas well employee casualties.
11. Airport employee casualties.
12. Uncontrolled gas release from a well head.
13. Explosive well head ignition and fire.

9.3.5.3 Utility Nodes

The intermediate *utility nodes* (value nodes) are used to evaluate the results and expenses of selected decisions, such as the cost of damage to the built infrastructure, or the loss of business resulting from an interruption of business activities. Utility nodes accept input from and are influenced by the probability distributions of the decision and chance nodes (Comfort, et al., 2013). For example, if the probability of a well head fire increases, the potential for property damage, as well as the potential negative impact on airport flight operations, also increases. To score the evaluation of each decision option, the four intermediate utility nodes are combined

and channeled into one overall *efficiency and effectiveness* utility node (Comfort, et al., 2013).

The utility nodes for the gas well scenario are:

1. Operational Costs.
2. Business Continuity.
3. Property Damage.
4. Casualties.
5. Efficiency and Effectiveness.

Figure 13 displays the Bayesian influence diagram used for the airport scenario (A larger copy is located in Appendix E).

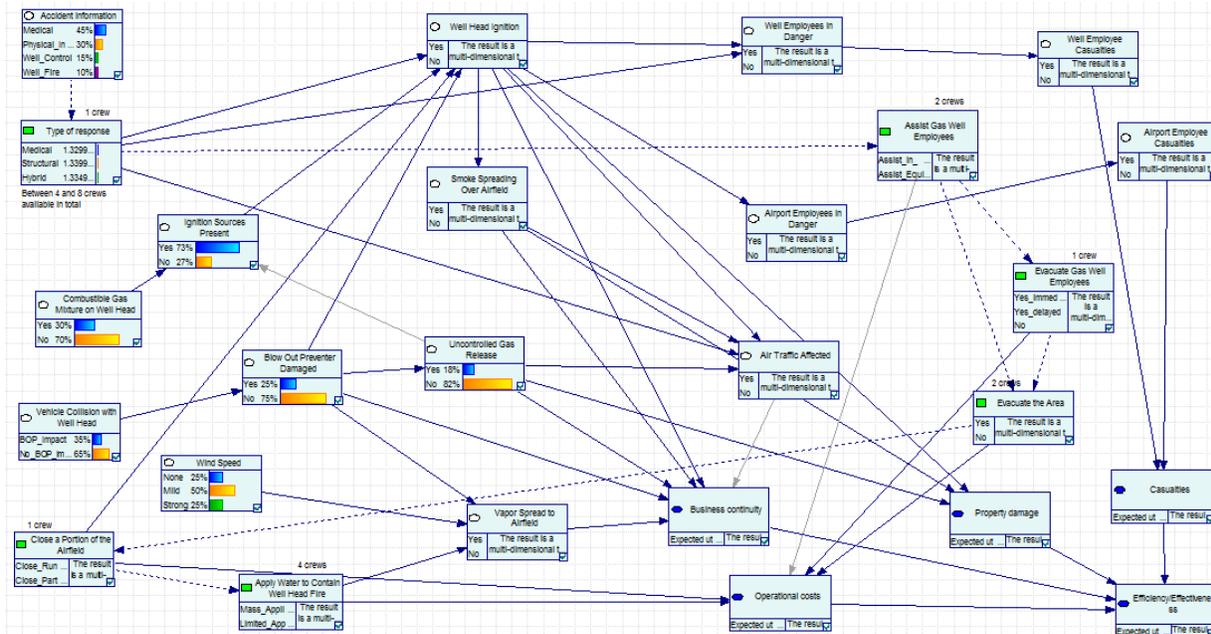


Figure 12: Airport Gas Well Scenario: Bayesian Influence Diagram

9.3.5.4 Processing Updates to the Gas Well Scenario

Incident command teams can account for changing incident conditions by updating the Bayesian model's chance node values. Using the airport gas well scenario, the command team could decide to change the chance node values as a result of dynamic incident conditions. For example, the command team might adjust the chance node values if the tactical teams detect a gas leak or an active ignition source, or if certain personnel or equipment has been prevented from reaching the incident scene.

9.3.6 Demonstration of the Airport Gas Well Model

The completed Bayesian model was demonstrated to Allegheny County Airport Authority Fire Rescue personnel during three separate sessions: March 2, March 3, and March 4, 2015. The FAA Regional Aircraft Rescue and Firefighting Training Facility, on the property of the Pittsburgh International Airport, provided the venue.

To become acclimated to the model, each evaluative team observed as the researcher explained the functionality of the Bayesian design and provided them with basic oral instructions regarding the use of the GeNIe 2.0 software interface. After five generic simulations (none of which involved the gas well scenario), the teams were given a gas well problem and asked to manipulate the model themselves to assess the user-friendliness of the Bayesian design. Following the demonstration, a discussion was held to assess the model's features and utility as an asset to decision making during a complex and specialized large-scale emergency.

9.3.6.1 Gas Well Scenario Inception and Progression

As designed by the researcher, the simulation begins with a phone call from a gas well employee to the airport's emergency dispatch center in which the employee reports that a construction vehicle has collided with a well head on Well Pad 4, and that gas appears to be leaking from the well head's valve assembly. While enroute to the scene, fire-rescue responders receive updates that suggest the situation is escalating, and the flow of gas is becoming stronger. Once emergency crews arrive, the incident escalates into a *loss of well control* scenario, with an uncontrolled release of high pressure gas from the well head. From this point, the teams are presented with five iterations of the gas well scenario, each representing a progressively more complex and dangerous situation. Utilizing the Bayesian model to assist their efforts, each team tries to achieve the goal of *preventing the situation from escalating* to the point where airport operations are affected, or where human life is put in imminent danger.

9.3.6.2 Assessment of the Airport Gas Well Model

Once demonstration and testing was completed, a discussion was held in which comments and suggestions were elicited from the platoon officers. Each participating firefighter was also asked to respond to a brief survey to assess the Bayesian model for its *user-friendliness* (the first six questions) and its *utility* (the last five questions). Questionnaire results are displayed in Table 6. The evaluation protocol for the gas well simulation can be found in Appendix F.

Table 5: Frequency of Responses to Key Evaluative Questions.

Question Range: 1 = Completely Disagree to 5 = Completely Agree	Mean	Median	SD	Min	Max
It was easy to understand the overall operation of the model.	3.20	3	1.08	2	5
It was easy to understand how the scenario was represented on the influence diagram.	3.46	4	0.99	2	5
It was easy to understand what the decision, chance, and utility nodes represented.	3.40	3	0.98	2	5
It was easy to understand how to update the model with new information.	2.13	2	1.02	1	4
The point and click function was an appropriate tool for adjusting incident information.	2.66	3	1.02	1	4
I would like to incorporate my preferences into the way that the “effectiveness” of each option is calculated.	4.13	4	0.71	3	5
I would be able to make more effective decisions with this tool.	2.80	3	0.74	2	4
This tool would be useful at a unified command post during a <i>typical</i> large-scale regional emergency event.	2.06	2	0.92	1	4
This tool would be useful at a unified command post during a <i>highly specialized</i> large-scale regional emergency event.	3.71	3.5	0.79	3	5
This tool would be useful for classroom or tabletop training.	4.13	4	0.71	3	5
This tool would be useful at the command post of a large regional exercise.	2.93	2	1.23	1	5

N=15. Respondents were asked to select the answer that most closely expressed their opinion of the demonstration. Answers ranged from “Completely Disagree” (1) to “Completely Agree” (5).

User-Friendliness

The mean and the median scores for the six measures of user-friendliness ranged between 2 and 4 (with 3 representing a neutral assessment), and all but one measure registered under 3.5. This result indicates a mixed, but decidedly low to neutral evaluation of the ease at which a team

of incident commanders, given minimal experience with this type of decision support system, could use the model during an actual emergency.

The comprehensibility of the Bayesian influence diagram elicited the highest scores, with a mean of 3.46/5.0. Evaluators, after a brief explanation of the diagram, were generally able to follow the flow of the graph and understand the logic of its design. As one evaluator commented, “The visual display of the decision points and incident possibilities are the best features of the model, and it gives a clear picture of what I can normally only imagine in my head.” The clarity of the model’s node and arc structure was also rated in a positive way, with a mean of 3.40/5.0.

The evaluating command teams were not clear on the use of the point and click function to update the model, even after the initial instructions were repeated during the simulations, ranking this feature at 2.66/5.0. The difficulties eased somewhat by the fifth iteration of each simulation, but it is possible that a more intuitive method of entering new information into the model would achieve better usability among incident commanders. Additionally, most of the fire officers were unsure of how their judgments should be incorporated into the model’s parameters, and this uncertainty resulted in the model’s lowest user-friendliness scores (2.13/5.0).

Reflecting a mean score of 4.13/5.0, all of the 15 evaluating fire officers expressed an interest in having the ability to update the parameters of the chance nodes to better reflect their perception of the hazards involved, and of the effectiveness of their options in relation to those hazards. It is not clear how this might be accomplished without invalidating a key feature of the model’s design; the input of the consulted domain experts. Additional research and testing will be needed to explore this possibility.

Taken together, user-friendliness scores were decidedly mixed. In discussions that followed the administration of the questionnaire, several participants mentioned that more time and experience would overcome the issues related to ease of use. As one evaluator remarked, “it’s like any other technical piece of equipment that finds its way to the fire service. You just need to practice with it in a real-life situation to learn how to use it and to see if it will really help you.”

Utility

With a mean score of 4.13/5.0, the three evaluative teams determined that the Bayesian model of decision support would be most useful during incident command *training activities*, especially in classroom settings or during tabletop exercises. As one evaluator commented, “I think it would be really helpful during inside training activities, as a way to get officers to think about all the possible options in front of them.” Potential use during regional exercises, however, was judged as neutral (2.93/5.0).

Evaluators provided the Bayesian model with a positive mean score of 3.71/5.0 for its potential utility during actual emergencies of a *highly specialized nature*, where information regarding hazards is limited and where options for action are not clear. In contrast, they did not feel that the model offered any great degree of assistance to decision making teams during events of a *more common* variety, as in the case of the commercial business district conflagration presented during the semi-structured interviews. In discussions afterwards, they explained that most large-scale incidents present too many decision options and too many potential occurrences for the Bayesian system to be effective. In such situations, they prefer to utilize the expertise of

their unified command team colleagues. Reflecting the mean score of 2.06/5.0, one officer remarked:

When you have a really technical incident like the one on the well pads, it's out of our experience range and there are only a few options we could choose anyway. So this system would work, or at least it would give us a good idea of what to do next and what might be successful. But at the big business district fire on 'main street Pennsylvania,' I don't think [the model] could sort through all the curves the incident would throw at you, or how you'd even know to program it with those options in the first place. And to be honest, I'd rather have a group of very experienced fire officers around me at the command post.

The evaluating fire officers seemed to be unsure of the overall usefulness of the Bayesian decision support system, scoring its ability to help make more effective decisions at a 2.8/5.0. Yet while over one-half of the members of the evaluative teams professed a neutral or negative opinion of DSS use, this might reflect a *disciplinary bias* against technology in general as it is currently applied to the emergency services environment. As one officer stated, "We've tried to use a lot of technology in the fire service, but it usually fails to live up to our expectations, and even when it works as designed, it doesn't add much to our ability to command an incident." Another remarked, "You'd have to prove to me that it would really work, and you'd have to do that by deploying it in the field and giving it a series of tests under really difficult conditions."

To sum up, the five measures of DSS utility were given mixed scores by evaluative teams, ranging from 2.06/5.0 to 4.23/5.0. While some officers admitted that they might be biased toward the more traditional tools of information gathering and decision making, others suggested that they might simply need, as one evaluator put it, "more experience and training with a system that none of us had seen or used before today." They also expressed interest in trying the model out at the scene of an actual emergency, to further evaluate its usability. One informant suggested a series of field experiments in which command teams using a Bayesian

style DSS would work in parallel with UCTs operating at actual events. The results could then be compared and a baseline of comparative information established.

9.4 CONCLUSION

Chapter 9 adds a new dimension to the first eight chapters of this research by exploring the possibility of enhancing collaborative decision making with modern, computer-based systems of decision support. While the demonstration, evaluation, and testing of the airport gas well scenario was conducted with a relatively small number of decision makers, and while the generalizability of the selected scenario is probably limited to the highly specialized shale gas drilling industry, the model was still received with many positive comments. The Bayesian network appears to hold much promise in either a training environment or at an actual specialized emergency event, where incident commanders would be presented with a *visual decision space* in which they could *explore a variety of options* for action.

The Bayesian model demonstrations also afforded an opportunity to observe the command team dynamics discussed in the chapters 5 through 8 of this research: how a group of emergency services leaders coalesce into a unified group, how a leader emerges from that group, how information is gathered and utilized, and how the actual decision making process plays out. Results of these observations are woven into the major findings and implications of this study, as described in Chapter 10.

10.0 MAJOR RESEARCH FINDINGS, POLICY RECOMMENDATIONS, LIMITATIONS, AND AVENUES FOR FUTURE RESEARCH

This study investigates the dynamics that lead to coordinated and effective incident management of large-scale regional events by unified command teams. The major themes of this research include: the impediments and facilitators of unified command team formation and collaboration, the mechanisms of leadership emergence from within the team, the role played by information and communications systems, the processes by which problem solving teams make their decisions, and the possibility of using modern systems of decision support to enhance the decision making process. Chapter 10 concludes this exploration by explicating the major research findings, discussing the limitations of this study, presenting a series of policy recommendations, and suggesting possible avenues of future research.

10.1 MAJOR RESEARCH FINDINGS

This research is guided by the overarching research question: *What are the dynamics that lead to coordinated and effective incident management by regional unified command teams?* The primary methods of investigation and data collection in this study include a content analysis of publicly available media and organizational documents, 75 semi-structured interviews of domain experts, and the design, testing and evaluation of a prototype decision support model.

Metropolitan area public safety networks employ a complex and often disjointed approach to the control of regional disruptive events. This research, using Allegheny County, Pennsylvania as a field study area, has uncovered numerous shortcomings in the effective management of large-scale emergency events. Most notable among the identified problems are:

- A lack of familiarization between agencies, which hamper the initial formation of unified command teams, and impedes their collaborative activities once they are set-up.
- Uneven processes of leadership emergence which do not guarantee that the most qualified individuals will rise to lead regional command teams.
- Inconsistencies in the education and training of command level officers, especially in relation to collaborative small team problem solving and decision making activities.
- Deficiencies in area-wide communications systems which prevent unified command posts from obtaining the information they need to construct a complete operational picture upon which to determine their strategies and tactics.
- Decision making procedures which are unsuited for operating under high stress, time pressure, danger and uncertainty.
- Decision support systems can be of help to command teams during complex and highly specialized situations.

10.1.1 Inhibitors and Facilitators of UCT Formation and Collaboration

This section investigates research sub-question 1: *What are the impediments and facilitators of unified command team formation and collaboration?*

Ostrom's (2005) notion of an "action arena where participants with diverse preferences interact, solve problems, dominate one another or fight" is highly applicable to this study's examination of unified command teams. Assembled at regional incident command posts, the participants are an often diverse band of chief officers, emergency managers, agency directors, and technical specialists who join forces to bring large-scale emergency events under control in the most expeditious manner possible.

Within the field study area, however, there is no guarantee that a unified command post will be established by the host jurisdiction, and if one is, there is no assurance that it will be operated in a collaborative manner. An analysis of semi-structured interviews identifies three major factors that affect these processes: a history of previous collaboration and familiarity, the policies and procedures of the organizations involved in the event, and a variety of situational variables.

10.1.1.1 **Previous Collaboration and Familiarity**

Familiarity gained through previous cooperative activities is the key determining factor in the establishment of unified command posts in Allegheny County. A regular working relationship, consisting of shared responses to everyday emergency situations, is the primary means of gaining familiarity. A system of regional mutual aid training activities, as well as meetings between the chief officers of area police, fire, and EMS agencies also figure prominently in the familiarity equation. In contrast, a *lack* of knowledge and experience with one's potential mutual aid partners serves to prevent the establishment of a bona fide command team.

Joint training and response provides a level of knowledge and comfort among those who would staff the county's regional command teams. Through these activities, officers come to

know one another on a personal level. They learn of each other's unique skills and abilities, as well as their shortcomings; they know what to expect of one another. Most critically, familiarity leads to *trust*, which is cited time and again by domain experts as the principal factor in deciding whether to allow officials from other agencies to have a meaningful role during unified command operations.

This research reveals the importance of becoming familiar with potential command post representatives *prior* to major event, as there is little time to become acclimated to one another during complex and dynamic incident operations. Where familiarity is absent, the legally responsible local officials are unlikely to establish an inclusive command team, relying instead on their own local agency staff. In the event unfamiliar officers are invited to staff the CP, it is highly unlikely that they will be given equal clout in decision making activities.

One of the most challenging aspects of gaining familiarity is the difficulty involved in working and training with the organizations that are outside of the immediate mutual aid network. While it is relatively easy to conduct such activities with adjacent public safety services, it is far more difficult to do so with the far-flung agencies that would be called upon to help control a major regional event.

Most large scale incidents within Allegheny County are primarily of a fire service nature, and over 90% of the county's 207 fire departments are staffed exclusively by volunteers. Yet the ranks of volunteer firefighters in the county, mimicking trends throughout Pennsylvania and the United States, have seen steady declines over the past four decades, and this situation has reached crisis proportions in some cases. The volunteers who remain on the rolls are often hard-pressed to maintain their own fire departments, and have little time to devote to the kind of

regional response and training activities that would lead to increased familiarization within their regions.

10.1.1.2 **Organizational Policies and Procedures**

Organizational policies and procedures exert strong influences on the establishment of legitimate unified command posts in Allegheny County. Accordingly, standard operating guidelines, formal or informal agreements between agencies, and regional customs may either inhibit or facilitate the joint management of large-scale emergency events.

An analysis of organizational documents and semi-structured interviews indicates that most agencies in Allegheny County follow the basic guidelines of the Incident Command System. Yet while *unified command* is inherent in ICS structure, most organizational standard operating guidelines do not specify its use for major events. This omission to agency SOGs suggests that single command is always to be considered an acceptable practice, even during large-scale operations. It further implies that unified command teams need not include a legitimate representation of officials that reflects the multiagency, multijurisdictional, and multidisciplinary nature of the event. In a few instances, as uncovered by this research, organizational SOGs actually *preclude* the inclusion of command team members from organizations outside of the political sub-division.

Formal agreements between public safety agencies regarding incident command posts are rare, but informal understandings abound. In some cases, these informal pacts are rooted in long established regional customs and practices, while in other instances they have resulted from associations between well-respected command officers. Typically, informal agreements do specify the establishment of joint command during multiagency or multijurisdictional incidents, and allow for the most experienced individual to assume the role as the leader of the team,

regardless of who might have legal authority. There appears to be little impetus to formalize these agreements within the county's mutual aid response networks.

10.1.1.3 **Situational Variables**

In the absence of formal procedures, the nature of the situation – its size, scope, and complexity – often compel the formation of a unified command team. Additionally, the same forces help to assure that the efforts of team members are collaborative in nature. Conversely, the existence of interorganizational rivalries and personality issues among public safety agencies in Allegheny County serve as major impediments to command team formation.

The availability of command level officers in the volunteer fire service, especially during weekday daylight hours, is often extremely limited. As a result, officers from the extended mutual aid network are usually needed to assist the local IC with incident management. Additionally, even if adequate management staff is on hand, the sheer scope and complexity of the event may oblige local officials to establish an inclusive and collaborative command post.

Interorganizational rivalries and personality conflicts among emergency services leaders have long been part of Allegheny County's emergency services culture. While not as prevalent in recent years, such antagonisms are still in evidence, and are exacerbated by a dearth of joint activities and a lack of good communications among neighboring agencies and their leaders. These rivalries present another set of strong obstacles to effective unified command team formation and collaboration.

The final major situational factor identified by this study is the availability and response of personnel and equipment from the Allegheny County Department of Emergency Services. Serving as a resource for the county's public safety agencies, ACES is staffed with a highly trained cadre of command level officers and specialists who have experience in all aspects of

incident response and management. In addition, ACES maintains an array of specialized equipment that can be deployed to the scene of major regional events.

The appearance of Allegheny County assets at the scene of a large-scale event exhibits a strong positive influence on command team formation, even among the most independently minded officials. The county mobile command post is cited by informants to be of particular importance, as it provides a neutral, non-threatening environment for collaborative work. Collocated in the county's command post, and provided with facilitation from highly experienced ACES personnel, regional officials often coalesce into a unified team of problem solvers.

10.1.2 Leadership of a Unified Command Team

This section investigates research sub-question 2: *How do leaders “emerge” from nascent unified command teams, and what are the characteristics displayed by effective team leaders?*

Once a regional unified command team is assembled at the scene of a large-scale regional event, a leader almost always arises to facilitate the work of the group. Comfort (2014) maintains that during a large-scale emergency event, “experience usually trumps position,” allowing the best qualified individual to rise and lead the command team. This study confirms Comfort's comment, but also finds that command team leadership is also likely to arise from legal or jurisdictional authority.

Informants to this research also shed light upon what they view as the most important characteristics of a command team leader. The findings of this study agree with the writings of

Straus (2002), who espouses *facilitative leadership*, where those with the power to act unilaterally opt for participative, consensus building approaches instead. Even so, facilitative emergency services leaders need not always operate by consensus, and it is sometimes completely appropriate to make a decision and announce it to the rest of the group (Straus, 2002).

10.1.2.1 **Factors Affecting Leadership Emergence**

In Allegheny County, the leading official from the agency having jurisdiction for, and *having the specialty* in, the incident at hand is most often the individual who rises to command an assembled unified command team. Thus at a command post consisting of principals from a variety of public safety agencies, the local EMS agency director will most often command a mass casualty incident, and the local police chief will head up a situation involving civil unrest. An interesting finding of this research is the frequency at which volunteer fire officers are granted authority to command by their full-time, professional police or EMS brethren.

While legal or jurisdictional leadership is a time honored tradition in Allegheny County, the landscape is slowly changing. In this study, an incident commander's experience level equates to a minimum of ten years of active emergency services practice, combined with a high level of training and expertise. With the shortage of such leaders in the region, local fire, police, and EMS chiefs are beginning to recognize the value of practitioners who can coordinate multiple response efforts at multidimensional incident scenes.

Another surprising finding of this research is the trend toward *deferring the lead* incident command role to an officer from outside of the local municipality if that individual has more extensive experience with large-scale operations. Indeed, many local volunteer fire chiefs have advised their junior officers to cede command team leadership – and with it the final say on

decisions made by the team – to highly skilled commanders from the mutual aid network. According to domain experts, this is a recent practice, and stems from the fact that due to manpower shortages, many junior officers find themselves in command of multiple company operations, and their superiors have recognized the risk to public safety. A high level of familiarity and trust among the chief officers of the regional mutual aid network serves as the prerequisite for these informal arrangements. Additionally, in some areas of the county, ACES personnel are permitted to assume the lead command slot upon their arrival at a major event. Finally, command team members with the strongest personalities sometimes rise to the lead position within the unified command group. This dynamic holds true even when the local IC does not yield formal command, but simply allows a strong and competent individual to assume de facto leadership of the command team.

10.1.2.2 **Characteristics of Effective Command Team Leaders**

This study reveals the most important characteristics of unified command team leaders, as identified by domain experts. These include: communications skills, critical thinking skills, rapid decision making abilities, and a flexible and open-minded perspective. In addition, prospective leaders should have an in-depth knowledge of incident command techniques and extensive experience in working with a team of officers at multiagency events.

The ability to communicate effectively is the most important characteristic of a UCT leader, far outpacing knowledge and experience in the eyes of domain experts. The skills of a good communicator include the ability to use modern communications technology to its maximum advantage, and to get one's message across to other members of the team. Knowledge of information gathering, analysis and dissemination techniques is also rated highly, as is the

capacity to assure situational awareness and a common operating picture throughout the area of operations.

Command presence, a somewhat nebulous term, is ranked by informants as the second most important quality displayed by effective unified command team leaders. This concept encompasses self-confidence, decisiveness, a calm demeanor, and an ability to express oneself naturally. The leader who exudes command presence has the ability to get his or her message out in the kind of self-assured manner that inspires confidence in the team's decisions; a vital ability on the scene of an emergency, where life safety is always at issue.

Additional characteristics of effective team leaders relate to management and human relations skills, including the ability to *recognize the unique skills* of command team members and to organize the officers at the CP in a way that maximizes their value to incident operations. A leader's reputation for integrity and an ability to engender trust among one's colleagues are listed as two other essential qualities.

UCT leaders are advised to establish a collegial environment at the command post by allowing the full participation of all team members. A willingness to accept input from colleagues and evaluate it objectively is also indispensable to the team leader. Further, the acumen to analyze and act upon new information by employing critical thinking skills helps to build confidence among the team members. A proactive nature that allows the team to get ahead of the incident, and a flexible perspective that permits changes to the incident action plan, round out the crucial elements of command team leadership.

10.1.3 Information and the Command Team

This section investigates research sub-question 3: *What is the role played by systems of communications, and by information availability, assimilation, and dissemination during unified command team operations?*

Comfort (1999) stresses the importance of real-time, specific information to inform the strategies and tactics of the incident commanders at the scene of major emergency events. An analysis of the semi-structured interviews reinforces the belief that communications networks, and the information streams they provide, are vital elements in the management of regional events. As such, the communications systems and techniques utilized to assimilate, analyze, and disseminate crucial information are among the surest determinants of effective unified command teams.

During large-scale emergencies, communications channels frequently become overloaded, preventing the accurate transmission and reception of messages and reports. In addition, complete information is rarely available to command teams as they develop and execute their action plans, forcing them to make risky assumptions about the future direction of events. During major emergencies, incident commanders must stand ready to use unconventional methods of communication in order to obtain the knowledge they need to assure situational awareness and a common operating picture for all operational units.

10.1.3.1 Incident Communications and Information Systems

In Allegheny County, as in most parts of the United States, the primary method of incident communications consists of a system of mobile and portable radios. These systems, utilizing updates to decades-old technology, carry the bulk of information to and from the

incident command post. Unfortunately, radio systems as they are currently designed and used are hampered by both human and mechanical shortcomings.

For reasons of safety, almost all emergency responders are equipped with portable communications equipment, and this translates into hundreds of radio sets and a commensurate number of possible simultaneous transmissions. Further, radio discipline varies greatly, but is generally lacking among the 400 divergent response organizations in Allegheny County. Finally, the practical limitations experienced by dispatch centers complicates the monitoring of multiple radio channels, thereby inhibiting the utilization of alternate frequencies.

This research reveals broad agreement about the preferences for and the advantages of face-to-face communications between incident command team members and their tactical crews. Face-to-face contact offers direct communications with little likelihood of the confusion, misunderstandings, and the incomplete information that is common to radio traffic. Additionally, members of the command team can gauge the body language and voice inflection of those sector chiefs who present an in-person report to the command post.

The main impediment to face-to-face communications lies with the size and nature of large-scale events, since sector chiefs may be located quite distant from the command post, or might be so involved in the tactical incident control efforts that it would be unsafe for them to leave their areas of responsibility. The preferred alternative, according to informants, is for one or more members of the UCT to travel to the operational areas and report back to the command post with a first-hand report of the situation.

Supplemental systems of communication and information retrieval, based on current technologies, are slowly making their way to major incident operations in Allegheny County. Computer aided dispatch (CAD) in combination with Mobile Data Terminals (MDTs) and

incorporating geographic information systems (GIS), allow real-time information flow between the Allegheny County 911 Center and the incident scene. Specialized information gathering systems such as thermal sensors, portable cameras, smart phones, and drones with visual transmission capabilities are all used to some extent. Yet because of their uneven acceptance and usage by the county's emergency services agencies, their utility during major incident operations is currently limited.

10.1.3.2 **Information Collection, Analysis and Dissemination**

Once the communications network has been established, the command team collects, organizes, and analyzes the information it provides. Command posts in Allegheny County receive information through a series of formal and informal reports. To be of optimal value during the decision making process, however, the information must be *current and accurate* with regard to incident developments.

The *initial report* details for the command team conditions upon arrival, the current situation, the steps taken to control the incident, the resources on hand, and a prediction of developments and resource needs in the immediate future. Armed with the initial report, the command team collaborates on an incident action plan, establishing goals for incident management and determining strategies and tactics. Throughout the course of the incident, *progress reports* flow into the command post from the operational sectors, largely in the form of radio transmissions which are supplemented by occasional face-to-face meetings. As new or updated information is received, the command team adjusts its action plan as necessary.

Excessive radio transmissions, usually caused by an inefficient communications network and a lack of radio discipline, combine to stifle the flow of *vital* information, causing the incident picture to be incomplete. As multiple transmissions occur on the same frequency, and as some

transmissions begin before others are received and acknowledged, messages become truncated, inaudible, or cut off completely. Quite often the command team has no idea if they have received enough information on which to base their decision making. Even when complete and detailed reports reach the command post, it is often difficult for the UCT to filter it out from the nonessential traffic received. A loss of situational awareness is frequently the result.

The inadequacies of large-scale incident communications systems also plague the command teams as they attempt to *disseminate* information to the operational sectors. Radio overload often precludes the proper acknowledgment of command post transmissions, which in turn prevents the command team from being certain that their instructions have been received. Dissemination difficulties also arise from an environment of noise, stress, confusion and intensity. An inability to disseminate information impedes the command team's efforts to assure a common operating picture throughout the incident scene.

10.1.4 Decision Making by Unified Command Teams

This section investigates research sub-question 4: *What processes do unified command team members utilize to make decisions during major emergency operations?*

Klein (1998) describes problem solving command teams as intelligent entities which have the ability to devise strategies and tactics that exceed the capabilities of any one incident commander. Collaborative problem solving and decision making under uncertainty lie at the heart of this research, and the findings of this study highlight the processes of small group dynamics, which are inherent in the work of unified command teams.

10.1.4.1 **Facilitators of Effective Decision Making**

This study reveals that effective unified command team decision making begins with standard *incident command protocols*, including a formal *incident action plan* which lays out one or more broad and achievable strategies, along with a set of specific and detailed tactics. Additionally, incident progress markers, or *benchmarks*, are an essential component of a facilitative IAP, which itself should be a *flexible* document; subject to change as incident conditions warrant.

This study also finds that during the type of large-scale regional event considered in this research, UCTs normally eschew the formal structure and rigid procedures which are characteristic of NIMS and ICS at the disaster level of operations. Informants describe such inflexible procedures as time wasters and impediments to creative thinking and rapid decision making. Accordingly, most unified command teams rely on a *basic* ICS structure that foregoes requirements for set operational periods, planning meetings, regular incident briefings, and the obligatory use of various written reports and forms.

Flexibility and proactivity are major facilitators of unified command team decision making. Along those lines, informants suggest that unified command teams would be more successful if they utilize their incident action plan as a *guide*, rather than an unalterable script. Since incident conditions can evolve rapidly, changes to the IAP should be expected and must be undertaken rapidly. Yet while malleability is a facilitator of command team effectiveness, it should be combined with the ability to *plan ahead* from the earliest stages of the event; as one informant notes, “to stay three moves ahead of the incident.” Without this proactive inclination, the UCT will find itself constantly reacting to incident developments and will lose the benefits of collaborative action.

Creative command teams facilitate effective incident management, especially during the types of complex, large-scale events that can be expected to present unusual or challenging problems. Still, command team members reach their full potential as effective and *creative* problem solvers only when the dynamics among the group are positive, and a *free flow of ideas* exists. Creative command teams are able to combine their skills with a *synergy* that leads them to craft novel approaches to incident control. Brainstorming, albeit in an abbreviated form, is considered to be an important element of the creative process, and is especially successful among individuals who have worked together previously, and are comfortable expressing their opinions with each other.

Effective incident command teams utilize all of the tools at their disposal as they work to control large-scale emergency events. Accordingly, they consult with technical specialists to facilitate their work; particularly those subject matter experts who have knowledge of processes or hazards that are specific to the situation at hand. Structural engineers, industrial hygienists, safety professionals, hazardous materials specialists and utility company representatives top the list of experts utilized by incident commanders to supplement the knowledge base present at the command post.

Conflict at the command post is to be expected as colleagues with strong egos debate the alternatives for action and work to build consensus regarding strategies and tactics. According to the findings of this research, conflict is considered to be a *positive* dynamic that permits a better understanding of the incident environment while facilitating a more critical examination of potential alternatives for action. The key is for the leader to channel the disagreements into an open and honest discussion among professionals, while avoiding outright hostility and personal attacks.

10.1.4.2 **Impediments to the Collaborative Effort**

Analysis of the semi-structured interviews reveals that a paucity of previous collaboration between the assembled members of a command team creates perhaps the most significant impediment to effective decision making. Another noteworthy barrier is the absence of open and judgment-free communications among the members of the UCT. A third difficulty is precipitated by a team leader who insists on strict adherence to ICS procedures, which can stymie the group's creative thinking abilities. Since Allegheny County's command teams are often formed on an ad hoc basis, and since the region still features chief officers with strong and unbending personalities, these are all common problems during major operations.

Theories of group dynamics suggest that *pressure to conform* can lead one or more members of a problem solving team to accede to the views of the majority, and this holds true at unified command posts. The same pressure can deter team members from sharing their ideas and suggestions, or from contributing to group debate over proposed courses of action. This phenomenon appears to be most prevalent when the group is led by a strong and opinionated leader, and particularly when that leader hails from the political sub-division in question.

Incomplete information, caused by deficiencies in the communications network, is another prime hindrance to effective collaborative problem solving. Yet even when the command team has adequate information, they may choose not to avail themselves of it, preferring instead to rely on their own observations, suppositions or intuitions. In such cases, informants suggest that the commanders are liable to make ill-informed decisions, especially with regard to changes in tactics.

Overconfidence is another inhibitor to effective problem solving, as it can prevent the command team from evaluating enough alternatives prior to making their decisions. Carried to

extremes, overconfidence can lead to the phenomenon of *groupthink*, which undermines the team's ability to conduct a forthright evaluation of the potential alternatives and risks of their decisions. This study finds that overconfidence, unlike most of the other inhibitors, is just as likely to strike long-established command teams as it is to afflict teams of a fledgling nature.

10.1.4.3 **Decision Making with Incomplete Information**

Incident commanders understand the value of accurate and current incident information, and go to great lengths to assimilate as much pertinent data as possible. They also realize that incomplete information will prevent them from forming a current, accurate, and complete picture of incident conditions. Yet in spite of such deficiencies, decisions must still be made using the information at hand, even if it is fragmentary. To compensate, unified command teams utilize their experience and the inherent strengths of the collaborative process to formulate their best educated estimates of incident conditions. It appears that well-established teams display a superior ability to work with the inadequacies of information, and over time they become adept at watching and listening for clues to incident developments.

10.1.5 **Decision Support Systems**

This section investigates research sub-question 5: *How can regional command team effectiveness be enhanced by modern systems of information technology and decision support?*

Decision making under uncertainty, during high stakes emergency events replete with conditions of high stress, danger, and time pressure, can overload the cognitive abilities of even the most well trained and experienced command teams, according to this research. Klein (1998)

suggests that human intuition, based on situational awareness, is a basic ingredient in team decision making. Still, SA does not always provide enough background or guidance to the command team, especially where the situation lies outside the realm of their collective experience. Additionally, limited cognitive abilities can prevent human decision makers from considering enough alternatives in a complex situation (Klein, 1998). Situations like these lend themselves to systems of decision support.

Decision support systems, based on computational modeling, have demonstrated the potential to assist decision makers by providing *option awareness* in complex situations. This study uses a Bayesian network model to investigate the usefulness of decision support systems during highly specialized and technical scenarios. As described in Chapter 9, the model selected is based on potential shale gas drilling scenarios on the property of the Pittsburgh International airport. It was designed, tested and evaluated with the assistance of emergency response personnel from the Allegheny County Airport Authority.

10.1.5.1 **Utility of the Bayesian Model**

The Bayesian network model appears to offer its greatest utility when incident command teams are faced with complex and highly *specialized* problems with a limited number of options, as in the case of the airport gas drilling scenario, or at an industrial fire involving unusual chemical processes, or during a highly toxic hazardous materials situation. Command teams in Allegheny County tend to have little experience with situations like these, and could benefit from a greater awareness of the options available to them, and of the possible consequences of those actions.

Current methods of decision support do not seem to be as utile for the management of large-scale events of *lesser complexity*, as with the business district fire scenario discussed

throughout this research. The difficulty lies with the myriad situational variables and options for action, which would present such a complex decision space that it would prove difficult to program and cumbersome to utilize.

According to the responders who participated in the airport scenario, a Bayesian-style decision support system would enhance the *training* of emergency services personnel by presenting easy to interpret influence diagrams and allowing for the selection and trial of numerous decision options. As a training tool, the model could also be useful in educating prospective incident commanders about the most probable decision options available to them in diverse situations.

10.2 POLICY RECOMMENDATIONS

To address the deficiencies of unified command team decision making uncovered during this research, a series of recommendations is offered for consideration by local and county officials.

10.2.1 Encourage Familiarization among Extended Mutual Aid Networks

Effective unified command teams are composed of individuals who have a high degree of familiarity and trust in one another's skills and abilities, can work well as a team, and have worked together previously. Achieving such familiarity is problematic beyond the confines of a given public safety agency's adjacent municipalities; a situation that must be rectified to assure genuine collaboration during large-scale incident operations.

To develop a more comprehensive system of collaboration, regular interorganizational contact could be expanded to include the more geographically distant police, fire, and EMS services located outside of local mutual aid networks. The command officers of each region can be given the opportunity to meet with each other to develop the personal contacts and relationships which are so important to the work of small decision making teams. Regional public safety officer's meetings, sponsored seminars, and simple meet-and-greet events would all provide opportunities to get to know one's peers. The key is to develop trust in the officers of the region-wide response network, *prior* to collaborating with them at the command post of a major event.

10.2.2 Provide Advanced Command Level Education and Training

Training was mentioned by more than 85% of informants as a critical factor in preparing for the kind of collaborative problem solving and decision making that is so important during unified command team operations. Analysis of the interviews conducted in this research suggests that the paucity of high level incident command training opportunities within the county inhibits the ability of mutual aid partners to provide competent staffing to each other's command posts.

To assure that incident commanders are equal to the task of collaborative incident management during major events, regular training activities should be held in each of the four regions of Allegheny County. Such training can be conducted as exercises where police, fire, and EMS groups from throughout the region intermix and become familiar with each other's personnel, equipment, and abilities. Training opportunities should be afforded to as many

agencies as possible; mimicking the extended mutual aid networks which would be summoned to assist with large-scale events.

Informants stress that unified command should be practiced until it is as easily undertaken as single command. Training activities, therefore, should be challenging and should focus on small team coordination and collaborative decision making. Domain experts espouse the need for training and educational programs that go beyond traditional incident command coursework, and they also recommend adding a mentoring component to the mix in order to assist and monitor the development of junior officers.

Focusing on the management of large-scale emergency events, regional training activities could be conducted as conference style seminars, classroom instructional sessions, tabletop exercises, or regional disaster drills. It is recommended that the Allegheny County Fire Academy, possibly in partnership with the Community College of Allegheny County, be charged with developing advanced level officership training activities. The establishment of a county-wide command school, integrating *all* three public safety disciplines and conducted within each area of the county, might offer the ideal training scheme.

10.2.3 Implement Cross-Training among Police, Fire and EMS Agencies

A common shortcoming identified by this research is the failure of the three major public safety disciplines to work together during the management of major events. Analysis of the semi-structured interviews illustrates that police, fire, and EMS agencies often attempt to manage their own aspect of large-scale incidents without involving each other in a coherent way. These agencies rarely engage one another in training sessions or other venues outside of the emergency arena, and thus struggle to develop trust or understand each other's procedures or priorities.

To facilitate genuine collaboration among public safety agencies, each region could provide opportunities for familiarization and cross-training among local command officers. Such efforts might begin with regional multi-disciplinary gatherings, where leaders from police, fire, and EMS organizations would have a chance to learn more about one another in an informal setting. These sessions would also afford the opportunity to air differences, correct misunderstandings, and propose ways to improve joint incident management.

Ultimately, the three disciplines could practice coordinated incident management during practical training sessions and regional exercises. One potential scenario suggested by several domain experts consists of a simulated *active shooter*³² situation; a law-enforcement led activity with the added complexity of a high number of casualties and a large structural fire. Since police are typically trained to work alone, this law enforcement-led scenario would help them become integrated into the regional public safety command structure, and to operate within a unified environment.

It is further suggested that regional cross-disciplinary activities be developed and coordinated through Allegheny County's councils of government (COGs); associations comprised of local officials who conduct regional planning. These organizations have long histories of providing resources for public safety training, and one COG in particular has been a frontrunner in its efforts to increase the effectiveness of incident command by promoting training and affiliation among its police, fire, and EMS services.

³² *Active shooter* training provides law enforcement officers with the tools needed to stop a weapons related crime upon their arrival, and without waiting to assemble large contingents of officers.

10.2.4 Develop a Common set of Standard Operating Guidelines

One significant hurdle to effective unified command work is the existence of dissimilar procedures for emergency response and incident management. To overcome this obstacle, it is suggested that a common set of standard operating guidelines be developed on at least a regional, and preferably a county-wide basis. Based on ICS guidelines, common SOGs would allow for seamless unified command team operation by establishing general protocols and a standardized lexicon for multiagency and multijurisdictional incidents. To assure uniformity, common SOGs could be developed by the Allegheny County Department of Emergency Services, and promulgated by the Allegheny County Police and Fire Academy.

10.2.5 Establish Reliable Communications and Information Networks

This study has detailed the deficiencies in the communications systems employed to gather information during large-scale events, and has also demonstrated a strong relationship between inadequate information and substandard decision making by incident command teams. During the past 15 years, Allegheny County has been able to consolidate a haphazard and fragmented network of local dispatching facilities into a modern 911 center, and this study reveals that public safety agencies throughout the region have come to depend upon it to provide critical information to command team members during major events.

Because of a demonstrated record of success, it is suggested that the Allegheny County Department of Department of Emergency Services spearhead the development of a comprehensive communications and information system that builds on the capabilities of the 911 center. ACES could speed the deployment of enhanced 911, which will allow photos, videos and

text information to be transmitted from callers to dispatchers, who in turn could relay these media in real-time for use by regional command teams. ACES could also serve as the nexus for pairing enhanced 911 with other technologies which could provide high capacity informational storage and retrieval systems.

Tactical on-scene frequencies are designed to alleviate the problem of excessive radio traffic on the main operational frequencies at major events. Yet domain experts complain that these tactical channels remain problematic due to inadequate monitoring issues and responder failures to select the appropriate frequency. Accordingly, a second communications proposal is for ACES to enlarge the scope of responsibilities of the 911 center's telecommunications officers (TCOs) by dedicating one TCO to monitor any major event in Allegheny County. From an operational aspect, the delegated telecommunications officer would be in a position to discern garbled, incomplete, or missed instructions or requests for information and relay them to the appropriate parties. From a safety perspective, the TCOs might pick up calls for help from injured or endangered response personnel that have been missed by sector and command staffs.

A third recommendation is for the deployment of a county command post staffed by Allegheny County personnel as a standard practice during major events. ACES resources would bolster on-scene communications by improving radio frequency monitoring and by helping to assure the interoperability of radio systems.

Finally, through programs developed and conducted by the Allegheny County Police and Fire Academy, ACES could help to ensure adequate training in proper communications procedures and radio discipline throughout the region. Such training should be undertaken during police, fire, and EMS recruit training, and reemphasized by academy instructors who teach other operational level training courses.

10.2.6 Continue the Development of Decision Support Systems

Domain experts stress the importance of finding new ways of using technology to make rapid, informed and accurate decisions in complex and uncertain environments. To assess the possibility of doing so, this study considers the use of computer-based systems of decision support to aid incident commanders during large-scale disruptive events. Toward that end, a Bayesian network model, envisaging possible emergency scenarios on one of the shale gas drilling rigs on the property of the Pittsburgh International Airport, was designed, tested, and evaluated. Overall, the model was received positively, although the evaluating incident commanders proposed several improvements to its design.

Proponents of decision support models are in a position to improve on current designs by increasing the utility and user-friendliness of these systems. Thus the suggestion here is for continued development of systems of decision support as an adjunct to unified command team decision making. This effort might feature collaborative research between public safety agencies and university research teams like the University of Pittsburgh's Center for Disaster Management. While financial support will be necessary for a project of this scope, it is possible that the research could be underwritten by federal grants or by university, private sector, or Allegheny County funds.

The decision support system modeled in this research, as well as the version developed in 2012 by the Center for Disaster Management at the University of Pittsburgh, has already gained acceptance as a tool for planning and training activities. It is therefore recommended that current versions of decision support systems be utilized during incident command classes, regional tabletop exercises, and full-scale disaster drills, especially when simulating situations outside of the common knowledge base.

10.2.7 Establish Four Semi-Permanent Incident Management Teams

Informants confirm that in Allegheny County, well-established incident command teams display superior performance. Yet today, major events in the region feature management largely by incident commanders who are brought together on an ad hoc basis, and who do not display collaborative problem solving and decision making skills. Impromptu command teams simply do not have the necessary time to develop the group-wide cognitive abilities and collaborative problem solving skills described by Klein (1998) with regard to the characteristics of “mature teams.” In short, the members of hastily assembled teams are largely unknown quantities to each other.

Correspondingly, this study has shown that command effectiveness suffers when the actors at the command post are unfamiliar with one another, when they have personality conflicts, or when they simply have not had enough time to develop familiarity and trust in each other’s abilities. Further, the management of large-scale incidents is also hampered by uncertain processes of leadership emergence and by the uneven levels of training provided to command officers in Allegheny County.

Accordingly, the *strongest and potentially most significant policy recommendation* arising from the grounded nature of this study is a call for the inception of *permanently established and professionally trained unified command teams*, referred to in the ICS vernacular as local *Incident Management Teams* (IMTs). Of 75 informants, 47 (63%) express interest in and support for this concept, and many of those interviewed feel that the idea should be championed and supported by the Allegheny County Department of Emergency Services. Such strong support for this regional solution – in a region rife with parochialism – is the *most unexpected outcome* of this research.

Regional incident management teams, as envisioned here, would respond to large-scale events, providing skilled and seasoned staffing for unified command posts. Proficient in all aspects of collaborative incident management, these regional IMTs would feature the collaborative problem solving and decision making abilities that local teams might lack. Further, by staffing the crucial command post *management* functions, these teams would free up the senior officers of local agencies to serve as leaders of the *operational* functions (e.g. operations chiefs, sector chiefs, branch directors, or crew leaders).

To allay the fears of local officials, the members of an established incident management team would invite the senior local commander – usually the official who has legal authority over the scene – to become a full-fledged partner for the duration of the event. Other local representatives could also be added to the command post staff as liaison officers or technical specialists. In any event, the goal of any regional IMT would be clearly defined; to offer *support* to the county’s mutual aid groups, and not to usurp local authority.

To further assure local acceptance, it is suggested that *four incident management teams* be recruited from public safety agencies in the northern, southern, eastern and western regions of Allegheny County, from the Allegheny County Department of Emergency Services, and from the City of Pittsburgh’s Department of Public Safety. By drawing their membership in this way, regional IMTs would assure the inclusion of well-respected and seasoned emergency services officers from *local* public safety agencies. The four regional IMTs would operate as public safety *strike teams*³³, responding within their geographic areas to large-scale emergency events.

As the literature on small group dynamics emphasizes, and as an analysis of domain expert interviews confirms, the most effective problem solving teams consist of individuals who

³³ In the ICS system, *strike teams*, according to FEMA (2008), are made up of five or more individual resources of the same kind and type, and are deployed to address a specific problem.

have worked together *frequently*, preferably over the course of several years. As Danczyk (2008) posits, “personal interactions are created over time and are solidified to understand the personal strengths and abilities of counterparts.” He adds that for effective collaboration to be achieved, “a deeper understanding of colleagues” is necessary, and can only be achieved over time, through personal communications and interactions (Danczyk, 2008).

Trust is a crucial ingredient of effective of small group interaction, and it emerges when actors become familiar with each other, interact over time, and develop respect for one another (LaPorte and Metlay, 1996). Similarly, Austin (2000) maintains that long-standing personal relationships are “the glue” that allows collaborating groups to interact and function effectively. Oh (2010) adds to the chorus by arguing that turnover among the members of an incident management team is inimical to building trust among group members. It follows that those incident commanders who repeatedly work as a team will become more cohesive and will achieve a higher level of collaborative success than their ad hoc counterparts.

The process of implementing the regional IMT concept would be facilitated if the Allegheny County Department of Emergency Services took on the lead role in its promulgation. ACES personnel could help to staff these regional teams, and the county’s mobile command posts could be deployed to the scene of major incidents to provide a point of focus and collocation for IMT members.

If and when the regional incident command team concept is launched, the program would need enough time to gain the support of local public safety officials and political leaders. Informants to this research suggest that if regional incident management teams are allowed to demonstrate their worth over a span of approximately five years, they would earn local acceptance and become regarded as *non-threatening assets* to public safety. Furthermore, the

individuals chosen to staff the IMTs would themselves need enough time to develop into genuine partnerships of collaborative and effective decision makers.

This study has identified a number of dysfunctions regarding the management of major emergency events in Allegheny County. Based on the analyzed results of this research, permanent incident management teams would help to overcome a flawed system by providing the enhanced collaboration, leadership, information management and decision making capabilities that are now sorely lacking at large-scale operations.

As a final note of attestation to the potential benefits of regional IMTs, it is offered that decision support systems such as the Bayesian network model might represent the ideal match for a highly experience group of semi-permanent incident commanders, who would have the time to become adept at their use.

10.3 LIMITATIONS OF THIS STUDY

The primary limitation of this exploratory research is that the field study area is restricted to the political sub-divisions and emergency services systems of Allegheny County, Pennsylvania. Yet while this fact reduces its generalizability somewhat, the researcher believes that the findings of this study are applicable to situations and locales well beyond the parameters of this investigation. In particular, the conclusions dealing with command team formation and collaboration should be applicable to any region where the public safety structure exhibits high levels of fragmentation. In addition, the findings regarding communications and information systems, small group problem solving, decision making under uncertainty, and leadership emergence could apply to regions throughout the United States and beyond.

10.4 POSSIBILITIES FOR FUTURE RESEARCH

The nature of this investigation lends itself to additional inquiries into the large-scale incident management process.

10.4.1 Follow-Up Studies of Allegheny County's Command Teams

Three to five years after the completion of this study and its recommendations, a follow-up study can be conducted to assess the extent to which its policy recommendations were followed, and more importantly, whether they led to positive changes in the management of large-scale incidents in Allegheny County. Empirical evidence combined with additional interviews of regional unified command team leaders could then be used to make adjustments to the adopted policies.

10.4.2 Studies of Major Events Led by EMS or Law Enforcement

While this research uses fire service led command teams as its primary focus, future studies can develop the law enforcement, EMS, or other public sector aspect of joint incident management. Mass casualty incidents, large-scale evacuations, or acts of terrorism might provide additional subject matter for study. In addition, planned events – similar to the G-20 visit of world leaders in 2009 – would also offer areas for multidisciplinary study.

10.4.3 Extend DSS Tests to additional Specialized Scenarios

As noted in this research, the Bayesian network model of decision support holds promise as an aid to command team activities during highly complex and specialized emergency events. A logical extension of the gas well scenario modeled in this research would be an exploration of a wider range of *uncommon* incidents, where collective command team knowledge would be limited and where potential decision options were largely unknown. Modeling the decision options for the control of major industrial fires involving specialized chemical processes, or for widespread hazardous materials releases featuring the release of toxic gases are but two examples.

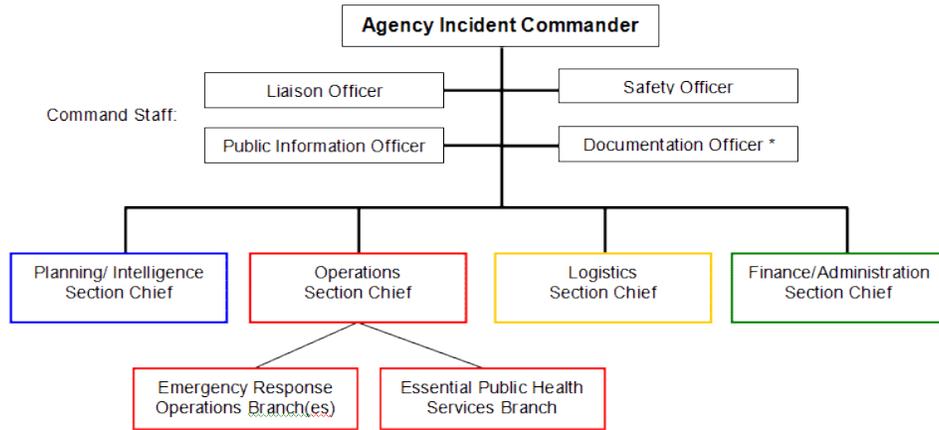
APPENDIX A

KEY OPERATIONAL CONCEPTS

<i>Nomenclature</i>	<i>Definition</i>
Major Disruptive Event / Large-Scale Emergency / Regional Emergency Event	An emergency event that requires the combined efforts of the personnel and resources of at least three municipalities, is multidisciplinary in nature, and requires at least six hours for emergency responders to bring under control.
Mutual Aid / Mutual Aid Agreements	Prearranged agreements between public safety agencies to provide essential assistance when local resources are inadequate to meet the needs of an emergency event.
Unified Command Teams / Incident Management Teams	Representatives of various agencies and disciplines – typically ranging from 3 to 7 individuals – who collocate at a command post to manage a large-scale emergency incident.
Operations / Operational Teams / Functional or Tactical Teams or Crews	Emergency responders who carry out the actual tasks that stem from the command team’s strategies and tactics. Responders are normally arrayed in teams serving under a supervisor, and report to a sector chief who controls several teams. Each sector chief reports to the command team.
Effective Incident Management / Collaboration	In this study, effective incident command is based on the guidelines of ICS. An effective UCT is able to collaborate on strategies and tactics that lead to incident control, while assuring the safety of emergency responders. It is also characterized by coordinated efforts that efficiently utilize disparate mutual aid resources.
Experienced Incident Commander	Knowledge, training, and expertise in the art of command. In this study, an experienced IC possesses a minimum of ten years in an emergency services specialty (police, fire, or EMS); five years of multi-agency incident command practice; and an advanced level incident command training.

APPENDIX B

SAMPLE ICS ORGANIZATIONAL CHARTS



APPENDIX C

SEMI-STRUCTURED INTERVIEW PROTOCOL

UNIFIED COMMAND OF MAJOR EMERGENCY EVENTS IN ALLEGHENY COUNTY, PENNSYLVANIA

Brian A. Colella
Interview Protocol
June, 2014

Introductory Questions

1. Can you give me a little background on your experience in the emergency services field?
 - a. How many years have you served in the emergency services field?
 - b. What is your current position with your agency?
 - c. How many years of experience do you have as a practicing incident commander?
2. Could you describe your agency's geographic response area?
3. Can you tell me about your agency's personnel and equipment?
4. What were the largest and most complex events that your agency has participated in during the last 10 years?
5. How often have you participated as a member of an incident command team (called a "unified command team" in this study) during large-scale emergency events which involved three or more municipalities?
 - a. How many individuals would you say are present as decision makers at the typical unified command post in your area of Allegheny County?
 - b. What has been your primary role at incident command posts?

Mutual Aid Responses and Networks

6. Does your agency regularly interact with other regional emergency service providers?
 - a. Which are you most likely to work with at the scene of a large-scale emergency?
 - b. At what type of incident would your service most likely participate in during a multiple agency response?
 - c. Does your agency participate in regularly scheduled or specialized training with your mutual aid partners?
7. Are there other agencies that you should be interacting with?
 - a. Why don't you work with them currently?
8. How often has your agency participated as a component of a unified command team during a large-scale emergency event?
 - a. What is the responsibility of each area agency or jurisdiction at a UCT?

Resource Allocation during Major Emergency Events

9. How are additional resources requested and dispatched during large-scale events?
10. Has the geographical distribution of area response agencies or municipal structures had any effect on (inhibited or facilitated) the dispatch of personnel or equipment into the threatened area?

Inhibitors and Facilitators of Command Team Formation

11. Do your agency's standard operating guidelines specify use of the Incident Command System (ICS)?
 - a. Are joint command posts set up during large-scale regional events?
12. Which factors facilitate or inhibit the formation of a unified command team?
 - a. Has the distribution of area response agency had any effect on (inhibited or facilitated) command team formation?
 - b. What are the effects of regular joint responses and training on command team formation?
 - c. What are the effects of joint training and exercises on command team formation?

UCT Procedures and Decision Making Processes

13. Does the process of joint command with your mutual aid partners help or hinder the management of a major regional emergency event?
14. How do you measure the effectiveness of a unified command team?
 - a. How could this level of effectiveness be improved?
15. With regard to the personal interactions that occur during UCT operations, how do the officials of different agencies, municipalities, or specialties deal with the question of legitimacy for joint decision making?
16. Please describe the decision making process at the typical unified command post.
 - a. Would you characterize it as formal or informal?
 - b. How does a command team typically arrive at joint decisions?
17. How often are technical specialists utilized at the command post?
 - a. Are these individuals given an active “voice” or role in the decision making process?

Leadership during Unified Command Team Operations

18. How do you define leadership at a joint command post?
 - a. What, in your opinion, are the most important leadership skills for incident commanders?
19. How does an official “rise to the top” to become the team leader or lead command official during joint command of an emergency incident?
 - a. Would you characterize this as a formal or informal process?

The Role of Information

20. In the event of a large regional emergency event, which communications methods are most and least helpful?
21. What types of information are critical to the management of a large-scale incident?
 - a. How quickly is this information needed?
 - b. How quickly is it typically received by the command team?

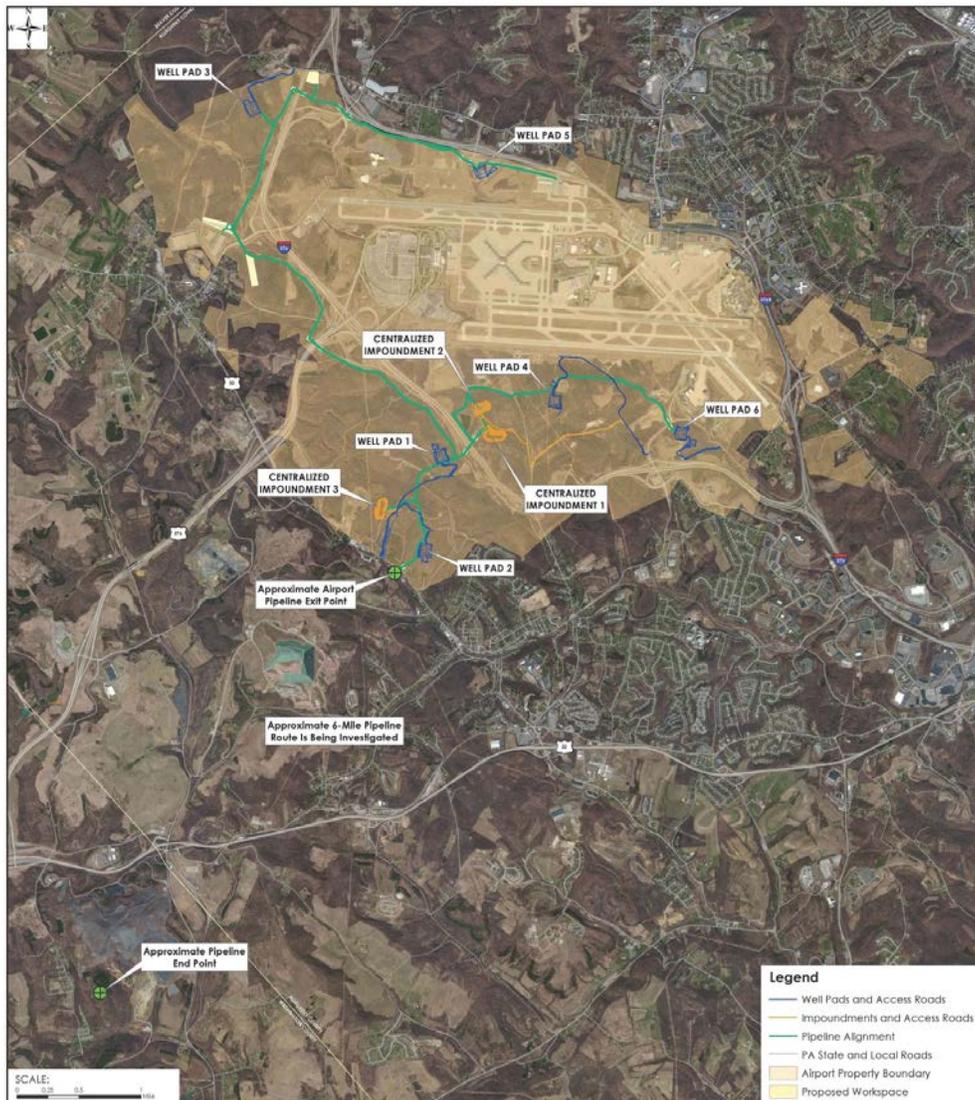
22. How does the typical command post in your area gather and use critical incident information?
 - a. How do the incident commanders disseminate this information to operational units at the scene of the emergency?
23. What type of information is typically available to you regarding the availability of county-wide assets?
 - a. Do you feel that it is adequate in order to request additional or specialized resources?
24. During command post operations, have you experienced difficulties with incomplete or inaccurate incident information?
 - a. Regarding abilities to communicate over the radio network?
 - b. Regarding availability of information?
25. What types of communications technologies are used by your response network?
 - a. Have these technologies created a common operating picture for the management of response operations? Why or why not?
26. What changes should be made to information and communications networks to enhance large-scale incident management?

Wrap-Up Questions

27. Do you have any suggestions for the future of the joint management of large-scale emergency events among Allegheny County's emergency services organizations?
 - a. Why are these suggestions necessary?
28. Would you like to add anything else to your description of the unified command process in Allegheny County?

APPENDIX D

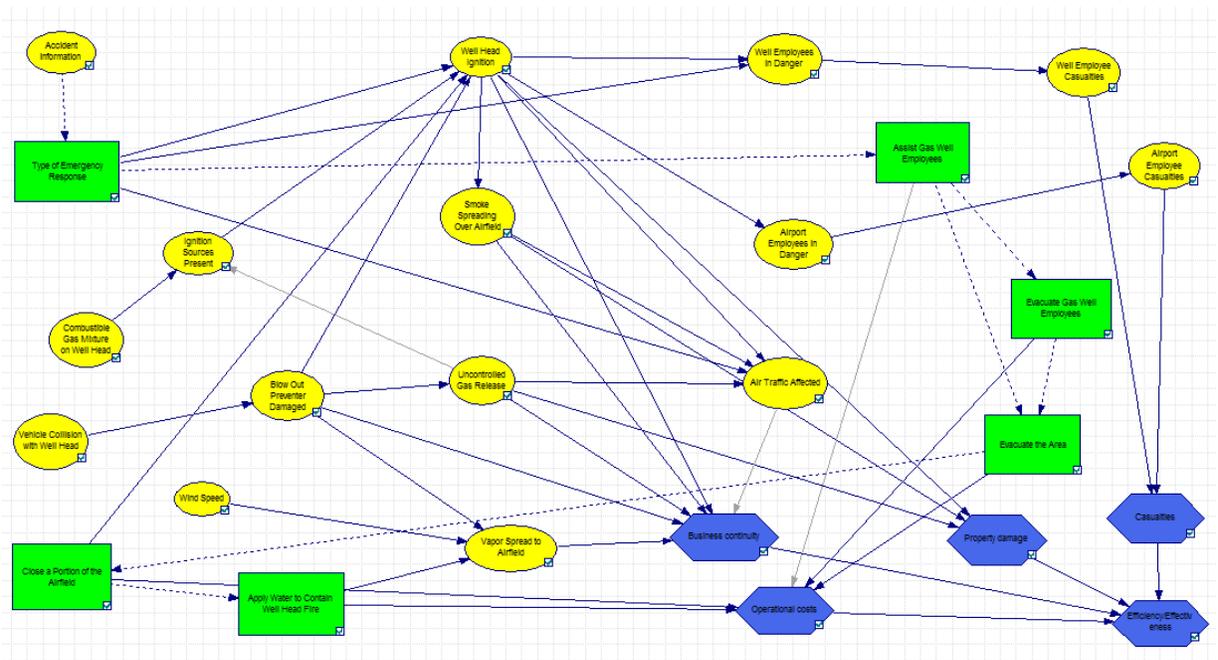
MARCELLUS GAS WELL PLAN: PITTSBURGH INTERNATIONAL AIRPORT

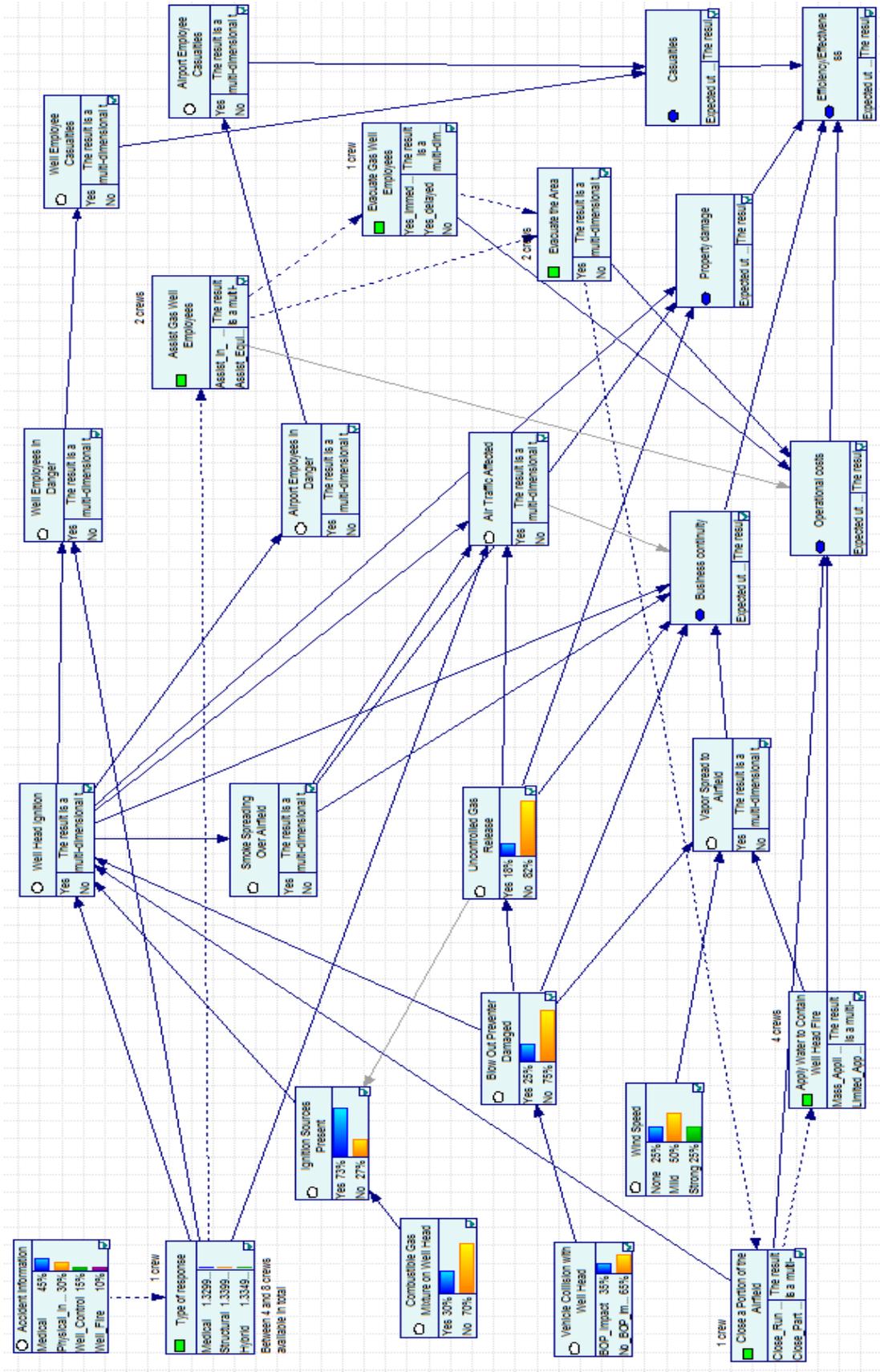


APPENDIX E

BAYESIAN MODEL OF DECISION SUPPORT USED IN THE AIRPORT SCENARIO

The following figures represent Node and Bar Chart depictions of the Bayesian Network Model utilized during the three airport demonstration and evaluation sessions.





APPENDIX F

BAYESIAN MODEL SIMULATION: EVALUATION SURVEY

Respondents were asked to select the answer that most closely expressed their opinion of the demonstration. Answers ranged from “Completely Disagree” (1) to “Completely Agree” (5).

1. It was easy to understand the overall operation of the model.
2. It was easy to understand how the scenario was represented on the influence diagram.
3. It was easy to understand what the influence diagram’s decision, chance, and utility nodes represented.
4. It was easy to understand how to update the model with new information.
5. The point and click function was an appropriate tool for adjusting incident information.
6. I would like to incorporate my preferences into the way that “effectiveness” of each option is calculated.
7. I would be able to make more effective decisions with this tool.
8. This tool would be useful at a unified command post during a typical large-scale regional emergency event.
9. This tool would be useful at a unified command post during a highly specialized large-scale emergency event.
10. This tool would be useful for classroom or tabletop training.
11. This tool would be useful in a large regional exercise.

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