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Terror Defeated: Occupant Sensemaking, Decision-Making and Protective Action in the 2001 World Trade Center Disaster

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TERROR DEFEATED:

OCCUPANT SENSEMAKING, DECISION-MAKING AND PROTECTIVE ACTION IN THE 2001 WORLD TRADE CENTER DISASTER

by

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TERROR DEFEATED: OCCUPANT SENSEMAKING, DECISION-MAKING AND PROTECTIVE ACTION IN THE 2001 WORLD TRADE CENTER DISASTER

Thesis directed by Professor Kathleen Tierney

This dissertation is a qualitative study of occupant behavior in response to the 2001 World Trade Center (WTC) disaster. Through analyses of transcripts from 245 face-to-face interviews with survivors from both WTC towers, collected by Project HEED, I investigate the pre-evacuation period in what became the largest full-scale building evacuation in history. The objectives of this study are to understand the types of actions performed before occupants began evacuation via stairs and elevators and why those actions were taken to improve techniques used and to address inadequacies in evacuation modeling tools. Drawing on social psychological theories of human action in normal times, collective behavior and sensemaking during normative crises, and emergency decision-making and protective action in response to hazards and disasters, and research on decision-making under uncertainty (including the importance of satisficing rationality), I examine how interviewees made sense of environmental cues, interpreted the situation and danger to themselves and others, and decided upon pre-evacuation actions, either to seek confirmation or achieve protection. Subsequently, I developed a predictive conceptual model of pre-evacuation actions by identifying the linkages between occupant- and situationally-based factors and the actions performed. I argue that occupant pre-evacuation behavior in the WTC disaster can be conceptually modeled by understanding both the disaster environment and the meanings individuals assigned to that environment. On 9/11, occupants consistently developed new social norms and lines of action based upon the meanings that occupants assigned to the situation, including perceptions of risk, familiarity with the building and others in the building, and responsibility for others. These meanings were dependent upon the receipt of environmental cues as well as on pre-existing norms, experiences, training, and social roles. My thesis contributes to empirical studies of decision-making during disasters and building fires, emergency planning and management, and the field of computer evacuation modeling

by examining the emergency decision-making process and the factors that influenced each stage of this process during the most deadly terrorist attack in U. S. history.

To my grandparents:

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Imagine a fire has started on the 5th floor of a 20-story office building. Luckily, the fire alarm sounds in ample time before toxic smoke exposes occupants to potentially life-threatening conditions. Everyone in the building is familiar with the meaning of the alarm and almost instantaneously, without question or disbelief, stands up. They recall from previous fire drills how to divide themselves equally among the available stairs on their floors. No one delays. Instead, they move quickly and calmly in efficient, single file lines to the closest stairs. Other than the constant beeping provided by the alarm system, occupants continue their evacuation in silence. There is no concern for people who cannot evacuate via the stairs, since all occupants in the building are able-bodied. They all evacuate safely and quickly via the stairs, leaving the elevators for use by the fire fighters.

This sounds like the perfect human response scenario, right? Unfortunately, this is far from reality. Just in 2009 alone, structure fires injured over 14,000 people and killed over 2,500 people in the United States (Karter 2010). In any fire, there are some occupants who are not able to self-evacuate under any circumstances, such as disabled or intoxicated occupants. Still, research on fire injuries and deaths shows that over two-thirds of the injured and over half of the dead in building fires could have evacuated, but instead were performing activities that delayed their safety, including fighting the fire, attempting to rescue others, and moving to safety under untenable, toxic conditions inside the building (Hall 2004). These realities raise the question of whether our buildings provide the necessary level of safety for occupants in building fires.

Life safety consultants, including fire protection engineers, fire marshals, and code consultants, use calculation techniques to assess the safety provided by a building. This is done by using hand-calculations or computer simulation models to calculate how long a population would take to evacuate a building design. If the population reaches safety before conditions in the building become toxic

(calculated by fire and toxicity models), by some added safety factor, then the structure is evaluated as sufficiently safe.

As impressive as these calculations techniques may seem, they make grossly inaccurate assumptions about the way humans respond during emergencies (Kuligowski, Peacock and Hoskins 2010; Santos and Aguirre 2004). Some calculation techniques assume people act in harmony with the perfect human response scenario described earlier. Other, more sophisticated techniques use safety factors or engineering judgments to account for any behavioral deviations from perfection. For example, time delays can be assigned to an evacuating building population to account for the performance of actions that are not directly related to safety. However, these provide only "band-aids" that fail to compensate for the lack of behavioral prediction included in calculation techniques, in that the engineer essentially determines human behavior ahead of time based on judgment and assumptions.

These assumptions likely originated from the longstanding belief in the field of fire protection engineering that human behavior during fires is just too complicated to predict. Misconceptions like this can arise from the media's constant misrepresentation of human behavior during emergencies as panic (Tierney 2003; Quarantelli and Dynes 1972). Newspapers, magazines, movies, and books consistently portray disaster victims in wild flight or hysterical breakdown, or in some cases, so shocked or "out of it" that they are unable to respond (Fahy and Proulx 2009; Fischer 1998). Since the 1995 Aum Shinrikyo sarin attacks in the Tokyo subway, the panic myth has also penetrated the discourse surrounding human response to terrorist events (Sheppard et al. 2006; Tierney 2003). After these attacks, the U.S. began to prepare for the "New Age of Terrorism," in which religiously motivated groups were likely to employ alterative weapons, such as weapons of mass destruction (WMD), against new types of targets (Chalk et al. 2005; Gearson 2002; Dishman 1999; Laqueur 1996). The media described response to the 2001 WTC attacks, the 2001 anthrax attacks and the failed 2005 bombing attacks on the London underground as panicked behavior (Fahy and Proulx 2009; Sheppard et al. 2006; Tierney 2003). Commentators also spread fears of panic by claiming that this new form of terrorism using chemical, biological or radiological attacks would lead to mass panic and deep-seated public fear (Cohen, Gould and Sidel 2004;

Stern 1999; Laqueur 1996; Kupperman and Trent 1979). Even authorities believed these myths about crisis behavior. In 2001, the United States government ran a bioterrorism exercise called Dark Winter in which the scenario depicted the public as panicked in response to a smallpox attack in the United States (Sheppard et al. 2006).

Also, human behavior can be deeply confusing to those who do not devote their careers to its understanding. For example, it is counterintuitive that people's first assumption in many disasters, regardless of the intensity of the information perceived, is that nothing unusual is happening, known as normalcy bias (Omer and Alon 1994; Tierney 1993; Drabek 1986; Okabe and Mikami 1982). Additionally, it is puzzling that individuals who have witnessed the same types of cues in an emergency can often react in very different ways.

Take two survivors from the 2001 World Trade Center (WTC) disaster, for example.[1] Survivor A was located in the bottom half of Tower 1 and Survivor B was located in the middle of the building; however, when the plane struck their tower, both felt the building jolt and heard the deafening, booming sound from the explosion above them (WTC1/025/0001[2] and WTC1/060/0001). Although they both began searching for information, Survivor A was only slightly fazed by the event, thinking that "I mean you're in America, nothing ever happens here" (WTC1/025/0001). As customers of Survivor A's company phoned to relay details of the event, that an explosion had occurred on the upper floors of his building or that a small plane had struck, he waited. Most of his department was leaving around him, encouraging him to leave as well; however, a group of them decided to stay. To him, there was no imminent danger if he stayed. He had worked on Wall Street for years and recalled nothing serious that had put him in danger before. Even when his group smelled something burning, they took it upon themselves to search for the source rather than leave the floor. It was not until Survivor A and his

[1] These examples were taken from the dataset used in this study, to be described later in this chapter (Galea et al. 2006).

[2] This code represents the HEED WTC identification number. An identification number is assigned to each interview transcript in the HEED database. The first set of information refers to the tower number, the second to the floor number, and the third to the number assigned to each interviewee on that floor. These designation codes will be used, as requested by Project HEED, throughout the dissertation when reference is made to a specific WTC respondent's story.

colleagues heard that another plane had struck the towers, this time hitting WTC 2, 16 minutes after the original crash at WTC 1, that they realized the seriousness of the event and began evacuation.

In contrast, Survivor B felt very much in danger immediately after his tower was hit (WTC1/060/0001). According to him, the only logical explanation for the sounds produced by the plane crash was that WTC 1 had been bombed again, similar to what had happened eight years before in the basement of WTC 1 (Isner and Klem 1993). It was not long until he began his duties as a fire monitor, instructing people in his section to "Get out, just get out!" and evacuated the floor himself.

Whereas Survivor B evacuated in a matter of minutes, Survivor A took over 16 minutes to even decide that evacuation was necessary. Scenarios like these likely cause confusion and frustration for engineers. Why such differences between two people in the same building during the same event? Why did Survivor A feel safe in the same situation that brought back fearful memories of the 1993 bombing for Survivor B?

What may seem at first like chaos or random behavior are carefully and logically constructed acts based upon occupants' understandings of the emergency. It is only when we understand how people interpret the situations around them, based upon the information that they perceive from their environment, that we can better understand and predict their resulting behavior.

The goal of this research is to develop theory that explains human behavior during building fires by examining occupant experiences in the destruction of the WTC towers following the terrorist attacks of September 11, 2001. My main research questions are the following: What self-protective actions did at-risk building occupants undertake during the 2001 WTC disaster, and why did they undertake those actions? To answer these questions, I developed a predictive model that explains occupant decision-making and action during the most deadly fires and building collapses in U.S. history. I developed the model by analyzing face-to-face interview data collected from survivors of the WTC building evacuations. The purpose of the model is to provide a qualitative understanding of why people behaved as they did prior to beginning evacuation from the two towers.

The purpose of completing this project is to expand the theory of emergency decision-making to include building fires and in turn, improve the calculation techniques that engineers use when assessing the safety of a building design. The assumptions of emergency behavior currently used in calculation techniques can produce inaccurate results. In cases where assumptions lead to evacuation timing estimates that are either too optimistic or too conservative, buildings and safety procedures may be designed that are insufficient on the one hand or unnecessary and costly on the other. We can improve the accuracy level of egress calculations through the incorporation of behavioral theories, which would ensure that future buildings are designed and built to a sufficient and necessary level of safety.

The description of the current state of egress calculations is by no means meant to diminish the significant efforts of previous researchers who studied behavioral response to building fires. Instead, this research study of the 2001 WTC disaster will build upon the important work of Bryan (2002; 1983; 1977), Canter (1980), Sime (1983), and others (Proulx 2002; Fahy and Proulx 1997; Brennan 1996).

Research Site

On September 11, 2001, two commercial airplanes flew into World Trade Center (WTC) Towers 1 and 2 and initiated full building evacuations from both 110-story office buildings. At 8:46 am, Flight 11 slammed into the north face of WTC 1, disconnecting the entire population above the 91st floor from any way out of the building. It was at this moment that the largest full-scale building evacuation in history began for occupants who had the opportunity to evacuate from both WTC 1 and 2. None of them knew, however, that another commercial jet was on its way – one that was heading straight for WTC 2. Sixteen minutes after WTC 1 was struck and after one-third of WTC occupants had already evacuated,[3] Flight 175 sliced into floors 78 to 84 of WTC 2 leaving only one of the three stairs available for evacuees above the 78th floor. Occupants who could evacuate continued to pour from the structures until the towers eventually succumbed to structural collapse.

[3] 21% from WTC 1 and 41% from WTC 2 (Averill et al. 2005)

The 2001 WTC disaster was the most significant high-rise evacuation in modern times. The event was studied as part of several different projects around the world. Three projects in particular performed interviews, both face-to-face and over the phone, to obtain information on survivors' experiences. I was involved in one of the first projects to perform an in-depth analysis of the evacuation -- the three-year National Institute of Standards and Technology's Federal Building and Fire Safety Investigation of the World Trade Center Disaster. I was a team member on the project assigned to investigate occupant behavior, egress, and emergency communications in WTC 1 and 2. We collected information on occupant experiences via face-to-face and telephone interviews, as well as focus groups with specific occupants. As I studied the face-to-face interview data, which inquired about individual actions taken during evacuation, I began to see basic trends underlying the performance of each action. At that stage in my career, I did not know about the methods used to predict evacuation actions. However, through the course of the investigation and working with experts in human behavior in fires, I developed an insatiable interest to learn more.

Other researchers conducted studies of the 2001 WTC disaster, with different objectives in mind. Researchers at Columbia University Mailman School of Public Health conducted a three-year, five phase study of the WTC evacuation of towers 1 and 2 to improve understanding of the individual, organizational, and environmental factors that helped or hindered evacuation (Gershon et al. 2008; Gershon et al. 2007). Both quantitative and qualitative data were collected as part of this study, and using participatory action research as their foundation, WTC survivors, researchers on the project, and consultants developed recommendations to improve high-rise evacuation from business occupancies.

The WTC evacuation was also studied as part of an in-depth research project carried out by the Project High-rise Evacuation Evaluation Database (HEED) research team (Galea et al. 2006). Project HEED was a three-year project to explore human behavior associated with the evacuation of high-rise buildings. The basis for this project was an analysis of the 2001 WTC disaster through both face-to-face interviews with survivors and computer simulation of the evacuation. The project resulted in over 250 face-to-face or telephone interviews with survivors from the 2001 WTC disaster, collected to both inform

the development of future building regulations and evacuation computer models and to make available to bona fide building safety researchers in countries around the world. The HEED dataset served as the interview data that I analyzed for this research study.

In this study of evacuation behavior, I examined evacuation behavior of WTC 1 and 2 occupants beginning with the moment they saw, heard, or felt the plane's impact into WTC 1. My analyses of evacuee behavior ended as soon as each occupant left his or her floor and entered the stairs or elevators. This is because I am specifically studying the pre-evacuation period of the evacuation process.

Egress calculation techniques represent occupant evacuation from buildings over two distinct time periods: the pre-evacuation period and the evacuation period. In these calculations, the pre-evacuation period begins when the occupant realizes that something is wrong and ends when he begins to travel an evacuation route out of the building. As noted earlier, some techniques treat this period as unproblematic and assume that evacuation begins almost immediately. The evacuation period ends when the occupant has reached a point of safety. This project focuses on the pre-evacuation period because this phase is poorly understood and modeled by researchers, and because occupants' tendency to delay, rather than beginning to exit the building during this period, can endanger lives.

Conceptual Framework

Data and theory on human behavior during the pre-evacuation period are sparse. Case studies and research on particular building fires (Averill et al. 2005; Grosshandler et al. 2005; Isner and Klem 1993) have shown that occupants are likely to engage in a variety of actions, such as information gathering, preparation, assisting others, alerting, and even fighting the fire (Galea et al. 2009; Bryan 2002; Canter, Breaux and Sime 1980). However, there is little or no understanding of why certain actions are performed (or not) during the pre-evacuation period or how long people engage in such activities.

What is known, instead, is what *does not* influence behavior during the pre-evacuation period in a building fire. First, occupants do not act randomly without cause, as if in a panic (Sime 1983). Second, they do not act in an identical "mass movement" manner as if they are a flock of birds (Johnson, Feinberg

and Johnston 1994). Rather, individuals perform very different activities under fire hazard conditions, typically recognizing different cues (e.g., flames, smoke, breaking glass, the sight of other occupants' actions) in different places throughout the building. As mentioned earlier, even in situations where the same or similar cues are presented to members of a group, individuals are likely to interpret those cues differently and act in different ways (Mileti and Sorensen 1990). Case studies and research have shown that behaviorist assumptions and simple stimulus-response models (Watson 1913) are not appropriate for most building fires. Indeed, even when a group of individuals hears the same fire alarm (Proulx and Laroche 2003) or witnesses the same cloud of smoke (Latane and Darley 1970) individuals respond in different ways.[4] Last, even though sociological structural theories posit that factors such as social position, status demands, social roles, culture, and norms and values (Merton 1968; Parsons 1951) directly influence the types of activities performed by individuals, no research has documented any fire events in which structural factors and roles predicted well either pre-evacuation or evacuation behavior. In sum, the field of human behavior in fire has been fairly silent on the nature and extent of behaviors undertaken during fires, or why people undertake those behaviors.

The constructed act

This dissertation relies on insights from the symbolic interactionist (SI) perspective which offers an explanation of individual and group behavior both during normal times and under threat conditions. Blumer (1969), who coined the SI term based upon Mead's theories of the self and self-indication (Mead 1967), argues that people act toward things based on the meanings that those things have for them, and that these meanings are derived from social interaction and modified through interpretation. Through the process of self-indication, humans take notice of various things in the environment, interpret and provide meaning to objects, develop various possibilities of action, and then select a line of action to take. Similarly, Thomas (1923) states that before any self-determined act of behavior can occur, there is always

[4] One possible exception is in mass crowd events in which all occupants are densely located in the same area and are affected by the fire in the same way. In such cases, they are likely to respond in similar ways to the fire cues presented (Santos and Aguirre 2004); however, panic is rarely seen even in these events.

a stage of examination and deliberation which he has termed the "definition of the situation." In problem solving (Mead 1938), for example, this process is seldom perfect in that individuals may neglect to note certain cues, misinterpret the meaning(s) of objects, or exercise poor judgment concerning potential options. Therefore, individuals may have to revisit various stages in the behavioral process in order to engage in the appropriate next action.

SI theorists recognize that the formation of actions by an individual through the process of self-indication always occurs in a social context (Blumer 1969). According to Blumer, group action is achieved by fitting together individual lines of action. Within the group, the individual is the primary actor who constructs her behavior to align with the behavior of others around her based on her symbolic representations to herself (i.e., meanings) of the situation, which include what others expect of her. This is achieved by taking the role of the other.[5] Human societies, according to SI, are composed of individuals who are continually taking into account the actions of others and then acting accordingly, in turn, indicating to others how to (re)act.

However, social constructionism argues that individuals need not define each situation anew before every action (Berger and Luckmann 1966). Many of the actions that we perform on a daily basis have become habitual. Berger and Luckmann (1966:53) state that "any action that is repeated frequently becomes cast into a pattern, which can then be reproduced with an economy of effort …" Habitualized actions are still performed based upon situational meanings. However, these meanings were developed historically, and over time, became embedded as routines enacted by individuals, so that when actions are performed in the present, individuals take meanings for granted. Under normal conditions, habitualization releases individuals from the burdens of decision-making. The stored meanings and interpretations direct individuals on a daily basis allowing them to "proceed with a minimum of decision-making most of the time…" (Berger and Luckmann 1966:53). Many different actions that an individual performs on a daily basis may be performed under these already developed "predefinitions."

[5] By taking the role of the other, Mead is referring to an individual aligning her actions with the actions of others in the group by determining what they are doing or what they intend to do (i.e., discerning the meaning of their acts) (Mead 1967; Blumer 1969).

As individuals engage in habitualized actions with one another, typifying themselves in various roles in relation to one another, institutionalization occurs, in which "the institution posits that actions of type X will be performed by actors of type X" (Berger and Luckmann 1966:54). Institutions are products of a history of individuals interacting with one another. Once they are developed, institutions shape individuals' actions by setting up predefined patterns of behavior that individuals follow. Institutionalized interactions of individuals become predictable, in that the meanings of each situation are already defined. Among other things, institutionalized behavior involves the fulfillment of roles that help to identify an individual's own behavior in the context of the behavior of others, with the understanding that they may hold a different role. The inclusion of roles helps influence the conduct of others mainly owing to the fact that compliance with the socially-defined role is strongly encouraged. Because individuals do not have to develop meanings associated with each action, their roles in institutions are taken as a given or as inherent, rather than something that was socially constructed. The existing institution has the character of objectivity rather than one of subjectivity and is taken as "reality" -- "as given, unalterable and self-evident" (Berger and Luckmann 1966:59).

This objective meaning assigned to institutional activity is referred to as the "social stock of knowledge" (Berger and Luckmann 1966), a form of knowledge that belongs to each individual in the institution and consists of the aspects of everyday life with which the individual deals most, including shared routines, habitualizations, and his and others' roles. Each individual possesses an internal set of knowledge about relevant aspects of society, experiences from participation in society, and structural relations within that society (Berger and Luckmann 1966). The individual relies on the social stock of knowledge when engaging in habitualized actions.

Both SI and social constructionism emphasize the concept of a constructed "reality" to explain how an act is constructed by an individual. SI refers to a "reality" that is constructed by the individual in preparation for the next action (Blumer 1969). This "reality" is *situational* in nature because it is established *in the present*, based upon the current situation, including the information perceived from the current environment. Social constructionism posits a "reality" that is constructed from actions and

interactions performed by members of society that eventually become internalized within the individual (Berger and Luckmann 1966). This "reality" is also *historical* in nature because it is established *in the past* (as recently as seconds ago) and brought to any current situation as an individual's social stock of knowledge.

The integration of the symbolic interactionist perspective and social constructionism theory provides the foundation for understanding how individuals act or behave both in everyday life when external conditions are unproblematic and during crisis situations. An individual act is the result of the following behavioral process: perception (or noting of the environment), interpretation or meaning-making regarding the current environment, and decision-making. For habitual actions, an individual's social stock of knowledge provides the basis for the meaning that the individual brings into any situation that in turn, contributes to the action taken. Figure 1-1 shows a schematic of the process by which individuals perform actions in normal, non-crisis conditions.

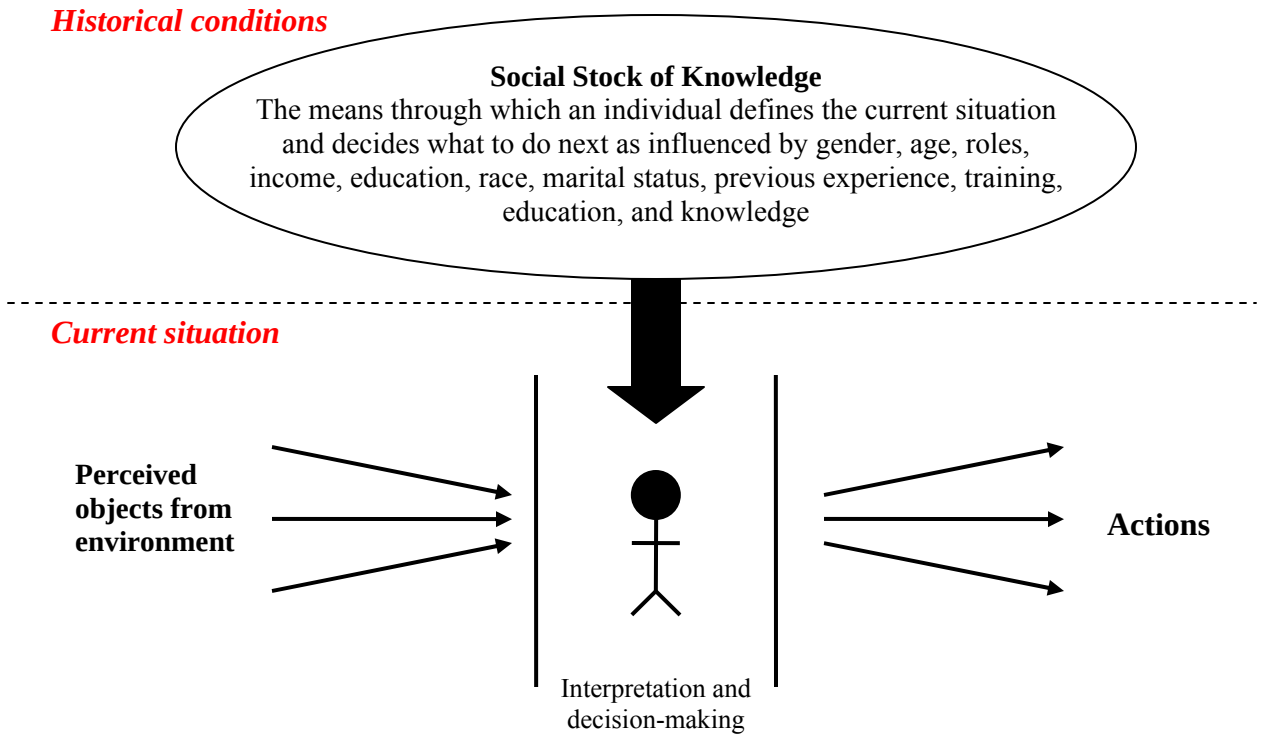


Figure 1-1: The production of action through habituated meanings

The constructed act in uncertainty and crisis

Most situations encountered by individuals on a day-to-day basis are already well constructed and defined and are thus non-problematic from the point of view of the individual. As Berger and Luckmann observe (1966:53), "…by providing a stable minimum of decision-making most of the time, [the stock of knowledge] frees energy for such decisions as may be necessary on certain occasions." However, rare situations, such as a building fire or some other extreme event, challenge existing constructions. In these situations, individuals confront unfamiliar cues (e.g., breaking glass, smoke, flames, others' actions, and other unusual sensory phenomena) and in turn, engage in interpretive processes and develop emerging definitions of the situation and various (and sometimes harmful) solutions on how to behave based on the changing circumstances.

Under such conditions, the actions of individuals are no longer habitualized. Individuals are required to make a concerted effort to create meaning out of new and very unfamiliar situations, often under time pressure, and from this meaning, a different set of actions is likely to be created. There are theories and research that discuss human behavior under uncertainty or unfamiliar situations. One such theoretical approach is the emergent norm theory.

Emergent norm theory (ENT), which is based on SI, explains the process of meaning-making in the face of uncertain conditions (Turner and Killian 1987; 1972; 1957). ENT posits that in situations where an event occurs that creates a normative crisis (i.e., an event where the institutionalized norms no longer apply), individuals interact collectively to create an emergent situationally-specific set of norms to guide their future behavior.

According to Turner and Killian (1987), collective behavior takes place when the taken-for-granted norms and social structure no longer provide adequate guidance for behavior. If the norms and social structure incorporate sufficient instructions or conditions for dealing with changes in the physical, social or cultural environment, collective behavior will not develop (Turner and Killian 1987). However, occasionally situations occur that are extremely novel and outside the parameters of routine experiences. Turner and Killian (1987) discuss the conditions that are conducive to collective behavior. The most significant condition is a "real or perceived conflict, ambiguity or change in the normative order" (Turner and Killian (1987:40). Other conditions include a change in the social structure or the flow of information within the collectivity. Additionally, there must be a group that has formed in relation to some event, interaction and exploration within the group from which a sense of feasibility and timeliness develops, and the formation of an emergent norm from this interaction that defines the current situation and the action that should result from the new norm.

The central process that takes place in collective behavior episodes is the construction of a novel definition of the situation through symbolic interaction (Turner and Killian 1987). Because conventional or traditional norms no longer apply, individuals must work together to redefine the situation and propose

a new set of actions. This new set of definitions and norms is the product of milling and keynoting processes.

Milling is a communication process whereby individuals in a collectivity attempt to define the situation (reminiscent of Thomas [1923] and Blumer [1969]), propose and adopt new appropriate norms for behavior, and seek coordinated action to find a solution to the shared problem at hand (Aguirre, Wenger and Vigo 1998). The group engages in both physical and verbal communication in order to ask the three following questions; 1) what happened? 2) what should we do? and 3) who should act first? (known as leadership selection) (McPhail 1991; Turner and Killian 1972). Leaders emerge as keynoters, or those who advance suggested interpretations of the event or suggestions on what do to next (Connell 2001; Turner and Killian 1987). Keynoters can even take the role of calming down other group members and providing confidence to the group. The consequences of the milling process are that individuals become sensitized to one another, that a common mood develops, and that a collective definition of the situation is decided upon that minimizes initial ambiguity (Turner and Killian 1957). Overall, in the face of new and uncertain situations, milling and the keynoting processes allow the group to define the situation and to propose next steps for alternative schemes of social action (Connell 2001; Aguirre, Wenger and Vigo 1998; Turner and Killian 1957).

Over the years, theorists have critiqued certain aspects of ENT, which have led to revisions of the theory (McPhail 1991; Tierney 1980; Weller and Quarantelli 1973). In an article by Weller and Quarantelli (1973) entitled, "Neglected Characteristics of Collective Behavior," the authors discuss the failure to identify the social properties of collective behavior. The critique of ENT most relevant to this study is that the theory suggests that individuals engage in collective behavior without guidance from previously defined social structure. "In their [Turner and Killian's] terms this means that participants act without the benefit of patterned generalized expectation associated with social statuses" (Weller and Quarantelli 1973:671). Weller and Quarantelli (1973:675) posit that the "foundations of the social action of any collectivity are social norms and social relationships." Rather than being a completely new definition of the situation, an emergent norm should be viewed more as a revised definition of the

situation developed within the context of pre-existing norms and social relationships. From this understanding, three different types of collective behavior are possible: one in which both norms and relationships are emergent, one in which norms are emergent and relationships are pre-existing, and one in which norms are pre-existing and relationships are emergent.

Similarly, McPhail (1991) has also critiqued ENT and its lack of acknowledgement of the influence of pre-existing roles in the milling process. ENT's discussion of the milling process suggests that any individual, regardless of social status, can produce suggestions that the group may or may not follow. In contrast, McPhail (1991) suggests that an individual's social roles and previous experience and knowledge are likely to influence her involvement in the keynoting and milling processes. Because some people within a collectivity may have more experience in the current situation than others, their experience is likely to redefine the situation for novices.

These theorists suggest that the norms developed within a collective do not emerge in a social vacuum. Rather, individuals within a collectivity bring to the situation their social stock of knowledge as well as conventional norms, which are likely to influence, in some way, the norms that are developed during collective behavior. Perhaps in response to these critiques, in the 1987 re-formulation of their theory, Turner and Killian (1987:54) stated that "…there is a continuity between the normal, seemingly well-structured situation and the ambiguous one in which new definitions are sought." Their revised version of the theory includes a description of collective behavior that acknowledges the influence of pre-existing norms and social structure on the development of the emergent norm during collective behavior.

Whereas ENT focuses on interpretation and decision-making as a norm-generating process, other theories and research focus in different ways on techniques used by individuals to make sense of new environments and develop possible options for action in situations involving uncertainty. Such approaches suggest that individuals engage in their own mental processing of events, interpretations, and decisions suggested by members of their group. In doing so, individuals use previously-developed behavioral scripts (Gioia and Poole 1984), mental simulation (Klein 1999), the use of mental models (Burns 2005), and sensemaking processes (Rudolph and Raemer 2004; Weick 1995; Weick 1993) to

interpret the current situation and make decisions on actions in which to engage. Through the use of these techniques, individuals can develop cognitive images of what is going on in their environment, based on the cues that they have perceived, and what is likely to occur subsequently. These images constitute mental pictures, or stories of an event, allowing individuals to begin to plan subsequent actions based on the consequences they envision.

The constructed act in response to disaster

Up until now, the perspectives and theories presented explain behavior during stable conditions and conditions where traditional or conventional norms no longer apply. ENT specifies that disasters may lead to collective behavior. However, the theory sees disasters as one of the many types of situations where collective behavior may take place, including demonstrations, looting, and general crowd movement.

In contrast, the Protective Action Decision Model (PADM) provides a framework that describes information flow and decision-making specifically in response to a disaster (Lindell and Perry 2004). This model, which incorporates insights from ENT, was developed based upon over 50 years of empirical studies on the social processes of human response to disasters (Sorensen and Vogt Sorensen 2006; Mileti and Peek 2001; Tierney, Lindell and Perry 2001; Mileti and Sorensen 1990; Drabek 1986; Mileti, Drabek and Haas 1975). This research shows that cues from the physical environment as well as information from the social environment (i.e., emergency messages or warnings), if perceived as indicating the existence of a threat, can interrupt normal activities of the recipient. Depending upon the perceived characteristics of the threat (e.g., assessments of risk to themselves or others), they will either seek additional information, engage in problem-focused actions to protect people or property, perform emotion-focused actions to reduce psychological stresses, or resume normal activities (Lindell and Perry 2004). In addition to perceptions of the threat, responses are also determined by the perceived feasibility of protective actions. Even though the focus of this model is on community-wide disasters, many of the stages in the framework apply to decision-making during more localized events, such as the building attacks studied here.

Theoretical and Practical Gaps in the Study of Building Fires

Research has established the process through which community residents make decisions in response to disasters (Lindell and Perry 2004). Models have been developed that describe the processes of seeking information, interpreting the situation, assessing the risk, and then deciding whether to take protective action. However, existing models do not provide sufficient information on the specifics or the *types* of protective actions in which occupants engage and why they engage in these types of actions during emergencies, which would be necessary for improving evacuation models to better incorporate and simulate individual and group behavior.

Additionally, research on disaster response, including the PADM, generally focuses on a different time frame from that of a building fire. Many of the empirical studies of disasters upon which the PADM is based focus on the decisions made by residents in response to emergency warnings and evacuation advisories. In these situations, the disaster has not yet occurred, and the warning recipients must determine if an emergency will take place that will put them at risk. In many cases, warning periods can be quite lengthy, extending over many hours or even days. These studies focus on whether (and how) those who have been warned decide to evacuate before the disaster occurs. In a building fire, occupants react to the situation as the fire grows and the event becomes more and more dangerous. Since actions are performed *as the emergency occurs*, and since in building fires, warning times are generally quite short, it is important to study building fires and how they differ from many other types of disasters. Some of the protective actions and factors that influence these actions may be different simply because they are taking place while the emergency is occurring, potentially placing building occupants at risk. For example, in addition to warning messages, occupants in a building fire are likely to be presented with environmental cues from the fire, including seeing smoke and flames. This is not the case in many other types of

disasters where residents are often provided with a warning to evacuate hours or days before the disaster occurs.[6]

Finally, many of the findings upon which the PADM was developed were obtained by using quantitative methods. What quantitative studies gain in the ability to generalize, they lose in the lack of detail regarding information-rich data, such as accounts of interpretations of the situations and risks that precede each action performed. Without sufficient detail on interpretations and risk assessments, it is difficult to understand how those at risk interpret cues and events, the ways in which interpretations change from one point in time to another, and the influence of these interpretations on actions. Also, quantitative studies are often unable to shed light on details and nuances associated with the actions themselves. For example, the act of information-seeking can be performed in a variety of ways, from scanning the internet to asking a person nearby. Whereas the first action type listed can be performed alone, the second action type initiates group behavior, potentially influencing the actions of others.

This project will directly contribute to disaster and fire theory by providing the first inductively-developed, individually- (or evacuee-) based model explaining the actions taken during the pre-evacuation period of a building fire. This project's extensive analyses and model results describe evacuation decision processes in much greater detail than either research on building fires or studies on community-wide evacuation, focusing on how people perceive and interpret environmental cues and warnings, how they seek confirmation during sensemaking and milling processes, and what they do before moving to safety. To develop the model, I analyzed 245 face-to-face interview transcripts of WTC survivors' evacuation experiences, originally collected by the Project High-rise Evacuation Evaluation Database (HEED) research team (Galea et al. 2006). For the first time in human behavior in fire and in disaster research, this study will describe *why* certain activities are performed during pre-evacuation by focusing on and highlighting the individual interpretations that led to decisions and eventually the performance of actions during the WTC evacuation. It is only through an understanding of the process

[6] Fires are of course not unique in allowing little or no warning. The same is the case for many technological disasters (e.g., industrial explosions) and some natural hazards (e.g., tornadoes).

through which actions are constructed that we can begin to predict the types of activities performed by evacuees in a building fire.

Research Questions

The goal of this research is to inductively develop an individually-based theoretical model that explains why certain activities were performed by individuals during the pre-evacuation period of the 2001 WTC evacuation. The following list of main and secondary research questions served as the basis for the proposed project:

What actions did building occupants undertake during pre-evacuation of the 2001 WTC evacuation and why did they undertake such actions?

- How did historical and situational conditions interact and affect interpretations, and in turn, how did individuals' interpretations affect decisions made to perform each type of pre-evacuation action?
- What were the consequences of each pre-evacuation action?

For the first set of secondary questions, I determined the historical and situational conditions that influenced certain interpretations of the situations that ultimately influenced the performance of pre-evacuation actions. Historical conditions can consist of any aspect of an individual's social stock of knowledge including structural factors (e.g., role, gender, age, income, and education) and experience and knowledge about an event (e.g., an occupant's previous experience in fire evacuations, previous training for or education about evacuation from a building fire, and knowledge about building evacuation procedures) that he brings into any current situation or event. These historical conditions could have been developed and established many years in the past or minutes before the current moment in time. Situational conditions can consist of any objects or information from the environment that were presented to the individual at the current moment in time, including both physical and social cues related to the event. Many of these conditions were experienced by individuals through social interaction, creating an interpretation of the event that then influenced the performance of a specific pre-evacuation action.

I also determined the consequences of each action in the pre-evacuation period. Because the pre-evacuation period is essentially a series of linked consecutive actions, in many circumstances, the

consequences of a specific action can be thought of as the conditions for the next action. By answering this question, I developed an understanding of not only the influences on each action, but also the sequences of behaviors during pre-evacuation.

Basic Premises of the Project

The research that forms the conceptual framework for this project highlights the significant influence of meanings on the actions performed. As mentioned earlier, in normal, everyday conditions, these meanings are incorporated into the social stock of knowledge, and we perform habitualized actions based on this knowledge, rather than creating and recreating meaning before each action (Berger and Luckmann 1966). However, in situations where these norms are not appropriate, collectivities develop a new definition of the situation through symbolic interaction, i.e., the milling and keynoting processes, based on the information perceived from the current situation (Turner and Killian 1987) as well as pre-existing norms and social relationships (Weller and Quarantelli 1973). Applying these theories to disaster settings, individuals engage in protective actions based upon their interpretations of the situation as an emergency, and their assessments of risk, as dangerous or risky (Lindell and Perry 2004). Using this conceptual framework, I proposed the following four hypotheses about what I expected to find when studying the 2001 WTC disaster:

1) When the event first occurred, WTC occupants engaged in symbolic interaction processes to create meaning. This meaning in the WTC was a new normative structure to guide their future behavior. To create this new normative structure, they engaged in ***information seeking actions*** to define the situation and what it meant to them.

2) Based on the definition of the situation (above), a new line of action was created. If occupants interpreted the situation as one that was risky to them, they began performance of ***protective actions***. If not, they continued their ***previous actions*** or continued ***information seeking***.

3) Each protective action was also ***constructed*** based upon the meanings assigned to objects in the occupants' environment, the definition of the situation, and the assessment of risk.

4) The search for the new normative structure and the performance of protective actions occurred within both pre-existing social relationships and norms (an individual's social stock of knowledge).

Discussions in the data analysis and concluding chapters of the dissertation explore the extent to which these assumptions were borne out by the data.

Organization of the Dissertation

The dissertation is organized into five chapters, including this introductory chapter. The second chapter, Research Methods, discusses the qualitative research methods used in this study. I discuss the benefits of qualitative research in addressing the study's research questions and the reasons why I chose to study occupant evacuation from the WTC towers on September 11, 2001. I also describe the specific qualitative methods used in this study, including data collection efforts performed by Project HEED and my methods for data analysis using the analysis method framework originally developed by Richie and Spencer (1994). The methods chapter ends with a discussion of methodological issues and challenges.

The third chapter describes the experiences of WTC occupants as they progressed through the emergency decision-making process and eventually decided upon a plan for achieving safety. I begin Chapter 3 with a discussion of social theory and the empirical study of emergency decision-making processes. Then, I present a description of the decision-making process in the WTC, highlighting the stages of activity in which occupants engaged to eventually achieve protection. Results from the WTC showed that the milling process was crucial, in that almost all WTC occupants engaged in milling to define the situation, the risk and newly-proposed actions. Once the decision to take protective action was made, occupants engaged in actions intended to protect themselves and other people in the towers. Finally, results from the WTC showed that the process of decision-making was iterative. Each time occupants perceived new information as the crisis in the twin towers unfolded, they spent time in the milling process to understand the information and what it meant. The chapter ends with a comparison of the experiences of 2001 WTC occupants with those in other building fire and disaster events, primarily discussing whether the WTC decision-making process was consistent with the processes outlined by ENT and the PADM. The WTC, for the most part, validated the processes outlined by ENT and the PADM.

The fourth chapter presents the predictive model for WTC pre-evacuation actions. I begin the chapter with a discussion of the factors identified by empirical studies of disasters and building fires as influential for the performance of protective action during an emergency. Then, I present the WTC pre-evacuation predictive model by identifying the factors that influenced each pre-evacuation action taken, including milling and protective actions. Occupants engaged in milling actions until they reached one of two thresholds, after which they transitioned to the performance of protective actions. The first group of occupants, those with pre-disaster management roles, military experience, or emergency-related experience, roles, or occupations, reached the first threshold after confirming or personalizing risk associated with the attacks. All other occupants, regardless of their perceptions of risk, transitioned to the performance of protective actions after receiving instructions to evacuate from select individuals in the first group. Additional protective actions were taken based upon occupants' perceived responsibilities or social ties with others; the actions of others, which increased the perceived safety of the action; social roles, including gender; and previous emergency experience or training in the towers. Although some norms truly emerged on 9/11, many others were developed based on existing norms and social relationships that occupants expanded upon during disaster response. The chapter ends with a discussion of the consistencies and inconsistencies among the WTC findings and social theory, including ENT and sensemaking theories, as well as empirical disaster and fire studies. Also, social and decision-making theories are presented to explain the underlying processes behind decisions made and actions taken in the WTC. I conclude my research efforts in Chapter 5 with a summary of my research findings and a discussion of the theoretical and practical implications of the study.

Chapter 2 - Research Methods

Chapter 1 presented the purpose, conceptual framework, and research questions for this study. The purpose of this chapter is to describe the methods for this research. The chapter begins with a discussion on the use of qualitative methods to understand behavior in the WTC towers. Then, I present a review of the data used for this project, along with a discussion on the techniques used to analyze the data. The chapter concludes with a discussion of the methodological issues and challenges that arose throughout the research.

Research Design

Social science research can be performed using qualitative methods, quantitative methods, or a mixed-methods approach. In the disaster field specifically, qualitative research dominated the early work (Mileti and Peek 2001; Drabek 1997; Phillips 1997). Early qualitative research focused on the understanding of human response to disasters, including response to explosions (Drabek 1968; Prince 1920[7]); disease threats (Diggory 1956); natural hazards (Ponting and Quarantelli 1973; Drabek and Stephenson III 1971; Friedsam 1961); and civil disturbances (Quarantelli, Ponting and Fitzpatrick 1974), as well as a summary of response to a variety of disasters (Fritz and Marks 1954). Other qualitative disaster research has focused on organizations and their role in emergency planning for disasters (Quarantelli et al. 1979; Dynes and Quarantelli 1975) and response to disasters (Dynes 1968; Warheit and Dynes 1968; Quarantelli, Dynes and Haas 1966).

Since then, the field of disaster research has used both qualitative and quantitative methods to study human response. Much of the research on human response to emergency warnings has been conducted using quantitative methods; i.e., survey research techniques, self-administered surveys, and telephone interviews (e.g., Averill et al. 2005; Lindell, Lu and Prater 2005; Bourque, Shoaf and Nguyen

[7] Most disaster researchers cite Prince's study of Halifax as the first disaster research study (Phillips 1997).

1997; Bourque and Russell 1994; Mileti 1993; Aguirre 1991; Cutter and Barnes 1982). From these numerical data, researchers use quantitative techniques, e.g., regression modeling, to determine the variables that influence, among other things, whether an individual engages in preparedness behavior before a disaster occurs, perceives a certain level of risk before or during a disaster, or decides to evacuate once a warning is disseminated. Even with the focus on quantitative modeling, disaster researchers continue to collect rich, in-depth qualitative data of human experiences before and during disasters, including studies of risk perception (Drabek 1994), the decision-making and evacuation process (Gershon et al. 2007; Ketteridge and Fordham 1998; Fischer et al. 1995; Fitzpatrick and Mileti 1990), disaster preparedness (Ritchie et al. 2008), emergency response after disasters (Wachtendorf, Kendra and Lea 2010; Lowe and Fothergill 2003), and vulnerable populations (Elder et al. 2007; Enarson and Morrow 1997; Peacock, Morrow and Gladwin 1997; Vogt 1991).

Several factors should be taken into account when selecting the method to use for a research project. It is not sufficient to choose a method based upon a researcher's comfort level with one approach over the other. In addition, choosing a method because others have used similar methods in a research discipline or topic is also insufficient. Rather, it is important to select a research design that is relevant to the project's research questions (Maxwell 2005).

Quantitative research aims to quantify or calculate relationships among variables. Quantitative researchers frequently collect data using statistical sampling techniques and structured research strategies, such as experiments or surveys, to gain information on important concepts in the research. Quantitative researchers then reduce these concepts to numerical variables that represent the quantity, intensity, or frequency of the concept (Denzin and Lincoln 2005). From these variables, researchers test, using statistical methods such as regression models, whether the variance in one variable causes the variance in another variable and the numerical significance of this relationship (Maxwell 2005). Some of the proponents of quantitative research claim that their work is value-free, or free from researcher bias, if the methods are followed correctly.

Qualitative research, on the other hand, investigates causal relationships among concepts in a different way. Qualitative researchers place emphasis on understanding the meanings that people give to their environment and how these meanings influence behavior (Maxwell 2005; Maxwell and Loomis 2002). Instead of focusing on relationships among variables that are measured quantitatively, qualitative research strives to understand the processes by which events and actions take place (Maxwell 2004), which is possible only through a collection of rich, detailed information. Some qualitative researchers (Miles and Huberman 1984; Denzin 1970) have stated that qualitative research is better than quantitative research at developing explanations of "local causality," or the events and processes that led to specific outcomes (Maxwell 2005). Also, instead of testing hypotheses based on pre-defined variables, as is done in quantitative research, qualitative research allows for the discovery of phenomena and causal patterns that were not originally anticipated.

To address the research questions proposed in Chapter 1, this research uses qualitative methods to analyze face-to-face interview data collected from survivors of the 2001 WTC evacuation. The face-to-face data provide detailed descriptions of occupants' experiences with their environment and the meanings that they generated as the event was unfolding around them. According to Denzin and Lincoln (2005:10), "[Q]ualitative researchers stress the socially constructed nature of reality, the intimate relationship between the researcher and what is studied, and the situational constraints that shape inquiry. They seek answers to questions that stress *how* social experience is created and given meaning." This study is qualitative in nature because it delves into the meanings developed by WTC occupants and how these meanings influenced decision-making processes during the pre-evacuation period – that is, the time period between the initial recognition that something dangerous could be occurring until they move into the building exits.

As mentioned in Chapter 1, this project employs the symbolic interactionist (SI) perspective to understand the actions performed during the pre-evacuation period of the 2001 WTC disaster. SI posits that people act toward things based on the meanings that those things have for them. Blumer (1969) stresses the importance of performing qualitative research in order to understand the constructed

meanings that lead to the performance of an action. He states that researchers should directly study the empirical social world through the examination of what people experience and do, their interlaced activities, and relations among individuals. According to Blumer (1969), if a researcher wants to understand action, he must see objects of perception as the subjects see them and interpret their meanings. To do this, the researcher must place himself in the position of the individual or collectivity being studied. Also, the researcher should have a body of relevant observations in the form of descriptive accounts of how subjects see objects, how they act towards them, and how they refer to them. These data can be obtained through direct observations, interviewing, listening to conversations, life history records, and other descriptive accounts from the study's population.

I chose to study the WTC evacuation for several reasons: the significance of the event for the study of decision-making under conditions of extreme uncertainty and danger; my own prior work in the investigation of the 2001 WTC disaster as a researcher in the Building and Fire Research Laboratory, recently renamed the Engineering Laboratory, at the National Institute of Standards and Technology (NIST) (Averill et al. 2005); and the availability of the in-depth, detailed interview transcripts provided by the Project High-rise Evacuation Evaluation Database (HEED) research team (Galea et al. 2006). Any data on survivor experiences from actual building evacuations are rare. However, even more rare are the types of detailed accounts collected by Project HEED on the individual processes in which survivors engaged for *each* action performed throughout their entire evacuation beginning with the first cue until they reached safety. Detailed accounts of the behavioral process for each action performed are the kinds of data needed and called for by Blumer (1969) in order to develop an understanding of why individuals performed certain actions during the WTC evacuation.

Project Methods

This project involves the secondary analysis of face-to-face interview data collected under Project HEED.[8] In the following sections, I provide a detailed description of the dataset and the data analysis methods used in this project.

Data collection - Project HEED data set

Project HEED was a three-year project that began on September 1, 2004 and ended on April 30, 2008, with the goal of exploring human behavior associated with the evacuation of high-rise buildings. The project was funded by the UK Engineering and Physical Sciences Research Council and consisted of a collaboration among three universities in the United Kingdom: the Universities of Greenwich, Ulster, and Liverpool. The basis for this project was an analysis of the 2001 WTC disaster through both face-to-face interviews with survivors and computer simulation of the evacuation. The project management team for this effort included Professor Ed Galea from the University of Greenwich, Professor Jim Shields from the University of Ulster, and Professor David Canter from the University of Liverpool. The project resulted in 271 face-to-face (or telephone) interviews with survivors from the 2001 WTC disaster, 252 of which have been transcribed and provided to select researchers (Galea et al. 2009). Interviews took place in New York City at the place of the participant's choosing, and 23 interviews were collected via telephone (Galea et al. 2007). The telephone interviews maintain the same interview format as the face-to-face interviews.

Researchers originally collected the data under a project funded by the UK government to inform the development of future building regulations and building evacuation computer models. Another objective of Project HEED was to make the interview data available to bona fide building safety

[8] Project HEED website: *http://fseg2.gre.ac.uk/HEED/index.html*; Reference: E.R. Galea, J. Shields, D. Canter, K. Boyce, R. Day, L. Hulse, A. Siddiqui, L. Summerfield, M. Marselle, P. Greenall, "Methodologies Employed in the Collection, Retrieval and Storage of Human Factors Information Derived from First Hand Accounts of Survivors of the WTC Disaster of 11 September 2001," Journal of Applied Fire Science. Vol 15, Number 4, 253-276, 2006 (published in Nov 2008).

researchers in countries around the world. Researchers interested in access to this data set must apply online and agree to a set of access conditions (attached in Appendix A of this document).

When the principal investigators verify that the researcher meets a set of requirements (not specified) and have agreed to the above access conditions, the researcher is given access to the data. On March 19, 2009, I was given access to this data set for a time period of 2 months for my proposed dissertation project. After the 2 months deadline, as long as I could show progress had been made on the analysis, which I did, I was then given access to the data set for another 2 months.

The data are organized in a Microsoft Access database format. The database consists of analyses already performed by the UK research team, and specific research topics (e.g., risk perception among occupants during their evacuation) can be searched in the database. Downloadable results include preliminary analyses of the collected information to identify and quantify some of the key issues that influence building evacuation, such as the types of actions performed by participants during the evacuation, details about group interactions among occupants (e.g., number of occupants in the group, the type of occupants, the type of interaction, etc.), and environmental conditions (e.g., the presence of smoke, debris, flames, etc.) encountered in various locations throughout the building. However, for researchers interested in performing their own analyses, there are transcripts available from 252 of the 271 interviews performed, as well as occupant information (e.g., demographics and occupant characteristics) on each of the 271 individuals interviewed by the UK WTC project. Both the interview transcripts and the occupant information were used for this project.

I obtained occupant characteristics from a pre-interview questionnaire that was made available in the HEED database. A list of the characteristics is provided here (along with a characterization of the type of data provided):

a) A unique ID assigned to each participant

b) The WTC tower number in which the participant was located on 9/11/01 (1 or 2)

c) The floor number (from basement levels to 110)

d) Participant's gender

e) Participant's date of birth (month, day and year)

f) Participant's height and weight on 9/11/01[9]

g) Participant's education level on 9/11/01 (university, high school, etc.)

h) Whether the participant had a medical condition (yes/no)[10]

i) Whether the participant evacuated during the WTC bombing in 1993 (yes/no)

j) Whether the participant had a spouse and dependents on 9/11/01 (yes/no)

k) Whether the participant had dependents present at the WTC on 9/11/01 (yes/no)

l) Participant's number of dependents (both in general and present in the WTC on 9/11/01)

m) Whether the participant smoked cigarettes (yes/no). If yes, the number of cigarettes a day[11]

n) How much time the participant spent doing a physical activity every week[12]

o) Number of stairways the participant was aware of on 9/11/01 (potential for up to 4 stairs)

p) Whether the participant knew where these stairs would lead to (yes/no)

q) Whether the participant used stairs as his/her normal route into the building (yes/no)

r) Whether the participant was visiting WTC on 9/11/01 (yes/no). If yes, the purpose of his/her visit

s) Time worked in the building (measured in months or years)

t) Whether the participant had a fire safety role (yes/no). If yes, what the role was (e.g., fire warden,

[9] This variable was not included as a factor in this research. If occupants mentioned a specific issue with their height or weight during the qualitative interview, then it was recorded as a factor that was considered during the qualitative analysis phase of this project. The specificity included in the interview transcripts provided more information than this general quantitative factor provided.

[10] The factor of "medical condition" was not used in this qualitative analysis. This is because the variable was a broad category that did not provide sufficient specificity on the type of medical condition to which the respondent was referring. Therefore, this broad variable was not one of the factors used to sort the data in the analysis phase of this research. If the respondent mentioned a more specific condition during the qualitative interview, including any mobility disability, that specific condition was recorded as part of the respondents' historical reality and thus used in the analysis phase.

[11] This variable was not included as a factor in this research. If occupants mentioned a specific issue with smoking cigarettes during the qualitative interview, then it was recorded as a factor that was considered during the qualitative analysis phase of this project. The specificity included in the interview transcripts provided more information than this general quantitative factor provided.

[12] This variable was not included as a factor in this research. If occupants mentioned a specific issue with inactivity during the qualitative interview, then it was recorded as a factor that was considered during the qualitative analysis phase of this project. The specificity included in the interview transcripts provided more information than this general quantitative factor provided.

searcher, etc.), the length of time that he/she held that fire safety role (e.g., years, months), the number of evacuation drills he/she performed in that role (if any), whether participant was issued fire safety equipment (yes/no), and whether participant had fire safety training in the fire safety role (yes/no)

u) Whether the participant had fire safety training as an occupant in the building (yes/no)

v) Whether the participant participated in evacuation drills in WTC (yes/no)

w) The total number of evacuation drills in which he or she participated

x) Whether the participant managed people in WTC (yes/no). If yes, the number of people he or she managed

y) Whether the participant had experience evacuating from another building other than the 2001 WTC evacuation (yes/no). If yes, the type of building, the building's name, and the number of stories in the building.

Along with this quantitative information, I obtained face-to-face interview transcripts from 252 interviews: 128 from interviews with survivors of WTC 1 and 124 from interviews with survivors from WTC 2. Each interview transcript began with an uninterrupted narrative of the participant's experience of his or her evacuation from WTC, where the participant was asked to *please describe in your own words your experience from the point you entered the towers until you evacuated them on September 11, 2001*. The uninterrupted portion of the interview is referred to as the unstructured narrative.

After the unstructured portion of the interview, the interviewer began the semi-structured portion of the interview. There was no structured set of questions asked of each participant. Rather, the interviewer asked the participant to go through the evacuation story again, which allowed the interviewer to interrupt with in-depth questions regarding the evacuation. In addition, three written questionnaires were given to the participant at various stages during the interview. The first was a risk perception questionnaire that attempted to gauge the participant's level of personal risk throughout the evacuation process. The same risk questionnaire was given to the participant multiple times during the interview to

gauge his risk at various points during the evacuation. Second, a company organizational structure questionnaire was given that attempted to gain an understanding of how the participant's company was structured prior to the 2001 evacuation. The company organizational questionnaire, which asked about the company's hierarchy and decision-making process, was given one time during the interview. The third instrument was a stairwell density questionnaire that attempted to gain an understanding of how crowded stairwells were at various points during the evacuation process. The stairwell density questionnaire was given multiple times during the interview when the occupant discussed his egress route via stairs in the building. Last, the participant was given a floor plan so that he could identify where his office was located and the route that he took to perform certain actions on the floor before beginning evacuation movement. Although I did not use the specific answers to the questionnaires in my analyses, the interview transcript often contained information on how the occupant responded to each questionnaire or floor plan discussion. This was especially the case if the occupant read the questionnaire and gave his responses aloud for the audio recorder, which occurs in almost 75% of the interviews.

Risk perception questions were asked with reference to as many as four points in the evacuation process: at WTC 1 impact or when the individual first noticed that something unusual was happening; when she decided to evacuate; when she realized that WTC 2 was hit (if applicable); and when she knew that WTC 2 had collapsed (also, if applicable). There was a "main" question asked during the risk questionnaire in addition to other more specific questions about risk perception, which focused on how "at risk" interviewees felt at particular moments during the evacuation process. Each respondent rated her perception of risk on a seven point Likert scale, from 1 (no risk) to 7 (very high risk) (McConnell et al. 2010; Galea et al. 2007; Galea et al. 2006) and also provided information on why she chose that specific level of risk. The "main" risk question was followed by a series of statements related to different risk attributes identified from risk perception studies, asking about the information available, control, and dread, to which respondents would rate their level of agreement (Galea et al. 2009). I used answers to the "main" risk question to establish occupants' perceived levels of risk and reasons for these perceptions at

various points during the pre-evacuation period. Additionally, if occupants noted specific attributes about themselves during their responses to the subsequent risk statements, that information was recorded as well. Risk perception levels were sometimes mentioned in reference to other moments during the evacuation process as well.

The data were provided to researchers with a series of restrictions to ensure the proper use of the interview transcripts and occupant information. I was restricted from downloading any of the transcripts onto my computer and was only able to access the transcripts online from one specified IP address. This condition was put in place to ensure that researchers could not carry around transcripts on their personal computers or share these transcripts with others. Additionally, to ensure confidentiality of the participants, identifiable information such as participant names and WTC company names had been coded with WTC ID codes and "[WTC company]" codes, respectively. I was not given access to the key to decipher these codes. Last, I agreed, under the access conditions, not to attempt to identify any of the WTC participants based on the information that was provided to me from the database.

For this research, I reviewed, coded, and analyzed 124 interviews from WTC 1 and 121 interviews from WTC 2. Seven transcripts from the original 252 were not used for the project because the respondents' experiences were not relevant (e.g., the person was originally located on the ground floor or in the subway system, known as the PATH, at the start of the incident). It was important to compare occupants with similar experiences in the building, and if occupants were not located on a floor above ground level in the building, their experiences in the pre-evacuation period would be very different from those of others located on floors in the towers. Overall, I used transcripts from 245 survivors for this project. Table 2-1 provides information on the participants included in this research.

Demographic Variable	WTC 1 (124)	WTC 2 (121)
Gender		
Women	36%	40%
Men	64%	60%
Age (mean years)	46	42
Management (role)	48%	38%
Women and managers	16%	12%
Fire warden (role)	10%	14%
1993 WTC bombing survivor	23%	21%
Military training/experience	5%	2%
Training (WTC procedures)	60%	64%
Years in the building		
Visitor (0 years)	4%	4%
Less than 6 months	12%	11%
7 to 12 months	7%	18%
13 to 23 months	11%	6%
2 to 5 years	26%	27%
6 to 10 years	24%	7%
11 to 15 years	9%	8%
16 to 20 years	5%	10%
21 years or more	2%	9%

Table 2-1: Individual factors or demographics of the WTC sample

Data analysis

I used the analysis method framework or "Framework," originally developed by Richie and Spencer (1994), for classifying and organizing data into themes, concepts, and categories (Ritchie, Spencer, and O'Connor 2003). Qualitative analysis of detailed interview transcripts is a continuous and iterative process that requires the researcher to first manage the data and then make sense of it through descriptive and explanatory analysis. Although this work can be performed on other types of computer software, I used Microsoft Excel© to analyze the dataset. Excel allowed the flexibility to capture and index data from the transcripts, describe the data using the categories and classifications I developed, and detect patterns in the data by sorting rows by specific categories and classifications. Each phase in the

framework -- indexing the data, describing the data, and detecting patterns in the data -- is described in the following section.

Data indexing

First, steps were taken to organize, or manage, the data from the interview transcripts provided by Project HEED. The data needed to be managed because there were 245 transcripts ranging from 10-43 pages in length for both WTC 1 and WTC 2. There was a significant amount of detailed, textual data, and without proper data management, there was the possibility of losing important information.

The first step in data management involved becoming familiar with the dataset. I read each interview from WTC 1 and 2 from the beginning to the end. As I read, I took note of certain pages within each transcript, especially the pages in the semi-structured interview that focused specifically on the pre-evacuation period. In each interview, there was a narrative in which the individuals were asked to discuss what happened, starting from the point where they realized that something was wrong to the point when they evacuated the building. Some narratives went into extensive detail while others were only a few pages long and discussed the overarching actions taken that day. In the semi-structured part of the interview that followed, interviewers went back through the respondents' stories with them and asked questions about their interpretations of the situation and their perceptions of risk at various points during their experience, i.e., at initial impact, during their decision to evacuate, and when WTC 2 was hit (benchmark events). Participants were also asked other specific questions about what they did during the evacuation phase of the emergency. However, for this project, I focused on the pre-evacuation period, or the time from the beginning of their stories to the point in time when they entered a stairwell (or elevator in WTC 2) to evacuate the floor.

The second step in the data management process was to identify themes and issues from the data that would be used to index or label sections of the raw text. Themes can simply arise from reviewing the data and identifying topics that are covered across interviews. Themes can also come from issues or topics discussed during each interview as part of the interview guide (Ritchie, Spencer and O'Connor

2003). Bulmer (1979) identifies ten different sources of themes for qualitative data analysis, including literature reviews, commonsense constructs, researcher experience, and general theoretical orientations.

After reviewing the transcripts, it was clear that common themes were emerging from the stories of the pre-evacuation period. Themes generally appeared at points in the narrative. According to Riessman (2002), a narrative is distinguished from other qualitative texts by ordering and sequence. In other words, an action is viewed as sequential for the next action and the interviewee, when telling a narrative, structures his stories both temporally and spatially (Riessman 2002). From the structure of the WTC interviews and the focus of this research project, i.e., on actions performed in the pre-evacuation period, it became clear that the "actions" or "behaviors" performed at different points throughout the pre-evacuation period was a common theme emerging from the data.

The theoretical foundation of this research also guided the development of additional themes used to index the raw transcript data. The conceptual framework for this dissertation is an understanding that an action is the result of an individual's interpretation of her environment (including cues and information perceived), filtered through her social stock of knowledge. Therefore, the additional themes identified from the transcripts were *individual characteristics*, including gender and assigned social roles, *environmental cues*, and *interpretations* of the event. These themes were also consistent with the paradigm model (Strauss and Corbin 1998) employed in grounded theory analyses, which emphasizes the grouping of data into three categories: conditions, actions, and consequences. The conditions (or contexts) represent the situation that gives rise to a phenomenon, the actions represent what happens in the event, and the consequences represent the outcomes of actions. Overall, the index in the data management phase of analysis contained four main themes: individual factors, environmental cues, interpretations, and actions.

Once the index was created, I developed a Microsoft Excel© spreadsheet to group the raw data from the transcripts. In most research, the indexing stage consists of the researcher applying the index labels or themes to the data set itself (Richards and Richards 1994). For example, a section of a transcript that mentions a specific theme would be highlighted in an analysis software program and labeled with the

appropriate theme. No text from the transcript is lost; rather, the raw data are organized into specific themes or concepts that will be further analyzed later. Since I was granted limited access to the raw data files, I created a variant method of indexing the raw data from the WTC transcripts, using the spreadsheet to index the dataset and adding columns to capture individual factors, as well as the sequential nature of the environmental cues, interpretations and actions performed, during the pre-evacuation period.

I also included textual information from the transcripts within the spreadsheet for each cue, interpretation, and action performed during the pre-evacuation period. It was important at this stage to remain as close to the respondents' words as possible. Therefore, I transferred (i.e., typed by hand) textual information -- often direct quotes from the transcripts -- from the transcript into the spreadsheet.[13] The textual information from the transcripts referring to cues and actions were not difficult to identify. Environmental cues were anything that the individual heard, saw, smelled, tasted, or felt, and the actions were anything that the individual physically performed. The textual information indexed for each interpretation were more difficult to define at the start of the data collection effort. Therefore, any thought mentioned regarding a cue, situation, or decision was captured very broadly in the interpretation cells of the spreadsheet.

Each time the participant mentioned a new environmental cue, I inserted a new set of columns into the spreadsheet. That way, the sequential nature of the cues, interpretations, and actions was maintained. Each set of cues, interpretations and actions represented one "behavioral process" for the occupant. I created spreadsheet columns for multiple processes of the cue-interpretation-action sets experienced by each occupant. Figure 2-1 shows an example of this for Respondents #1-10. Blank cells are displayed in the figure where data on the second and third behavioral processes were captured on three of the four major themes (i.e., cues, interpretations and actions). The "additional information" column was provided for each process to capture data that did not necessarily fit into the indexing themes.

[13] However, since I was limited by the HEED data use agreement in the number of quotes that I could store on my computer, a temporary spreadsheet of textual information and quotes (involving cues, interpretations and actions) was created and then immediately deleted once the first stage of coding and classification was completed.

Hypothetical responses are included for Respondent #10 in Figure 2-1 to provide an example of data input.

Individual ID #	Cue 2	Interpretation 2	Action 2	Additional Info 2	Cue 3	Interpretation 3	Action 3	Additional Info 3
1								
2								
3								
4								
5								
6								
7								
8								
9								
10	"And then I saw some stuff falling down outside the window" "...it was white, maybe paper?"	"I had no idea what was going on. I mean, I had never experienced anything like this before."	"So, I turned to my friend sitting beside me..." "I asked her what was going on."	[Risk assessment - answer from questionnaire] "I thought it was moderate risk at this point. I was scared, but I still did not know what was going on"	"Then my boss screamed to us to leave. She looked very concerned and she was screaming to us..."	"I got scared. She is usually such a calm person. She never yells or screams like that. I knew then and there that it was serious."	"So I grabbed my stuff. I put my computer into a bag, got my phone, and looked for my glasses."	[Evacuation decision here]

Figure 2-1: An example of the spreadsheet created to track multiple behavioral sets of cues-interpretations-actions with hypothetical responses for Respondent #10

This was an extensive data management process. I developed separate spreadsheets for WTC 1 and WTC 2, mainly because different events occurred at different times in each building, and there were clear differences between the experiences of the occupants in WTC 1 versus WTC 2. I also developed spreadsheet columns to index data on individual factors. For some individual factors, the interview protocol included a direct question, and for others, the information was extracted from the interview narratives.

In addition, I included other data I thought could be relevant. These details included the following information: 1) how the egress route was chosen, 2) the times assigned by interviewees to any or all of the actions performed during the pre-evacuation period, 3) information regarding previous fire drills in the building, 4) whether the individual mentioned leaving the stairs at any point during evacuation, and 5) any other comments considered relevant.

Describing the data – Categories and classifications

Once the data were indexed, the spreadsheets for WTC 1 and 2 contained very detailed text describing the sequence of cues, interpretations, and actions that shaped interviewees' subsequent actions, and information on individual factors was also indexed. However, at that point, the spreadsheet data were

too detailed and specific to analyze. To make further analysis possible, I transformed the detailed spreadsheet data into more abstract codes.

Ritchie, Spencer and O'Connor (2003) describe the next stage in the "Framework" as descriptive analysis. There are three main steps involved in descriptive analysis: detection, categorization and classification. In detection, the researcher should look within a theme, across all occupants or cases in the dataset to identify the range of the content and dimensions within the theme. This is similar to grounded theory analyses, in which the analyst identifies the properties (components or attributes) and dimensions (modes of variation within the category) of the data (Strauss and Corbin 1998). The properties and dimensions identified are then developed into categories. Once these categories are defined, the data are assigned to them. Finally, if necessary for further analysis, groups of categories are assigned to classes.

Within the detection step, all of the textual information from each major theme was combined and listed within four columns of the spreadsheet (one column for each theme). I examined each column of data for axes of variation. Glaser and Strauss (1967) refer to this technique as the "constant comparison method" in which the researcher constantly questions "when, why and under what conditions" data in various themes appear. I developed new categories within the four major themes (cues, interpretations, actions, and individual factors) through this analysis exercise. The properties and dimensions of the cues, interpretations and actions developed are described in the following section.

Cues: All of the cues for a variety of behavioral processes were listed out and compared against one another to identify the ways in which the cues differed. One obvious difference was by type of cue, which I categorized as physical, social, and internal cues. Physical cues were external cues from the physical environment that the respondent heard, felt, saw, smelled, or tasted (if applicable). Social cues were external cues that came from other people that the building occupant spoke with, heard or saw both inside and outside of the towers. Last, internal cues were any type of thoughts or memories recalled, including memories of previous evacuation experiences, thoughts of roles and responsibilities in the towers, and thoughts of specific people either inside or outside of the building.

Physical cues: Physical cues differed even further, specifically by the timing, intensity, and the location of the cues. In terms of timing, cues could be categorized as pre-impact (i.e., cues witnessed before the plane crashed into WTC 1, such as the sight of a plane); impact (i.e., cues witnessed during the time period when the plane crashed into WTC 1); and post-impact (i.e., cues witnessed after the plane crashed into WTC 1, as well as cues witnessed during the time period when the second plane crashed into WTC 2). The cues could also be categorized by intensity, depending upon the nature of the cue as described by the occupant. Some cues were very intense and others were less intense. An example of a cue that was less intense was witnessing the office lights flickering. More detail is provided regarding physical cue intensity in Chapter 4. Cue locations could also be categorized based on where they originated, i.e., either inside or outside of the building.

Social cues: Social cues differed based upon the type of information conveyed, the method of delivery of the information, the source of the information, and the intensity of the social cue. First, if WTC occupants received social cues, these cues could contain information *about the event itself* (categorized as Type #1), or information about *what to do* (categorized as Type #2). Type #1 cues could include others' interpretations of the event or the cues that others were noticing in the building, whereas Type #2 cues could include an instruction from someone in the building on what individuals should do next. The method of delivery took four basic forms: a question about the event, a suggestion about the event, a suggestion or instruction about what to do, or witnessing a physical act performed by another occupant on the floor. Additionally, I recorded the source of the information for each social cue, including whether the information was provided by a coworker, a manager, or a group of people in the building. The description of the source was dependent upon how specifically the participant identified the source in the interview. Finally, the intensity category could also be used to differentiate social instructions that were clearly screamed or yelled (an intense cue), versus cues that were merely suggested in a more moderate tone of voice, which could be considered as less intense cues. More detail is provided regarding social cue intensity in Chapter 4.

Internal cues: Internal cues included any thoughts recalled by the individual (i.e., thoughts or memories of previous events, people or some material item), knowledge or information that the person remembered during the event, as well as any interpretations of the cues witnessed. Internal cues were not categorized further than this.

Next, the data collected in the "Interpretations" and the "Additional Information" columns of the detailed spreadsheet were organized into two major sections. Interpretations included both situation interpretations and risk interpretations. The situation interpretation was any thought or idea about what was going on. These could change after receiving a new cue, so a column was added to each behavioral process as a placeholder in case the individual developed multiple interpretations. Also, if someone was not sure what was going on at a particular point in time, uncertainty was recorded was well. The risk interpretation was any statement about the level of risk perceived throughout their pre-evacuation period. As mentioned earlier in this chapter, each participant was specifically asked about his or her perceived level of risk at various times during the pre-evacuation period, so perception of risk for each behavioral process was captured in these columns.

Situation interpretations: Within the category of situation interpretations, I created two subcategories: a label for the interpretation of the event or a label of "uncertain" if the occupant was unsure what was happening. For example, if the occupant provided an interpretation of what was going on, e.g., "an earthquake," that interpretation was included in the spreadsheet. However, if the occupant was uncertain about what was taking place, a label of "uncertain" was added to the spreadsheet. If occupants provided an interpretation of the event, depending upon the details provided, the interpretations were further categorized as indicating emergency or non-emergency events. More detail is provided in Chapter 4 on the difference between these two categories. Additionally, the reason for developing this interpretation, if specified, was included as well.

Risk interpretations: The risk interpretation column captured both the reported risk perception levels (corresponding to the levels provided by the HEED survey) and the detailed explanations of why occupants felt either more or less at risk. I compiled data on risk levels and explanations at various times

during the retelling of the WTC experience, namely at the time of impact, at the time of evacuation decision, and at the time when WTC 2 was hit. The risk levels noted in this category were "none" for people who said that they felt no risk, "low," "medium," and "high." These followed the numbering scheme given by the HEED project questionnaire – with a '2' as a low average, a '3' as a low/medium, a '4' as a medium, a '5' as a medium/high, and higher than this (6 to 7) labeled as high. Then, I added another column to capture explanations for these values, entitled 'risk explanation.'

Later in the analysis, I condensed the interpretation of the risk into two categories, using both the information from the risk and situation interpretation categories. Occupants either did not perceive risk ('none') or perceived a 'general' level of risk. The label of 'none' means that the individual specifically mentioned not feeling or perceiving any level of risk during a specific behavioral process. A perception of general risk meant that the individual thought that something was happening in the building that was potentially serious. The reason for developing risk perceptions was included as well. Chapter 4 provides additional detail regarding the differences between perceiving general risk and personalizing the risk.

Actions: I organized occupants' actions into six categories by combining the specific physical actions taken with stated motivations for performing the action, if provided. Individuals often described their actions in a very specific way, e.g., walking around the floor or talking to someone. However, when combined with the reason for performing the action, e.g., to ask a coworker what was going on, the action could be categorized as "information seeking." The six main action categories are the following: information seeking, continuing to work, preparing for evacuation, searching for people or helping others, defending in place, and evacuating. In addition, the process associated with the decision to evacuate was identified in the action column.

Individual factors: I also categorized individual factors into specific categories. A list of categories obtained from the transcripts is listed here. These categories are in addition to the quantitative data on individual characteristics obtained from the Project HEED questionnaire, discussed earlier.

- Initial activity of the participant at 8:46 am
- Initial location of the participant (e.g., his/her office, hallway, cubicle, elevator, etc.) at 8:46 am

- Initial position of the participant on the floor (i.e., north, east, south, or west)
- Whether the participant had visual access to the windows or others on the floor at 8:46 am
- Whether there was a manager on the floor (or whether the participant was a manager) on September 11th
- Whether there was a floor warden on the floor (or whether the participant was a floor warden) on September 11th
- The number of people on his/her floor or sections of the floor at the time of impact
- Whether the participant had a location outside of the building to which he/she could go after evacuation
- Whether he/she had additional experience with military, other types of disasters, familiarity with building construction, familiarity or knowledge of planes, and experience with fire or fire safety
- Whether the participant had a mobility impairment
- The type of company or department for which he/she worked.

Once the categories and the properties and dimensions within each theme were fully developed, I added these categories as columns into the original data coding spreadsheet. First, I transferred the detailed data word-for-word from the data indexing spreadsheet into the appropriate new column in the spreadsheet. The data from the coding spreadsheet still contained the same amount of detail, but was simply reorganized into the appropriate "new" and more abstract column. Later, I combined and condensed the data placed into the new categories (columns in the spreadsheet) to produce abstract codes for each occupant. The production of higher-level abstract codes from the detailed data allowed for the development of the conceptual model.

I used the categories and classifications developed from the descriptive analysis phase to describe what was going on in the WTC during the pre-evacuation period. Ritchie, Spencer and O'Connor (2003:244) state that "categorization and classification can be used to describe the form or nature of any social phenomenon" and that from the categories and classifications, typologies can be developed as a

useful way to describe the types of phenomena that were present in the dataset. Based on the descriptive analysis phase, I developed a general conceptual model of the process of decision-making during the WTC pre-evacuation period. The conceptual model describes the processes that occupants went through to perform pre-evacuation actions before evacuating the floor. I present the model in Chapter 3.

Detecting patterns in the data

The last stage in the "Framework" was associative analysis. According to Ritchie, Spencer and O'Connor (2003), associative analysis allows the researcher to find links and connections between two or more phenomena in the qualitative data. Typologies and other groupings are very useful in identifying associations that exist within a qualitative database. For example, showing that a specific group included in a typology is made up of persons with common experiences or views is a sound method for identifying patterns of influence within a dataset (Hammersley and Atkinson 1995).

Another method for detecting patterns of association within a dataset is to construct a central chart (Ritchie, Spencer and O'Connor 2003). The central chart allows the researcher to display a mixture of individual factors and categories developed in the descriptive analysis stage. In the associative analysis stage, I developed a new, more concise, and visually appealing spreadsheet to serve as the central chart. The abstract codes developed in the descriptive analysis phase were grouped together in a spreadsheet, referred to here as the "mini-model." At the end of the descriptive analysis phase, the data spreadsheet consisted of 30 to 250 columns of codes for each person, depending upon the number of behavioral processes in which he engaged during the pre-evacuation period. In this phase, I arranged the data into the mini-model spreadsheet so that I could see all of the cues, interpretations, and actions of each participant on the width of a computer screen, in addition to many of the salient individual factors.[14] The mini-model displayed the abstract categories associated with pre-evacuation experiences in approximately 16 columns (not including individual characteristics), so that each column could be viewed from a computer screen. A

[14] The salient individual factors were: the respondent's floor number, managerial or fire safety role on the floor, gender, age, education level, experience in the 1993 WTC bombing, number of family members, number of years worked in the building, experience with training and fire drills, initial visual access (of people, the windows or both), initial location on the floor, initial activity, and the trigger cue and source (the cue that helped them to decide to evacuate and why).

screenshot of a blank section of the mini-model spreadsheet is shown in Figure 2-2 below, including a hypothetical example of data input for Respondent #10.

3	Individual																	
4	ID #	Floor	# of info seeking	Other actions b4 Evac Dec?	# of cues	Deciding cue	Cues b4 Evac Dec	Internal Status	Evac Decision on own?	# of actions	Help	Prepare	Call	Cues	Actions	Internal Status	Source (of evac)	Individual characteristics...
5	1																	
6	2																	
7	3																	
8	4																	
9	5																	
10	6																	
11	7																	
12	8																	
13	9																	
14	10	37	1	Continued working (first action)	3	Social instruction	1. Low intense (thunder); 2. Physical (debris); 3. Social instruction (intense)	Risk increased with Cue 2; High risk with Cue 3	N	2		x		Social (direction to stairs)	Prepared; Evac	[None noted]	Boss	[Additional columns contain information on gender, age, experience, etc.]
15																		
16																		

Figure 2-2: A screenshot of the "mini-model" created for easier data sorting and analysis

Ritchie, Spencer and O'Connor (2003) suggest that the researcher examine the central chart based on previous theory, empirical studies, the theoretical framework of the study, and other sources of hypotheses that could shed light on patterns that exist among categories. Based on the underlying theory for this study and the understanding that actions are a result of both environmental cues and interpretations (filtered through their social stock of knowledge), I sorted the data in the spreadsheet by a variety of factors. First, the occupants were sorted by their historical "reality" (or their social stock of knowledge), such as gender, experience in the 1993 WTC bombing, and managerial role, to identify any trends in emergent interpretations (or their situational "reality"). In other words, did survivors of the 1993 WTC bombing, for example, interpret the situation or the risk in the same way? Then, occupants were sorted based on the cues that they perceived, again to identify relationships between cues and the subsequent development of cognitions. Finally, occupants were sorted based on the interpretations that they developed to identify any trends in the pre-evacuation actions performed. For example, was there a trend in the actions performed once occupants perceived that they were in danger? Occupants were also

sorted based on combinations of factors, such as the juxtaposition of their historical "reality" and the cues witnessed.

During this process, it is important to verify any associations that emerge from data interrogation (Ritchie, Spencer and O'Connor 2003). Each time I indentified a behavioral trend among factors, codes, or categories, I developed diagrams and wrote extensive memos to document the trend. Within the memos, I noted how the level of matching was distributed across the data set by recording what percentage of occupants was involved in a given behavioral trend.

On the assumption that interpretations and behaviors could have emerged in different ways in the two towers, I identified separate behavioral trends for each tower. Then, I compared and contrasted the trends in each tower to develop models that described occupants' experiences in both of the towers. The validity of observations concerning trends was then tested by viewing the data from a variety of different perspectives (i.e., sorting the data in a variety of different ways). If the trend was still valid after viewing it from different perspectives, the diagram was incorporated into a conceptual, predictive model.

More often than not, I identified negative cases (or outliers) for many of the observed data trends. Negative cases are any evidence or data that contradicts the current explanation or theory (Katz 1983). Negative cases help to broaden the scope of the theory by either invalidating parts of the model or suggesting new connections of the categories (Ryan and Bernard 2000; Katz 1983). Each time a new negative case was identified, I altered the specific model to include the case. New cases modified the concepts in the model to be more inclusive (or exclusive) of a certain person type, interpretation or action; identified a new influential factor to the model; or altered the direction of the linkages among concepts. With each change, the new model was 'tested' again with the original cases to see if the new conceptual understanding was a better fit than the original model. If so, this model or part of the model would remain until another negative case was identified, and then the process of alteration would start all over again. In some instances, the negative case was accounted for, and in other instances, the negative case was labeled as an outlier and was not included in the final predictive model. This process was completed for all

negative cases identified throughout the analysis for each action during the pre-evacuation period of both towers.

Based on the results of the associative analysis phase, I developed a predictive pre-evacuation action model for the 2001 WTC disaster. I constructed the model to highlight the factors that influenced respondents to develop interpretations of the event, formulate perceptions of risk, and perform pre-evacuation actions. To accompany the model, for specific pre-evacuation actions that required further explanation, I created supporting ethnographic decision models to identify the "if-then" statements that linked factors (or combination of factors) to the action (Ryan and Bernard 2000; Gladwin 1989). The model, along with its supporting decision models, is presented in Chapter 4.

Methodological Issues and Challenges

Any research project faces issues and challenges that need to be addressed. Some challenges are inherent in any research, while others are characteristic of qualitative research projects. One such challenge involves assessing the validity of findings, models and conclusions. Although validation in qualitative research differs from validity tests in quantitative studies, qualitative researchers still must assess the credibility of their results and conclusions.

Maxwell (2005:106) describes validity in qualitative research as the "correctness or credibility of a description, conclusion, explanation, interpretation, or other sort of account." In other words, I should ask myself at various stages in the analysis process how and why I might be mistaken about what is going on in the data. Katz (1983) raises four questions regarding the validity of the data collected and conclusions developed by participant observers in sociology. Even though I did not conduct a field study, these four questions also apply to the analysis of qualitative interviews, and thus, I consider them here: Can the results from this study be generalized to the larger population in the building, populations in other office buildings, and even populations in other building types (representativeness)? How do I know that the interviewer's presence or the interview itself did not influence the responses provided by the interviewee (reactivity)? How do I know that my results and conclusions are the right ones, in that I did

not overlook disconfirming data or make it all up (reliability)? Is it possible for others to repeat my study and if so, how would they know what to do (replicability)?

The first of the four questions asks about the representativeness of this study's results. Qualitative researchers must assess the transferability (or generalizability) of their results to other populations or events (Maxwell 2005). As is the case with most qualitative research, the individuals included in this project's sample were not statistically selected to represent the larger population, and therefore, the results from this research cannot be generalized to the occupants present in the building during the 2001 WTC disaster, much less to occupants of other building populations. However, a strategy of analytic research is to continually expand and alter the theory based upon the discovery of new and varying cases in the data so that the theory encompasses a broader population and thus can be generalized (Katz 1983).

The HEED database is the largest publicly available database of face-to-face transcripts ever assembled on the pre-evacuation and evacuation behavior of building occupants (Galea et al. 2006). It is the only extant dataset available to researchers that would enable this type of qualitative analysis on building evacuation behavior. The database contains rich, extensive narratives in occupants' own words, as well as a wealth of information on the individual characteristics of the WTC survivors in the HEED Project's sample, of which 245 were analyzed in this project. The data sufficiently offered the variation in occupant experiences that was crucial to generalize about patterns of causality. For my purposes, for example, it was important to have variance in the types of cues perceived, the types of interpretations made, including perceptions of risk, and the actions performed. If no one felt at risk during the incident, for example, then clearly it would not be possible to determine whether perception of risk influenced actions during the 2001 WTC disaster. However, after a thorough review of the data and extensive coding and analyses, it was clear that WTC experiences varied on all of the factors that were analyzed in this research project, including occupant characteristics and other important factors such as initial location in the towers and experience in the 1993 WTC bombing. Even following the initial attack on WTC 1, where one might assume that occupants in both towers heard the sounds of the plane hitting the building, some WTC 2 occupants did not experience any impact cues at all. Moreover, many who did perceive such cues

did not consider themselves to be in danger. Project HEED collected occupants' experiences from almost all floors in both towers on which occupants survived, and their experiences provided enough variation to identify factors that influenced pre-evacuation behaviors in the 2001 event.

The WTC database presented one difficult challenge to the representativeness threat. Obviously, WTC occupants who perished in the 2001 disaster were unable to participate in this research project, making this a study of survivors. However, it is important to note that other research in which I was also involved indicates that the key factor determining survival in the September 11, 2001 attacks was whether a tower occupant was above or below the floors into which the planes crashed (Averill et al. 2005). No one in this sample was a survivor from above the impact zone in WTC 1, so there is a perspective missing from this sample and consequently, from the results of this analysis. Everyone who was included in this project's sample evacuated the towers during the 2001 event. Even though there were occupants in this study's sample who stayed in their tower until 9:03 am, when WTC 2 was hit, they were in the minority. While it is unclear how the results would change with the addition of other WTC victims' stories, there is no a priori reason to believe that tower occupants who lost their lives were significantly different from those who survived.

The second of the four questions asks about reactivity. Reactivity refers to a situation in which the researcher or interviewer influences the interviewee in some way during the interview and can present roadblocks to obtaining an interviewee's accurate description or interpretation of her experiences (Maxwell 2005). Reactivity, while never completely absent, was reduced in this project in a number of ways. The structure of the interview presented a situation that reduced the possibility for reactivity. A strength of qualitative field methods is the lack of preset methods that remind the participants that research is taking place (Katz 1983). Qualitative methods, and in this case the HEED face-to-face interviews, were performed in such a way that the interviewees were able to relax, tell their stories in their own words, and participate in what seemed more like a conversation than a research interview (Galea et al. 2006). Although the interviews began with a pre-established discussion of the research project and an introductory questionnaire, the probing questions administered after the uninterrupted narrative were

tailored to the interviewee's topics covered during the narrative. Additionally, the tone and approach that the interviewer took during the interview differed depending upon the emotional state of the interviewee (Hulse and Day 2010).

Interviewer training also reduced the possibility of reactivity during interviews. The HEED interviewers had training in interviewing individuals about traumatic experiences (HEED 2009; Hulse and Day 2010). The interviewers were trained in eliciting narratives, probing for details, and looking for signs of interviewee discomfort during the interview.

Also, the location of the interviews was chosen to minimize the effect of reactivity. Where possible, HEED interviewers conducted interviews in quiet, private places due to the sensitive nature of the subject. Most interviews took place in the interviewee's closed office, closed offices used by the interviewers, and participant's homes. In the few cases where public places were used, interviewers chose less crowded locations to eliminate the possibility of others listening in on the interview (Hulse and Day 2010).

The third question asks about the reliability of the study's results and conclusions. In my focus on the reliability of my findings, I ask myself whether my descriptions are accurate and how I know I did not overlook disconfirming data. In addition, how do I confirm to the reader that I did not make up the findings based upon my own biases or ideas of how the results should look?

The issue of my own potential biases was one that I took seriously throughout the entire research project. Researcher bias can involve selecting certain data to fit an already developed conclusion or an existing theory (Maxwell 2005). No researcher can escape her own socially constructed reality. Because of this, it was important to engage in reflexive accounting throughout the project (Altheide and Johnson 1994). According to Goodall (2000:137), reflexivity refers to "the process of personally and academically reflecting on lived experiences in ways that reveal the deep connections between the writer and her or his subject." Through reflexive accounting practices, the researcher makes explicit her own perspectives, explains any possible biases that she has, and describes how she has dealt with them throughout the research.

The work discussed here was clearly shaped by my prior experience in studying the 2001 WTC attacks. As mentioned in Chapter 1, I was a member of the WTC investigation team at the National Institute of Standards and Technology, and I briefly analyzed a different set of face-to-face data from survivors of the 2001 disaster (Averill et al. 2005). However, whereas the NIST investigation sought to describe the experiences of building occupants and specifically identify any obstacles or aids that influenced their time to evacuate from the building, this study of the HEED data focused specifically on the pre-evacuation period and on identifying the factors that influenced specific actions performed. This study is a more in-depth examination of pre-evacuation actions with a completely different purpose when compared with the NIST investigation.[15]

As a researcher studying a large emergency, I should also mention that I have never been in a fire or disaster where other residents, building occupants or community members were injured or died. Consequently, I do not have a fundamental understanding of what it is like to evacuate a building in extreme fire and smoke conditions. I have been in one fire in my life. It took place in my apartment complex at the time, in the middle of the night about 12 years ago. I heard the fire alarm, walked out of the room to search the apartment and the hallway, and looked out the window in an attempt to find out what was going on and confirm whether or not there was an emergency. All of this was done before I woke up my roommate, told her about the smoky conditions in the hallway, and instructed her to get up and evacuate with me. I then gathered my cat in her carrier and we proceeded to our closest stair. Because of my academic background as a fire protection engineer, I know what can happen if I am unfortunate enough to encounter fire or smoke in a building. It was unlikely, however, that many (or any) people in my building had had the same experience with fire studies that I had. For one reason or another, almost all residents remained in their apartments throughout the entire ordeal, even with the fire alarm blaring. I found myself recalling that fire experience frequently as I read the transcripts of the interviews of people in the WTC on 9/11. However, I constantly reminded myself of the differences between the two

[15] As part of my position at NIST, I also studied the 2003 Station Nightclub Fire in Rhode Island, in which 100 building occupants died.

situations. I do not know firsthand what it was like to evacuate the towers on September 11, 2001. To understand that experience, I relied on the individuals who told their stories to the HEED project team. I do not, and did not during the analysis, pretend to understand all of the experiences that WTC survivors went through. I stayed as close to their words and experiences for as long as I could in an attempt to understand their thoughts and actions without interpreting or projecting my own biases.

In addition, I took steps to avoid any potential bias from previous studies of the WTC, as well as my own constructed reality of social behavior and society. I engaged in continual checks for negative cases. According to Katz (1983:130), "[w]hen encountering a 'negative case' – evidence contradicting the current explanation – the researcher must transform it into a confirming case by revising the definition of either the explaining or the explained phenomenon." Each time I found a negative case, I used it either to expand the results of this research (i.e., further develop the conceptual model) or disregard a portion of the modeling results that did not apply (Maxwell 2005; Strauss and Corbin 1998). By searching for negative cases, the qualitative researcher engages in a holistic analysis that combines propositions and data into "an intricate network" (Katz 1983:140) and increases the likelihood that the network or theory accurately depicts the phenomena on which the analysis focuses.

Also, as suggested by Altheide and Johnson (1994), I discussed my findings with professors, students, and colleagues to elicit their opinions about the results and model conclusions. Finally, to avoid researcher bias, I consulted existing theories and empirical data, as suggested by Maxwell (2005). Although there is no overall conceptual model specifically explaining pre-evacuation actions in a building fire, there are models that predict processes involving community-wide evacuations (e.g., for hurricanes). The data from disasters and other fire incidents were used to assess the validity of the results from this research.

Aside from all the work that a researcher must do to reduce the potential for bias, Katz (1983) admits that in analytic research, readers can recognize if the data collected or the findings of the research are inconsistent or unfounded. Because I make use of quotes from the data to support the research findings, a critical reader can distinguish a careless analysis from one that reflects the data collected.

Also, creating false data and findings that will deceive a critical reader is not a trivial task. The frustration of "[t]rying to convince oneself that a quote or episode can be interpreted to fit the analysis…make[s] stepping back and modifying the analysis seem the easier course" (Katz 1983:143). My research asks readers to make their own judgments on the reliability of my findings. Throughout the analysis chapters, I present quotes to support those findings and compare my findings with the results from other research.

The fourth question asks about the replicability of the study. Other types of research in which questionnaires are administered using a specific sampling procedure invite other researchers to follow the same methods and see if they arrive at the same conclusion. Qualitative research makes the idea of replication much more problematic because the procedures for data collection and analysis are not fixed. Improvised judgments are made throughout the data collection and analysis phases and are only able to be reported through retrospective reconstruction of the process (Katz 1983).

The way in which replicability can take place in qualitative analytic research is through the promotion of subsequent research and testing of the findings (Katz 1983). Such research makes the claim that no (or very few) negative cases were found, which in turn, invites other researchers to find negative cases without necessarily repeating the original research. In his search for negative cases, the researcher may document new types of phenomena from different datasets. For this research, I created a predictive model of the pre-evacuation period of the WTC disaster. I incorporated negative cases that both expanded and changed the theory to reflect the entire range of responses. With the exception of a few unique cases, the model reflects the diversity present in the dataset, and it prompts other researchers to continue verifying my findings for other types of office fires, building fires, community disasters, and other comparable events. To assist those wishing to move forward with similar studies, I have included a discussion of future research in the conclusions chapter, Chapter 5.

The final threat to the validity of the findings of this research involves the time delay between the event and the completion of the face-to-face interviews. Katz (1983) does not discuss these threats since the focus of his research and questions about validity involve participant observations and field studies. The study of the WTC, and any study of behavior during a disaster, involves the collection of data some

time after the event has taken place. For some studies, interviews are conducted hours after the event. In this case, the HEED study conducted interviews up to four years after the event took place (Galea et al. 2006). Two major issues arise when asking interviewees to recall events that happened in their past that present threats to the validity of the research findings: retrospective interpretation and false memories.

Retrospective interpretation is perhaps the largest threat to the soundness of this study. Here, behaviors performed in the past are seen from the point of view of the present. In other words, past behavior is continually re-evaluated based on happenings in current situations and on typified understandings that may be novel (Keel 1999). As more time passes, the individual may come to a new understanding of her past which serves to confirm or reconfirm the present (Goffman 1963). An example of this is the fact that all of the WTC interviewees knew, after they evacuated, that the towers collapsed; however, did not know that they were going to collapse at the time of the event. The "new" knowledge of the collapse may have influenced their recollection of the events. If WTC respondents mentioned that they collected their belongings because they suspected that the towers were going to collapse, for example, was this the actual reason that they did so?[16]

False memories are another threat to this study. False memories can be created through what is known as the misinformation effect (Loftus 2003; Loftus and Hoffman 1989). Studies have shown that "when people who witness an event are later exposed to new and misleading information about it, their recollections often become distorted" (Loftus 1997:70) and that "our memories are vulnerable to 'post-event information'" – even to information that surfaces some time after an event (Loftus 2002:43). Misinformation can enter our memories as a result of talking to other people, reading or viewing media coverage, or being asked leading questions about experiences after an event has taken place. Additionally, memories are more easily modified by misinformation when enough time has passed allowing the original memory to fade (Loftus 1997).

Differences between accurate and inaccurate memories are often difficult to decipher, in fact, such adjectives are misleading because no memory is a complete "copy" of any event. Just because a

[16] This is a hypothetical example and not an actual example from the HEED database.

memory is retold with confidence, detail, and emotion does not mean that it is an accurate memory and that the event actually happened (Loftus 2003). However, research has shown that veridical memories are more emotionally intense for the individual and are more likely to be viewed in the first person perspective, rather than the perspective of an observer, during recall (Loftus 2002). This difference diminishes, however, as the recollections are repeated and retold.

The threats of retrospective interpretation and false memories were minimized through the HEED study's method of data collection. The data were collected via a method that synthesized the Behavioral Sequence Interview Technique (BSIT), originally developed for fire studies by psychologists John Keating and Elizabeth Loftus, one of the foremost experts on memory (Keating and Loftus 1984). The interviewing method assists interviewees in retrieving more comprehensive and accurate memories of incidents and sharing important details with the interviewer. The HEED study's approach began by allowing the interviewee to retell an unimpeded chronological account to increase recall for the additional questions asked in the second portion of the interview. Also, the interview was structured more like a conversation than an interrogation, and there were no leading questions asked by the interviewers. If the interviewer was interested in finding out more about a specific topic, probes such as "tell me more about that" or "why did you think that was taking place" were used, as opposed to leading questions. Interviewers asked these types of questions to continue the conversation rather than to elicit specific types of responses from the interviewees. Also, the BSIT interview approach was more likely to elicit 'true' memories from the event because the approach specifically places the interviewee back in the situation and requires him to tell the story from a first-person perspective.

Last, threats of retrospective interpretation and false memory were minimized by the extreme nature of the event itself. The 2001 WTC disaster was the largest terrorist event ever to take place in the United States. WTC survivors were faced with extreme, unique, and dangerous situations unlike anything they had ever experienced. Research has shown that experiences in extreme events, such as the 2001 WTC evacuation, remain vivid in people's minds for long periods of time after the event has taken place (Sharot et al. 2007; Brown and Kulik 1977).

Chapter 3 - "And All of a Sudden…the Building Moved": Interpretations of the WTC attacks and decisions made to achieve protection

> *And all of a sudden, there was this, the building moved…and in such a way, **that you knew that was not normal** [my emphasis], the way the building moved. Most of the chairs in the conference room had rollers on the bottom of them and most people were knocked from their original positions, not really knocked out of their chairs, but...everybody moved, because the building moved.* (WTC1/081/0005)

Disasters, especially ones as intense as the terrorist attacks of the WTC on September 11, 2001, interrupt normal life. A disaster creates a normative crisis in that the norms and behaviors suitable on any other day suddenly become inappropriate. The normative crisis forces the affected population to recognize that the situation is not normal and to create an emergent normative structure to guide future behavior (Turner and Killian 1987; 1957). This emergent structure becomes the "new normal," as the affected and at-risk population engages in a communicative process, known as milling, whereby individuals attempt to define the situation (reminiscent of Thomas [1923] and Blumer [1969]), propose and adopt new appropriate norms for behavior, and seek coordinated action to find a solution to the shared problem at hand (Aguirre, Wenger and Vigo 1998). By engaging in this process, an affected collectivity identifies the decisions and actions that are appropriate to take in response to the disaster.

As might be expected under unfamiliar conditions that appear to create an urgent need to act, there are often complications in the process of creating the "new normal." These complications can cause a building population to engage in a variety of actions, some of which are inconsistent with personal protection. The first complication is that people involved in a disaster rarely perceive the same information and cues from the event. Second, even if people do perceive the same cues, they are likely to interpret the situation and personalize the risk in very different ways. After receiving what many would consider obvious evidence of danger, some people disbelieve or disregard the threat altogether -- thinking that nothing is happening that places them at risk, known as normalcy bias (Sekizawa 2004; Drabek 1986;

Okabe and Mikami 1982), or thinking that "they are less likely than others to experience negative events and more likely than others to experience positive events," known as optimistic or optimism bias (Helweg-Larsen and Shepperd 2001:74). In the former case, individuals believe that "nothing unusual is happening" (Tierney 1993:26) and in the latter, that "it can't happen to me" (Kunreuther 1991:12). Because of these complications, individuals can take a variety of different paths and engage in various actions to eventually decide upon a protective action plan. Moreover, even those who develop the same plan of action may take action at different times.

The purpose of this chapter is to describe the experiences of WTC occupants as they progressed through the emergency decision-making process and eventually decided upon a plan for achieving protection. Data on the variety of cues and information presented to WTC occupants allow for a comprehensive investigation into occupant perceptions, interpretations, and decisions, resulting in a variety of action plans in the face of the normative crisis set in motion by the attacks. By studying the stories told by survivors of the WTC evacuation, we can understand what they heard, saw, and felt during the tragedy and how these experiences and perceptions correlated with their interpretations of the event and decisions to evacuate the building.

This chapter begins with a description of theoretical and empirical approaches to the study of the emergency decision-making process. Then, I describe the WTC decision-making process, highlighting the stages in which occupants engaged to eventually achieve protection. The chapter ends with a comparison of the experiences of survivors of the 2001 WTC evacuation with other building fire and disaster events, primarily discussing whether the WTC decision-making process was consistent with other theories on crisis-related behavior such as ENT and the PADM.

Emergency Decision-making

Over the last 50 years, many empirical studies, based to at least some degree on ENT, have sought to chart systematically the social processes involved in human responses to disasters (Sorensen and Vogt Sorensen 2006; Mileti and Peek 2001; Tierney, Lindell and Perry 2001; Mileti and Sorensen

1990; Drabek 1986; Mileti, Drabek and Haas 1975). The PADM, which is directly based on these empirical studies, provides a framework that describes the information flow and decision-making that influences protective actions taken in response to natural and technological disasters (Lindell and Perry 2004). This model, briefly described in Chapter 1, will be described in further detail here.

Research on social influence, the decision-making process, and the performance of protective actions provide the theoretical foundation for the PADM. Studies of social influence provide insight on the types of cues and information that affect behavior. Research and studies on the decision-making process shed light on the steps in which people engage to make decisions on their next course of action. Additionally, the PADM is based upon other theories and conceptual models that link together cues, cognitive processes and subsequent protection actions.

First, since people perceive information from both the physical and social environment, the PADM incorporates insights from social influence research. Theories of social influence posit that the actions of others and the risk communication process can influence human response in disasters. In ambiguous situations, the presence of others helps to define what behavior is appropriate in a particular situation. If people are seen to be taking protective action, others are likely to follow suit and conform to what appear to be new behavioral norms (Turner 1991; Latane and Darley 1970). Conversely, if people are not taking emergency action, others are also likely to do nothing. Informational influence, or the "personal acceptance or internalization of information as a valid description of objective reality" (Lindell and Perry 2004:27), provides insight on how various forms of risk communication influence a person's beliefs, attitudes, and subsequent behavior (McGuire 1985; Hovland, Janis and Kelley 1953). Research has shown that aspects of the risk communication process, e.g., the source, the message, the channels, and the receiver characteristics (i.e., the receiver's perceptions of the credibility of the message, message comprehension, and channel preferences), can ultimately predict whether or not protective action is taken before or during crisis (Lindell and Perry 2004; Mileti and Sorensen 1990).

As a decision-making model, the PADM also relies on behavioral decision theory. In a perfect world, in which those at risk behave like rational actors, decisions would be made based upon all of the

necessary information available to the individual, which would be weighed based on costs and benefits of the various outcomes, leading ultimately to a decision on the best course of action. However, more often, people lack the necessary information needed to make decisions, and they do not always search for additional information. Instead, they make decisions based on their beliefs about the situation, and many times, these beliefs can reflect poor understandings of the situation (Tversky and Kaheman 1974). Decision scientists argue that people are often poor judges both of the likelihood of a disaster event and of the range and severity of impacts disasters can produce. This is because people use a variety of "quick and dirty" heuristics, which are simple rules or "cognitive short cuts" through which individuals judge a situation or event (Klein 1999; Kahneman, Slovic and Tversky 1982). One example of a heuristic that people employ is the availability heuristic, or judging the likelihood of an event based on the ease of recalling similar instances from memory (Kunreuther 2002; Kahneman, Slovic and Tversky 1982). Another short cut, similar to theories of social influence, is an over-reliance on social norms (Kunreuther et al. 2002). In cases of procedural uncertainty, where individuals have little experience dealing with high-stakes decisions, "a natural resolution is to adopt the decision strategies used by others, or follow established social norms" (Kunreuther et al. 2002:263). Heuristics can result in biased understandings of the situation, which may then be used to make decisions during a disaster.

Judgment and decision-making under uncertainty research also provides insights into the ways in which people make decisions on their next course of action based on their beliefs. "Rational-actor"-based research claims that individuals will optimize decision-making by weighing all options and choosing the best one (Slovic, Fischhoff and Lichtenstein 1977; Peterson and Beach 1967). Under uncertainty or crisis, however, individuals or groups are unlikely to search for a large number of options due to significant time pressures (Zakay 1993; Karau and Kelly 1992; Janis 1982; Ben-Zur and Breznitz 1981); limited mental resources (e.g., when they are under stress) (Gigerenzer and Selten 2001; Vaughan 1999; Simon 1956); or if they perceive themselves as experienced in or knowledgeable concerning recommended protective procedures (Klein 1999; Thompson et al. 1997). In situations with greater time pressure, dynamic conditions, and ill-defined goals (Klein 1999), all of which are likely to characterize building

emergencies, people are likely to *satisfice*. Satisficing (Gigerenzer and Selten 2001; Slovic, Kunreuther and White 1974; Simon 1956) is a method in which an individual chooses what she sees as the best viable option, "not to find the best [option] but to find the first one that works" (Klein 1999:20). As the decision-maker develops options, she evaluates each one as it is developed and stops developing options when a specific option is deemed to satisfy the search criteria. These decisions may not be optimal in the long-term, but may be satisfactory in the short-term.

Finally, the PADM is based upon theories that link cues, cognitive processes, and subsequent protective action. Much of that research seeks to establish links between the perception of risk and the performance of protective action. Janis and Mann (1977) developed the conflict model to describe the process of emergency decision-making. An individual's response to a warning is based upon his perception of the severity and immediacy of the threat, the perceived effectiveness of the possible protective action, and the possibility of gaining more information about the event and possible actions. There are several possible outcomes for the individual based upon the perceived hopefulness or hopelessness of the situation, the perceived effectiveness of the protective action, and the perceived availability of time to complete the action. According to this model, if a situation is viewed as hopeless and the effectiveness of the protective action is seen as very low as well, then the individual goes into denial of the emergency's danger. Denial can take many forms including a lack of interest in the emergency, depending on someone else to make decisions, and rationalizing the safety of a particular protective action and ignoring available information about its defects. If the situation and the time available to implement the protective action are viewed as hopeless, hypervigilance, or the fear of entrapment, is evoked. Janis and Mann (1977:40) further explain the nuances of hypervigilance in the following way:

> "[a]n extreme form of hypervigilance, popularly referred to as 'panic,' occurs, for example, when people are confronted by a rapidly approaching fire, realize that it is possible to escape, but can see that the escape routes are rapidly being closed off."

The individual perceives that there is not enough time to make a thorough search for other options and instead, makes quick judgments about next steps, often based on what others are doing. This extremely

intense emotional state could lead to poor judgment and maladaptive (e.g., risky) behavior. In contrast, if the individual views the situation as hopeful, with hope about the time available for protective action or the effectiveness of the action, then he is motivated to engage in actions to reduce potential consequences from the event.

Mileti and Sorensen (1990) developed a model that describes the influence of cognition on warning response. Whereas the PADM focuses on responses of people to various types of cues before or during a disaster, this model summarizes the determinants and consequences of public responses to disaster warnings. The model outlines a process in which the receiver must hear, understand, believe, and personalize the message in order to respond in an appropriate way. The first stage of the process is perceptually receiving the alert or warning; Mileti and Sorensen (1990) note that before anyone can respond to a message, they must receive it first. Once the warning is received, it must be understood, and in this instance, "understanding does not refer to correct interpretation of what is heard, but rather to the personal attachment of meaning to the message" (Mileti and Sorensen 1990:5-2). For example, what does a flood warning mean to one person, versus another? The next stage involves whether the person believes the warning or not – involving whether they believe that the warning is authentic and the contents of the message are accurate. Finally, the last stage in the process before response is personalization. This is the stage in which people think of the warning in personal terms, in that they begin to consider the implications of the risk for themselves and others around them. If the individual has heard, understood, believed, and personalized the warning, she will then decide what to do about the risk. Mileti and Sorensen (1990:5-2) do not discuss the decision-making process in depth, but rather state that "[i]n general, people do what they think is best for them to do." An important part of this process is confirmation. In threat situations, people are constantly seeking out new information to confirm prior information, whether from family, friends, neighbors, and co-workers, or from various media sources and authorities. Confirmation affects each stage of the warning process, in that it helps people to better understand warnings, believe them, personalize the risk, and make decisions.

Although the PADM is similar to the Mileti and Sorensen warning response model, the PADM provides a more general framework that describes information flow and decision-making specifically in response to various types of cues that originate from natural and technological disasters (Lindell and Perry 2004). The PADM asserts that the process of decision-making begins when people witness cues from the disaster event. Individuals can encounter only one type of cue (for example, seeing smoke) or may be presented with a variety of different cues, including environmental cues, the behavior of others, and warning messages. The introduction of these cues initiates a series of pre-decisional processes that must occur in order for the individual to perform protective actions. First, the individual must perceive or receive the cue(s). Then, he must pay attention to the cue(s). Finally, the individual must comprehend the cue(s). Comprehension means understanding the information that is being conveyed. If the message uses a different language or highly technical terms, comprehension will be difficult. Comprehension also refers to the development of an accurate understanding of environmental cues. For example, will the individual understand that the smoke he smells is coming from a building fire rather than from burnt toast in the kitchen?

After the three pre-decisional processes are completed, the core of the decision-making model consists of a series of five questions (Lindell and Perry 2004):

- Is there a real threat that I need to pay attention to? [If yes, then the individual believes the threat]
- Do I need to take protective action? [If yes, then the individual decides that he needs to take protective action]
- What can be done to achieve protection? [The individual begins searching for possible protective action strategies]
- What is the best method of protection? [The individual chooses one of the action strategies developed in the previous stage and develops a protective action strategy or plan]

- Does protective action need to be taken now? [If yes, the individual follows the plan developed in the previous stage]

Individuals must "answer" each question in order to proceed through the perceptual-behavioral sequence, in which the outcome of the process is the performance of a behavioral action. A graphic of the process is shown in Figure 3-1.

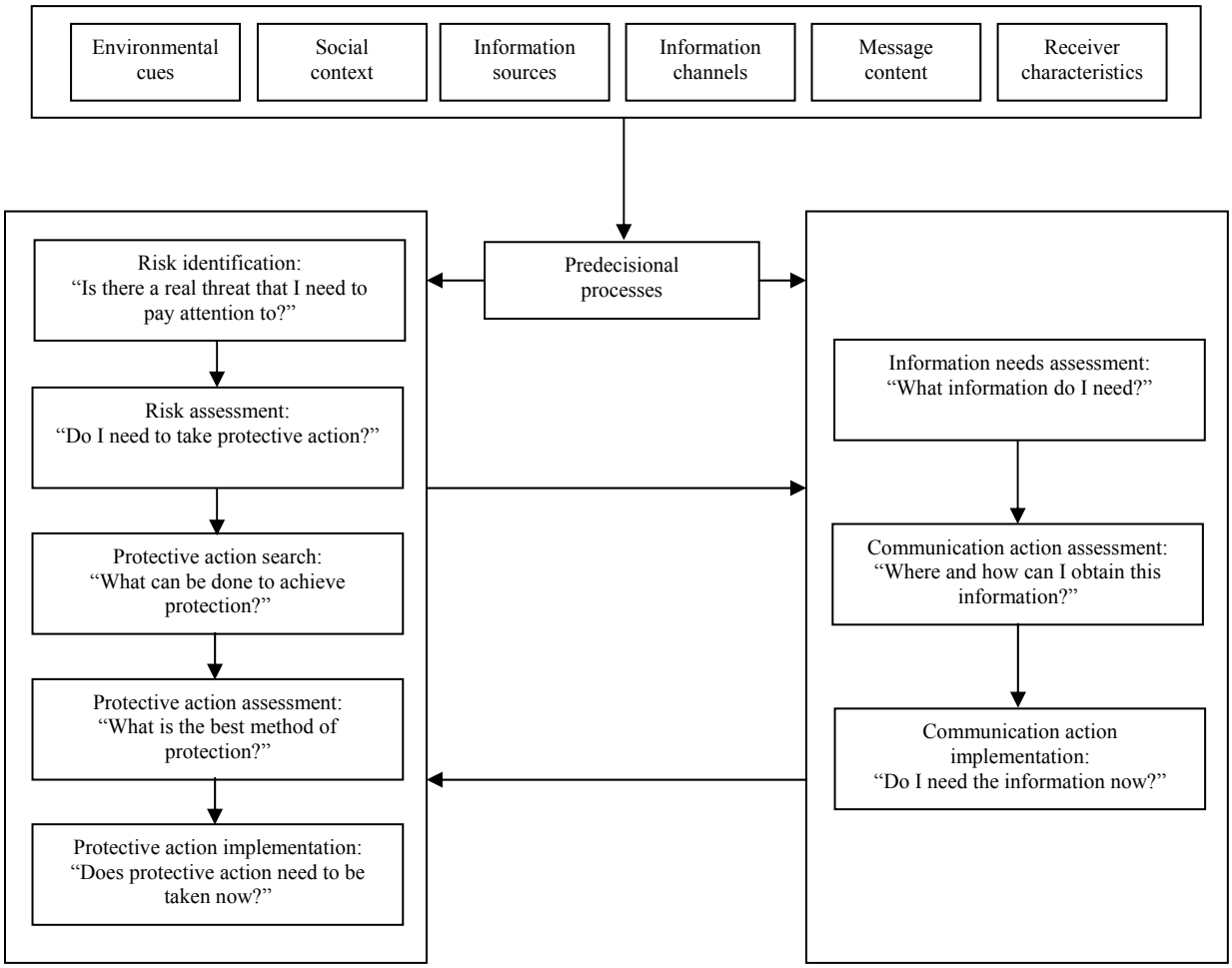


Figure 3-1: The Protective Action Decision Model (Source - Lindell and Perry (2004) redrawn from p. 47)

The first stage of the decision model involves the issue of risk or threat identification. If the individual perceives, pays attention to, and comprehends cues associated with an event, she first asks "Is there a real threat that I should pay attention to?" In this stage, the individual decides if there is actually something occurring that may require her action, sometimes referred to as warning belief (Mileti 1974),

"but this term unnecessarily excludes people's reactions to environmental cues so the term *threat belief* is generally more appropriate" (Lindell and Perry 2004:51). This stage corresponds to the phase in ENT in which members of a population realize that the norms and behaviors for "stable times" no longer apply (Turner and Killian 1987). If the individual's answer is yes, then she is said to believe the threat, and she subsequently moves on to consider the next question in the process.

The second stage of the decision model is referred to as risk assessment. Research has shown that a person's perception of personal risk, or "the individual's expectation of personal exposure to death, injury, or property damage" is highly correlated with disaster response (Lindell and Perry 2004:51). In this stage, also known as personalizing risk (Mileti and Sorensen 1990), the individual determines the likelihood of personal consequences that could result from the threat and asks himself the following: "Do I need to take protective action?" Essentially, at this point, which is also discussed in human factors research as "situation awareness" (Groner 2009), the individual tries to gain insight on the potential outcomes of the disaster and what those potential outcomes mean for his safety. The internal dialogue that takes place at this stage can be thought of as mental simulation or mental modeling (Klein 1999), in which the individual develops a mental model of what is going on in his environment, based on perceived cues, and then expands the mental model to predict the personal consequences of the event. The more certain, severe, and immediate the risk is perceived to be, the more likely the individual is to perform protective actions (Perry, Lindell and Greene 1981).

In the third and fourth stages, the individual engages in a decision-making process to identify 1) what can be done to achieve protection; and 2) the best available method of achieving this protection. The outcome of the third stage is a set of possible protective actions from which to choose. After establishing at least one protective action option, individuals engage in the fourth stage of the PADM: protective action assessment. This stage involves assessment of the potential option(s), evaluating the option(s) in comparison with taking no action and continuing with normal activities, and then selecting the best method of protective action. In emergencies, individuals at risk have two general options: taking

protective action or continuing previous activities. Once an action is chosen, the end result of stage 4 is an adaptive plan, which can vary in its specificity. For example, for households under threat conditions,

> "[a]t a minimum, a specific evacuation plan includes a destination, a route of travel, and a means of transportation. More detailed plans include a procedure for reuniting families if members are separated, advance contact to confirm that the destination is available, consideration of alternative routes if the primary route is unsafe or too crowded, and alternative methods of transportation is [sic] the primary one is not available" (Lindell and Perry 2004:60).

After a protective action is chosen and the adaptive plan is developed, the final step in the decision process involves the implementation of the protective action plan or strategy. Here, the individual asks whether the protective action needs to be taken now. If the answer is yes, then she engages in that action. However, Lindell and Perry (2004) note and other studies confirm (Bryan 2002; Canter, Breaux and Sime 1980; Best 1977) that individuals are still likely to delay the performance of protective action, even when the threat is perceived as imminent.

Passage through these stages is often problematic. If at any stage the individual is uncertain about the answer to a question, she engages in additional information-seeking actions. The greater the ambiguity involved in the situation, the more likely that individuals will search for additional information that can guide their actions (Fahy and Proulx 1997; Mileti and O'Brien 1992; Mileti and Beck 1975; Turner and Killian 1957). Information seeking is especially likely to occur when individuals think that time is available to gain additional insight on the question at hand. If information seeking is successful, in that the person at risk judges she has obtained enough information to answer the question, then the individual moves on to the next stage or question in the decision-making process. However, if the information-seeking action is unsuccessful, there will be additional searching for information as long as she is optimistic that other sources or channels can help (Lindell and Perry 2004). If she is pessimistic regarding future information seeking success, she is likely to attempt to decide on a protective action based solely on whatever information is available.

This description is not meant to imply that decision processes are linear and straightforward. Such processes are typically quite complex, because crisis situations are dynamic (Sime 1984). For example,

information feedback loops allow for the receipt of new environmental and social cues after initial engagement in information-seeking actions. An individual who gains additional information is likely to carry on with the decision-making process until he is ready to implement a protective action. Additionally, individuals do not have to go through each stage or question in the decision flow chart (Lindell and Perry 2004). For example, if an individual is presented with information about the event from a credible source or if he is ordered to evacuate, he may move on to later stages in the decision process rather than going through each one in succession.

This decision-making framework describes the process of how individuals respond to disasters. Throughout the process, individuals' responses range from seeking information, to performing "problem-focused actions," to performing "emotion-focused actions" (Lindell and Perry 2004:46). Even though the focus of the models discussed so far is on community-wide disasters, it is clear that the models also apply to decision-making during more localized types of events, such as building fires and the terrorist attacks that are the focus of this research.

Decision-making in the WTC

The PADM and the models on which it is based form the foundation for the remainder of this chapter, which outlines the decision-making process of WTC respondents during the pre-evacuation period. As I show here, WTC occupants needed to perform the same cognitive and behavioral actions as any other at-risk group – defining the threat, assessing the risk, information seeking, and considering and selecting protective action(s), before actually evacuating. The purpose of the sections that follow is to describe the overarching decision-making processes in which WTC respondents engaged and present supporting evidence for this process by providing rich, detailed descriptions of the respondents' experiences. Discussions in this chapter, which are primarily descriptive, set the scene for the following chapter, Chapter 4, which specifies in more detail the factors that influenced definitions of the threat, assessments of the risk, and actions to seek information, as well as protective actions undertaken before moving into stairwells.

My primary focus is on the pre-evacuation period in the WTC disaster, or the period between the time an occupant first becomes aware that something unusual has occurred and the time she moves into the stairs (or elevators) to begin evacuation. A general process diagram describing WTC occupants' pre-evacuation experiences is shown in Figure 3-2. The portion of the figure that is outlined by dotted lines represents the experiences of a minority of WTC occupants.

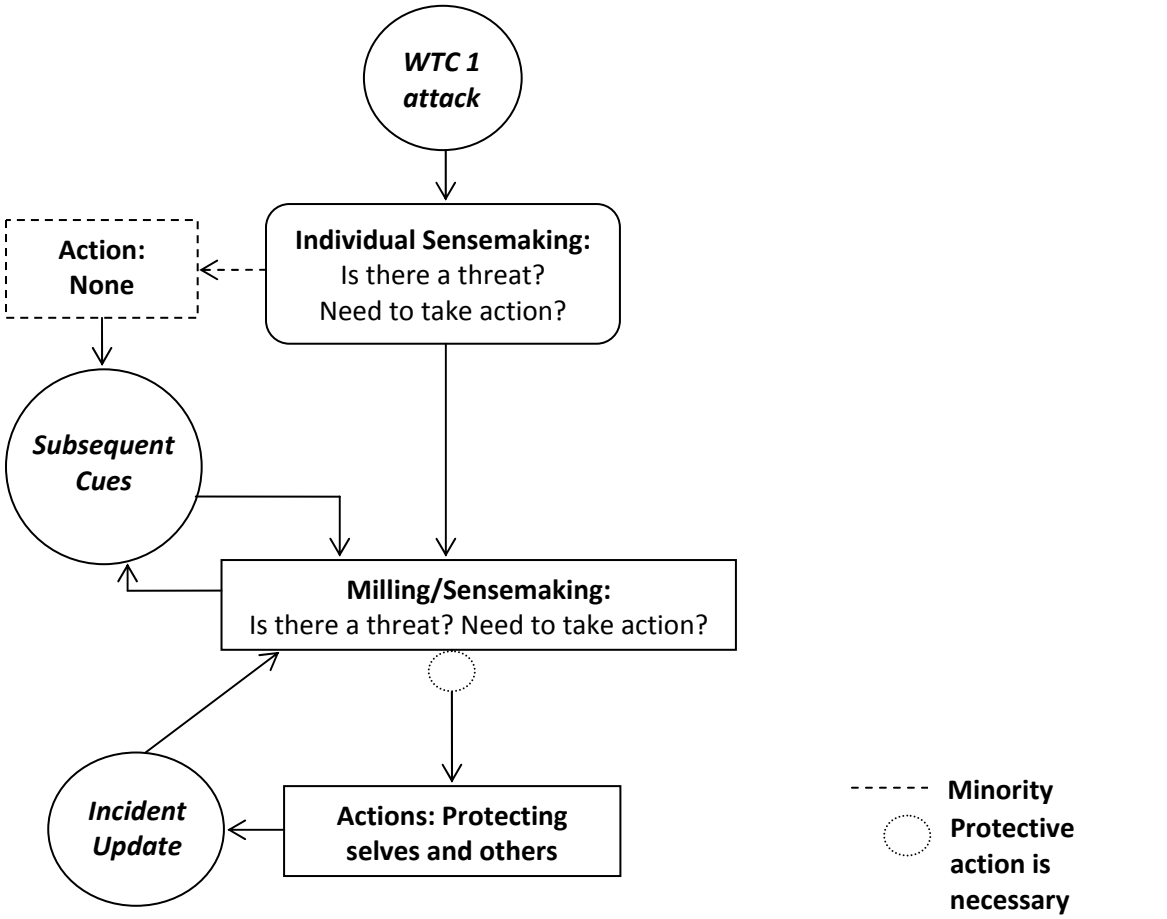


Figure 3-2: The general process model describing occupants' experiences in the pre-evacuation period of the WTC evacuation

It is important to stress that this is a study of survivors of the WTC attacks – people who lived to relate their evacuation experiences. The approximated 2130 victims who perished in the attacks did so for

several reasons:[17] they were killed outright, had no opportunity to escape, did not attempt to do so, and in a very small minority of cases, jumped or fell to their deaths. Some unknown number may simply have delayed too long in the milling process before trying to escape. The threat conditions and impediments faced by these victims were in many respects qualitatively different from those faced by interviewees in this study, even if the decisions many faced were similar.

The following discussion presents the story of the pre-evacuation period on 9/11. Information captured in quotation marks or indented in the text represents direct quotes from interviews. Textual quotations are presented throughout this chapter to allow the reader to "experience" the things that WTC occupants experienced, expressed in their own words.

The attack on WTC 1

The WTC towers were iconic buildings in downtown New York City. They were largely occupied by bankers, traders, insurers, and others promoting business relations domestically and around the world. Towering over other buildings half their size and featuring floor to ceiling windows, the towers presented occupants with a breathtaking view of the city, constantly reminding them of the sheer size of the Statue of Liberty, the beauty of Battery Park, and the various means of transport plying the Hudson River. During normal times, occupants used the extensive elevator system to travel around each tower, which offered to building occupants a total of 99 elevators, some of which traveled only among local floors in each of the three elevator zones, and others that traveled directly to the ground floor lobby (Averill et al. 2005). In case of emergencies, however, elevators were not to be used. Instead, three exit stairs were located on each floor, providing access to the ground levels of the building.[18]

[17] Of the 17,400 +/- 1180 occupants in the WTC towers, an estimated 2146 - 2163 perished. Approximately 630 occupants died in WTC 2. The NIST Investigation of the disaster found that only 11 occupants initially below the 78th floor, the point of the second plane's impact, were killed when WTC 2 collapsed at 9:58:59 am. There were approximately 1500 occupant deaths in WTC 1, 107 of which were estimated to be below the 92nd floor, where the first plane crashed (Averill et al. 2005). The most important risk factor for dying on 9/11 was whether occupants were above or below the impact floors.

[18] Averill et al. (2005) presents detailed information on the WTC towers' building configuration, means of egress, and emergency procedures.

Although the buildings were not yet fully occupied around 8:40 am on September 11, 2001 due to early morning voting in primary elections, people had begun arriving at their offices, meeting rooms, and cafeterias to start the work day. Some had already sat down at their desks and were engaging in routine tasks: checking emails, typing documents, and taking part in conference calls. As they worked, those who had a view of the outside, especially those facing northward, saw something in the distance.

An office worker on the 99th floor of WTC 2 was sitting at her desk at 8:45 am checking her voicemail messages when she heard her boss nonchalantly mention, "'Hey guys, look at that plane. It's flying way too low'" (WTC2/099/0001). Because she had seen so many helicopters, Cessnas, and blimps flying around the buildings before, she neglected to look. Within seconds, her boss's voice rose in pitch, until he was screaming, "'Oh my God, that plane is coming in towards us!'" It was unusual for this very calm, even-tempered man to scream about anything, she thought, even in the most frustrating office situations. She hurriedly hung up the phone and looked out the window. She was paralyzed as she watched:

> The plane, the wings were so steady that he wasn't flailing; it was coming in straight towards us. I could see the American Airlines on the back of the plane. I could see into the cockpit, I could see the cockpit windows although they were dark. ...I couldn't see a pilot or any passengers, but I could see that the face of the plane and I could see on the side of [the] plane -- all the window shutters had been pulled down. (WTC2/099/0001)

She began to try to piece the puzzle together. She remembered thinking, "…did the pilot have a heart attack? Is he having a heart attack?" Her boss screamed, "'it's gonna hit us, it's gonna hit us, get away from the windows, get away from the windows!'" At that point, the plane made contact with WTC 1. In her opinion, the building almost swallowed up the plane, as if the airliner was going into cotton.

Even though WTC 1 absorbed some of the impact, the plane forcefully jolted the building, causing it to sway back and forth several feet. WTC 1 occupants, like one on the 17th floor, were left to cling to desks, chairs, and anything available to keep balance, reporting that "…the building rocked. It just rocked back and forth and then it steadied itself…the impact was so hard that it almost knocked me off my feet" (WTC1/017/0001). The building swayed so far from side to side that a woman on the 89th floor thought that she was falling to her death into the Hudson River. With her heart beating faster, the

only thought that crossed her mind was how this was such a strange way to meet death (WTC1/089/0001).

As if the building sway was not enough, many occupants were deafened by the plane's jet fuel explosion. The explosion was so loud that it almost knocked one occupant on the 62nd floor of WTC 1 right off of his chair (WTC1/062/0001). The ripping explosion sent flames throughout the upper floors, down the elevator shafts and through the air that surrounded the building. As tiles fell from the ceiling, furniture, computers and other equipment tumbled to the ground, and an occupant on the 90th floor of WTC 1 witnessed

> the wall in front of me, bubbling, kind of, flames came roaring towards me. The ladies room door opened against the hinges, just sort of snapped open against the hinges, and out came a plume of burning...of flame… And the men's room, which was directly, sort of, off on the side there, just disintegrated because that was up against the, what do you call it, elevator courts... (WTC1/090/0001)

Even an occupant seven floors below the area of impact stood and watched a fireball heading right for him. The elevator doors blew away from the shaft as the fireball erupted onto the floor, and it was only until the very moment that it would have incinerated him and everything around him, that the ball dissipated into thin air (WTC1/083/0001). The fireball surrounded the tower as well, pushing a "huge wall of, what looked like … plasma, that was kind of a reddish-brown in color and was 300-400 ft in length…" against the windows of towers 1 and 2 (WTC2/073/0001).

The plane's explosive crash into WTC 1 was not witnessed only by occupants inside the wounded building. Some occupants in WTC 2 recalled hearing loud, explosion-type sounds and even feeling their own tower slightly shake or shudder. As a woman from the 99th floor of WTC 2 stood and watched the impact, she could feel the heat on her face from the fireball that erupted from the building next door. "It felt like you were leaning over a barbeque pit" (WTC2/099/0001).

The occupants farther away from the windows or located farther down in the building did not witness such obvious cues. An occupant on the 101st floor of WTC 2 said that she had no access to windows and heard "…a little boom, nothing loud, just a little boom, the lights flickered…and they um

came back on" (WTC2/101/0001). An individual in a 92nd floor conference room only heard yelling, screaming, and peoples' quick footsteps outside the door (WTC2/092/0002).

No matter the type of interruption, people's curiosity got the best of them. They could not help but begin to engage with the people around them - asking their neighbors whether they had heard the same noise or seen the same thing. People were quick to react and provide information to one another. An occupant on the 84th floor of WTC 2 recalled that "one of the guys in the next area over …stood up and said 'Something had happened to the building'" (WTC2/084/0006).

Most occupants did not know that at 8:46 am, American Airlines Flight 11, a Boeing 767, hit the north face of WTC 1, resulting in a direct hit on floors 93 through 99. Additional damage extended to several floors above and below the impact zone. At that moment in time, all access to safety, via both the stairs and elevators, for those at or above the floors of impact, was destroyed, sealing the fates of all occupants above the 91st floor of WTC 1.When the aircraft struck the building, the jet fuel on board the plane ignited. A portion of the fuel immediately burned off in large fireballs that erupted at the floors of impact. The remaining fuel flowed across floors and down elevators and utility shafts, igniting intense fires throughout portions of the building. One such fire, in the form a large fireball, killed and injured several occupants in the Concourse Level (ground) floor lobby. Seconds after WTC 1 was attacked, the nation's largest full-scale building evacuation began to unfold (Averill et al. 2005).

Individual sensemaking – Is there a threat? Is protective action necessary?

Only a few occupants in both towers initially realized that a commercial airliner had hit WTC 1, because they had seen it flying toward the towers. An individual in WTC 1 worried about the structural integrity of his building, saying that "…[he] didn't think there was any question how this building was gonna stay up with this aircraft, that large, going that fast hitting it" (WTC1/054/0001). Even some in WTC 2 thought that they might be facing fatal consequences as well, since they were so close to the incident. A WTC 2 occupant on the 79th floor was concerned that the airplane had released so much jet fuel into the air between the buildings that all someone had to do was light a match and they would all go "boom!" (WTC2/079/0001). However, not all WTC 2 occupants who saw the plane strike its sister

building were as concerned. Instead of worrying about her own safety, an occupant on the 99th floor was initially relieved that the plane missed her own building and more concerned for the safety of her neighbors in WTC 1 (WTC2/099/0001).

Others may not have known a plane had hit, but a few were prone to think the worst. An individual on the 77th floor of WTC 1 felt in danger every time he walked into the WTC. In his view, since a previous terrorist event had occurred there, the towers would always represent a target for future terrorist attempts. He perceived very high personal risk immediately after impact "because [he] was always very nervous about being in the building and [he] always thought that it would be real easy for something to happen and then you couldn't get out" (WTC1/077/0002). As soon as WTC 1 was hit on September 11, 2001, some occupants felt that their lives were at risk, whether they were in WTC 1 or 2.

However, the majority of people in both towers were not yet sure whether they were in danger. They were still trying to figure out what was going on. An occupant shocked by the attack in WTC 1 said that "…I didn't really have a clue what was going on, didn't know where or what caused that …" (WTC1/049/0001). Many acknowledged that something unusual was going on, even a dangerous or horrible event because, according to an individual on the 64th floor, "you don't hear [a]n impact like that in a building every day..." (WTC1/064/0002).

The uncertainty prompted some to wager a guess as to what was going on. Some WTC 1 occupants thought that an earthquake in New York City was the cause of the building swaying back and forth. Others were captured by memories of the 1993 truck bombing, particularly the explosion sounds and the shaking of the building. Eight years earlier, on February 26, 1993, a truck bomb had been detonated in the basement of WTC 1 that obliterated the main electrical power line to the towers, knocking out both the emergency communication and lighting systems. Six deaths had occurred in the basement of WTC 1 as a result of the detonation (Isner and Klem 1993). A survivor of the 1993 bombing in WTC 1 began to remember that the building jolted in a similar manner back in 1993; however, he described the jolt in 2001 as "…ten times worse" (WTC1/057/0001).

The impact on WTC 1 also prompted memories of previous accidental explosions in both buildings, such as construction or maintenance accidents, an incident where an elevator had crashed to the bottom of the shaft, and building equipment failures (transformer or generator failures). An individual located on a higher floor in WTC 1 thought

> … that some poor plumber or electrician had tapped into a gas line or something had blown themselves up. I thought it was very localized. I sort of felt sorry that they had, you know, that they had killed themselves. (WTC1/090/0001)

Only seconds had gone by since the impact of WTC 1. Many described their feelings as jittery, nervous, frightened, and confused about what was coming next. Even with interpretations of the event that indicated a potential threat, many individuals had not yet begun to personalize the risk. Although they recognized that something could be wrong in the building, they were not sure what it meant for their safety. An occupant on the 52nd floor of WTC 1, who thought that an earthquake had hit New York City, had not yet developed an assessment of risk:

> … that can't be good, that's not normal....Yet at the same time, I didn't know how much at risk we were, whenever you're in a high-rise, you're at risk of things happening, but like I honestly didn't feel at that moment that 'Oh, we're done for. We're never going to get out.' (WTC1/052/0001)

Seconds after the building stopped swaying, some WTC 1 occupants altered their mental models slightly. Instead of thinking that they were going to die when the tower swung to the ground, once the building stabilized, they began to think that they had a chance for survival. Describing his fluctuations in risk perception, as indicated in the risk perception survey, an occupant on the 73rd floor of WTC 1 said that:

> …I mean at the instant I heard the impact and felt the impact, maybe I would have had a '7' if that's when you know, but 30 seconds later after the building stopped and everybody had a chance to decide what they were going to do, at that point I would have selected a lower number. (WTC1/073/0001)

Others defined the situation as non-threatening to building occupants' safety. For example, some individuals, especially those higher in the buildings, labeled the building sway as heavy wind and the

explosion sounds as thunder. Not necessarily threatened by the building sway, an individual on the 81st floor of WTC 1 remembered the following:

> …I was used to being in the towers, and I knew that they swayed, and I have been in a North-easter on the east side, on Water Street where the building literally rocked back and forth and they had to send us all home, we got sea sick (WTC1/081/0004).

Remembering frequent construction efforts in the WTC towers, some individuals thought that the loud sounds were simply construction or maintenance workers dropping equipment on the floor above their heads. The more "local" or common events did not seem to scare the veteran occupants of the building, such as a WTC 1 occupant on the 47th floor who thought a generator had blown up in the building. When asked about his perceived risk level following impact, he stated:

> I'll have to say little risk…because I didn't feel like my life was in danger. I didn't feel any type of danger…maybe a generator blew up. That wasn't uncommon. (WTC1/047/0002)

Some occupants in WTC 2 explained away the sounds that they experienced as, "just benign…like you would expect to hear" (WTC2/016/0003) or simply the air-conditioning duct over a desk making the same *boom* sound that it usually made (WTC2/054/0002), and the lights flickering on the floor as simply a power surge. Apparently, to some, the office, floor, or New York City in general was a very noisy place. After time, one begins to ignore or disregard the same types of noises because they are a common occurrence. An occupant on the 58th floor of WTC 2 explains this phenomenon:

> Now I was used to hearing bangs, you know you would hear bangs quite often and mostly we never knew what they were, you know? A lot of times you would just think it was some kind of construction going on somewhere like a dump truck door closing or something, you know? (WTC2/058/0003)

No matter how loud the sounds were and how much the building swayed, there were people who initially felt safe after impact. To a respondent on the 44th floor of WTC 1, it was "beyond your thinking that something so serious was going to happen that would put you in danger" (WTC1/044/0004).

So what should they do? A minority of people in WTC 2[19] discontinued protective action decision-making. They re-engaged in their previous work activities directly after WTC 1 was hit. For them, the information that they perceived at impact was not sufficient to interrupt their previous activities. They did not commit to questioning the event and went back to typing, reading, or whatever they were initially doing prior to 8:46 am. A person on the 92nd floor of WTC 2 was packing up her office for a move somewhere else in the building. After only seeing the lights flicker and hearing a "little boom, barely audible" (WTC2/092/0001), she did not pay much attention to the cues, especially since there were no coworkers in the immediate area to confirm or disconfirm the information. After assessing the sounds as normal noises that always occur in a busy city, she continued packing.

The majority of people in WTC 1 and 2 wanted more information. Some were frightened, some were curious. In either case, they wanted to know more. In turn, they looked to the environment and the people around them for answers.

Milling and sensemaking

The majority of people in both towers began milling almost immediately after WTC 1 was hit. In the milling process, individuals connect with the environment and the people around them.[20] Many were interested in finding out what was going on or whether something was going on at all. Others were convinced that they knew what was taking place, but were uncertain about what to do.

Searching the environment

Within minutes of the impact, occupants reacted to the event. On open-plan floors, some had to only turn their heads to look around or outside the windows. Others without initial access to windows ran out of their offices to other locations for a better view of the outside. Even after something as subtle as the lights flickering on the 31st floor of WTC 2, an occupant noted that the next thing he did was turn towards the windows and look outside (WTC2/031/0001).

[19] A minority refers to 18 out of 121 people in the WTC 2 sample, or 15%.

[20]The 2001 WTC disaster was an unusual event in that all building occupants perceived cues from WTC 1 at about the same time. Therefore, it was likely that respondents in both towers began milling at or about the same time. In other types of emergencies, occupants may perceive many different cues from the event and will likely begin milling at different points.

Seeing others looking out the windows seemed to entice curious individuals to follow suit. An individual on the 67th floor of WTC 2 noticed other people looking out the windows after hearing a distant thunder sound and seeing the lights flicker. "So we all rushed over to the windows at the uh…facing …[Church Street]" (WTC2/067/0003). They were looking for any shred of evidence that might indicate what caused the loud (or even distant) noises, shaking of the building, or the interruption of electricity within the building.

Also, people who had developed an initial understanding of the event looked around for any information that would confirm or refute their beliefs. A person on the 40th floor of WTC 1, who originally thought that an earthquake had occurred, looked out the windows after the tower stopped shaking. Since his tower was still standing, he wondered about the other buildings and whether they were damaged (WTC1/040/0004). Similarly, a WTC occupant thought that underground steam pipes had exploded. He turned to look out the window and onto the concourse "trying to see if there [were]…emergency trucks or whatever, down there some place…" (WTC2/052/0003). Individuals also looked to one another for clues about what was going on. After hearing a loud sound, a WTC 2 occupant on the 84th floor scanned the trading floor, looking at others to see if they heard the sound as well (WTC2/084/0010).

Occupants in both towers examined their surroundings for information about what was going on. In turn, they perceived alarming signs that something had gone awry. As they searched the floors, they saw black smoke billowing outside the windows and heavy debris flying past the buildings. An individual in WTC 1 watched as an I-beam or building girder that was 20 feet in length flew by the window (WTC1/089/0001). The building seemed to be "shedding itself" and the more paper, metal and flaming debris that went by, the more occupants stood glued to the windows (WTC1/054/0001). Occupants could hear the clanging of the metal pieces hitting the windows. Amidst the heavier debris, lighter debris was also falling. What at first looked like silvery, shiny confetti was later recognized as sheets of "…computer, Xerox sheets of paper, standard 8 x 11 whatever it is, thousands of them floating in the breeze" (WTC2/043/0001; WTC2/084/0006).

Regardless of whether they searched for information, people above the 77th floor in WTC 1 watched as the conditions on the floors worsened with each passing minute. What had originally taken shape as a fireball after impact had succeeded in starting small fires around the offices nearby on the 83rd floor (WTC1/083/0001). An occupant on the 88th floor could not help but notice the fire raging in the public corridor through the office's glass windows (WTC1/088/0001). The fires and debris confined occupants to only certain areas of the floor and forced them to cautiously step over and around shattered glass doors and broken, overturned furniture in order to find other, less obvious routes to safety. What had been their comfortable offices just minutes before now looked and felt more like a war zone. It soon became obvious that only the stairs were available, if they could find them. On the 77th floor, for example, the elevator banks collapsed inward, with flames licking the entrance. White smoke surrounded the broken elevators cars and began to envelope the waiting lobbies (WTC1/077/0002).

Discussing the event

In the growing uncertainty, coworkers became sources of information to one another. After occupants witnessed the devastating damage both inside and outside of the building, they began to work together. Some hypothesized about the event together. An occupant located in a windowless classroom on the 55th floor of WTC 1 spoke with his classmates for five minutes after impact, talking "…back and forth about what it could be …" (WTC1/055/0001). Similarly, people on the 83rd floor discussed the event:

> there were I think 6 people in there, or maybe 8 people, and the first person I saw was this guy who was, like a, shouting that an American Airlines jet just flew into the building…[different place in the transcript] so he was completely freaked out. (WTC1/083/0004)

However, since very few occupants at that time were aware that a commercial airliner had hit the building, other suggestions were more common. Occupants in both buildings offered suggestions including: "a bomb had exploded in the other building, in the south building..." (WTC1/089/0001) or "it sounds like it is a construction explosion" (WTC2/058/0001). An occupant on the 33rd floor of WTC 1 mentioned that "…two or three or four people came out in the hall and they were talking amongst

themselves and kinda guess[ing] as to what it was. Someone said 'Oh, the elevators crashed.'" (WTC1/033/0002).

Occupants also talked about what they should do next. Should they evacuate? What did they do in the past? What was the procedure? What did their boss or their fire warden think? An individual on the 36th floor in WTC 2 talked with six to eight colleagues, saying that: "Quite literally, that the cluster of people I was with…we looked to each other…'shall we leave?'" (WTC2/036/0003).

Many still needed additional information. Occupants (especially in WTC 2) joined together to search their environment again. It was not enough for occupants to stand up and look out their closest window. Once they began to see debris falling outside their windows, they wanted to know exactly where the debris was coming from. They wanted to get closer, to see what was really going on. They did this as a group. According to an occupant on the 55th floor of WTC 2, "so like lemmings, we all ran over to the window. And looked up" (WTC2/055/0001).

As they moved closer to the windows, they had a better view of the damage outside. Looking straight out, they saw papers falling by their windows. They were mesmerized by the beauty of what seemed like a tickertape parade, until they realized that the falling papers were burning in the air. Higher in WTC 2, people looked directly at the impact zone and were horrified to see "this gaping hole in One World Trade. Fairly high up. …see the hole and the smoke." (WTC2/055/0001). Black smoke and flames poured out of the jagged edges of the building's exit wound. But what had caused such devastation was still unknown to many.

Sensemaking again – Is there a threat? Is protective action necessary?

With all of this new information, groups were still working together to further develop, confirm, and alter their interpretations of the situation. Understanding the event became a social activity.

With the new information, many original guesses no longer seemed probable. A thunderstorm, heavy winds, routine construction in the building, or an elevator failure were unlikely to be the cause of fire, smoke and heavy debris raining outside of the building. It also seemed improbable that an earthquake was the cause of the event. An occupant on the 82nd floor of WTC 1 explains

> that nothing else fell down, that none of the other surrounding buildings were shaking, there wasn't any other...it wasn't like you looked out and New Jersey was just sitting there, so it had to be something local… (WTC1/082/0003)

Seeing the faint, white smoke in their immediate areas and heavy, burning debris raining outside the windows in both towers helped work groups, especially veterans in the building who recalled the 1993 WTC bombing, to develop a new assumption that someone had attempted to bomb the towers again. Justifying the revised interpretation, an individual stated that, "I think bomb would have been still fresh in everyone's mind because of …the first one" (WTC1/026/0001).

As an intentional bombing became more of a possibility, memories of the consequences of the 1993 bombing came flooding back to WTC occupants – often memories that they had hoped to forget. After the bomb detonated in 1993, thick smoke had filled the stair shafts in both buildings, forcing occupants to evacuate the stairs in crowded, smoke-filled conditions. Also, hundreds were trapped in elevators when the buildings lost power (Isner and Klem 1993). Even those who had been absent on February 26th remembered pictures of the evacuees' soot-stained faces exiting the towers that day. It took some individuals two to three hours to evacuate the towers in 1993 (WTC2/068/0001). For those who waited on floors, it was even longer before fire fighters came to rescue them. They remembered having to ransack the offices for traces of food as the hours ticked by. And once they left, they were unable to return to the building for weeks. They had been through this before, and many thought that they were going through it all over again.

Not everyone suspected foul play. More and more occupants began thinking that an accidental plane crash was the cause of these significant events. WTC 1 occupants were either told about the plane crash or came to that conclusion, based on the falling debris outside of the windows. One respondent on the 33rd floor saw a plane door fly past the windows (WTC1/033/0002). The individuals in WTC 2 also began piecing together the puzzle that a plane had hit WTC 1. The occupants who saw the damage to WTC 1 – the gaping hole in the side of the building and the fire and smoke billowing from the building –

began to suspect a plane had hit. Others heard about the plane hitting the tower next door from people around them.

However, it was rarely suspected that the plane was a commercial airliner. Most visualized a smaller, more compact plane like a Cessna or helicopter, as demonstrated here by an occupant in WTC 2:

> and then the thought crossed my mind…like a helicopter, the traffic helicopters that go up and down the Hudson? Or, or a tourist helicopter; I presumed at that point Tower One only because I didn't feel anything, or I was standing, right, I thought I would have felt something. (WTC2/082/0002)

These types of planes represented what they were used to seeing flying very close to the building on a regular basis.

Unlike a bombing, a plane crashing into the building was an event that they had not experienced before. Because of that, they did not know what to expect or what it meant for them and their safety in the building. A plane flying into the building meant different things to different people in WTC 1. A manager on the 45th floor suspected that the plane had produced a dangerous fire above him and that "…we should get out cos fires have a way of getting into the elevator shaft and we were right near the elevator…" (WTC1/045/0001). An occupant on the 64th floor whose colleague had smelled jet fuel was convinced that they were in trouble regardless of whether a small or a large plane had hit their building (WTC1/064/0002). On the other hand, as long as it was only a small Cessna that had struck such a big building, and there was nothing particularly dangerous on the floor, some people thought that they were in no danger at all.

A plane impact meant different things to the occupants in WTC 2 as well. Some considered themselves safe, since nothing had actually occurred in their building. For example, an occupant on the 60th floor of WTC 2 thought that:

> There was no damage to our building. As I said I got up, I went to the next office and I asked [Occupant] 'what did he think happened?' He said 'it looked like a small plane hit the building. It looks like an accident.' Okay. Terrific. It's an accident; another day in the World Trade Center. (WTC2/060/0004)

On the other hand, individuals still worried about potential dangers from the event next door. An occupant on the 105th floor of WTC 2 knew that the buildings were connected at the bottom and thought that whatever happened to one building would eventually affect the other building (WTC2/105/0001).

Even while people discussed the event, the majority were still not sure what it was. They realized that something bad was taking place. They were nervous and alarmed to see chunks of the building continually falling around them. When would it stop? What was going on?

Protection action is necessary

Even though building occupants in both towers absorbed an overwhelming amount of information from the event, one piece of crucial information was missing. Building occupants had been trained to listen for an announcement that would tell them what to do when an emergency occurred. Due to the fact that the plane knocked out the communication system in WTC 1, and there was initially no incident taking place in WTC 2, occupants in both towers were not provided with an official order to evacuate from the building or any other information over the public address system. WTC 2 occupants did receive a building-wide announcement to evacuate, if they wanted to, one minute before the second plane crashed into their own tower. However, by that time, most had already begun to leave. Generally, occupants were left to decide on their own whether they needed to take protective action and if so, how they would do it.

Minutes after WTC 1 was hit

Luckily for the WTC survivors, there were occupants in both towers who decided on their own that protective action was necessary, without waiting for an official warning. These occupants are referred to here as *early responders* because they began protective action before the others around them, often only minutes after WTC 1 was attacked. For WTC 1 occupants, the building had finally finished swaying, debris continued to fall, and some saw smoke and flames moving throughout the floors. They suspected that if they stayed any longer, they and their coworkers could be in grave danger. This line of thinking extended to WTC 2 as well. A WTC 2 occupant on the 74th floor noted that the event did not occur in her building,

> … but when anything happened in any of the buildings and especially having worked with [colleague] for so long and he had gone through 1993, when something happened we all became a little sensitive. Did you hear that noise...so just because it happened in that other building we thought this could ultimately affect our building... (WTC2/074/0002)

And, regarding the options to achieve protection, they only had a few in the high-rise towers: evacuate the building, evacuate a few floors down in the building, or remain in place. On floors throughout the towers, early responders made their decision to leave the building almost immediately, automatically and without hesitation. Even without a clear idea of what was going on, a 1993 survivor from the 82nd floor of WTC 1 decided to evacuate within minutes of the attack on WTC 1:

> It was robotic. Again, the first thing I thought was, my God, I can't believe I'm back in that situation. There's a way out and it's that way. It wasn't with a lot of thought, it was just very automatic. (WTC1/082/0002)

It was the large-sized debris that shook an individual on the 32nd floor, who had worked in the towers for over ten years, into realizing that the event was serious. After speaking with other veterans of the towers, many of whom remembered the 1993 bombing, they realized together that: "…the smart thing to do, on our own, is leave" (WTC2/032/0001).

Just because early responders decided to evacuate did not mean that they rushed directly to the stairs or the elevators. Instead, evacuation was often delayed, as occupants elected to attend to other things before leaving. A manager and 1993 survivor on the 73rd floor of WTC 1 made his decision to evacuate the floor almost immediately after impact and then noted that he "…thought of four or five things I wanted to do before I left…" (WTC1/073/0002). Early responders engaged in various activities before actually leaving, including instructing others to evacuate, physically assisting others to the stairs, and preparing for evacuation.

Protection of people

Consistent with ENT's concept of keynoters during normative crises (Turner and Killian 1987), a portion of the early responders in the WTC emerged as leaders, focusing first on the safety of the people around them. A person on the 35th floor of WTC 1 was discussing the event with colleagues:

> when all of a sudden one of our, [chief/boss] came running through the building, came running through the floors yelling 'everybody out, everybody out,' he just came yelling at everyone …screaming 'everybody out.' (WTC1/035/0002)

These individuals, referred to here as *leaders*, ran around the floor – telling, shouting, yelling to their colleagues and employees to evacuate. People could sense the fear in their voices as they screamed for people to leave during their sprints to the stairs. Leaders hoped to prompt everyone within hearing distance to follow them – to persuade them to leave the building now. A manager and 1993 survivor on the 36th floor of WTC 1 stated that, "I immediately made my way to the stairs. I was telling everybody in front of me to get out of the building …" (WTC1/036/0003). Also, in the smaller offices with fewer people, the task of informing others was a bit easier to perform. A manager in WTC 1 had to tell only six employees to evacuate, which was easier still since they were all standing in the same place (WTC1/052/0004).

Once individuals were instructed to evacuate, they decided that protective action was necessary for them. A group on the 55th floor in WTC 1 suggested that "… maybe we should get the hell out of here." A group member later acknowledged that she "probably wouldn't have left if they wouldn't have had done that" (WTC1/055/0001). The instructions were often given with such intensity and fear that they were almost impossible to ignore:

> ...it was fearful, you could sense a fear, and like I said, I don't know who he is so I don't know if this was in character, out of character, if he was a take charge guy or if he was a manager, he was wearing a long sleeve shirt but I don't know so I listened, you know, he was, yes, authoritative, he just, and he seemed panicked, so you're going to listen, I think in that instance we listened. (WTC2/037/0001)

The instructions also relieved the pressure on individuals who knew they were in trouble but did not know what to do. Instead of continuing to ponder her next move, an individual on the 28th floor in WTC 1 felt the decision had been made for her:

> I think I sort of remember feeling a slight sense of relief as to, we were all kind of saying, 'Let's go' and then I was trying to go because I have a feeling like we didn't want to go separately, we wanted to … you know like … we were all going or we were all staying... (WTC1/028/0001)

Occupants who received instructions to evacuate quickly began to develop protective action plans of their own. Should they leave right away, or were there other things or people that they needed to protect beforehand? This started the second wave of protective action in the towers, which would continue to prompt others in the building to follow suit.

It became a priority for some evacuees, a second wave of leaders, to share their decisions with others. For example, an occupant in WTC 1 on the 51st floor notes that, "I remember looking to a gentleman next to me and I'm like 'I'm getting the hell outta here.' So we went to the hallway…" (WTC1/051/0001). They made sure that their officemates and friends were evacuating the building with them. If they were getting out, they wanted to make sure that the people around them were reaching safety as well. Others called loved ones outside of the building. The conversations with loved ones were similar among respondents, in that many wanted to check in with their loved ones, tell them what was going on, and let them know they were safe and were evacuating the building.

Protection of property

What did occupants do next after deciding to evacuate and, in some cases, sharing these decisions with others? Many individuals felt that they could not leave the building without pausing to gather some essential items. An individual in WTC 2 remembered his evacuation in 1993 after the bombing, saying that:

> The only thing that made me linger for a minute was remembering that there were things I would like to have taken with me, for business purposes, back in '93. …I tried to think of objects within a reasonable minute. (WTC2/032/0001)

They ran back to their offices and cubicles and grabbed purses, wallets, briefcases, jackets, glasses, laptops, cell phones, papers, files, calendars, and ID cards before leaving. Some people left with whatever would fit in their pockets, while others left with multiple bookbags, briefcases, gym bags or purses filled to the brim. Someone in WTC 1 described his preparation experience as the following:

> So in a very organized fashion I found my Palm Pilot and put it in my briefcase, put on my regular glasses, took off my reading glasses, put those in my briefcase…gathered up all my personal belongings that I would travel with, put them in my case and try to find my way out. (WTC1/070/0002)

Many who gathered items thought they were at least leaving for the day. They had to bring certain things with them that they needed to travel home for the day, or else they would be stranded in downtown Manhattan with nowhere to go and no way to get home.

Companies that had been through the 1993 bombing had prepared for the possibility of future emergencies in the form of "go kits." Individuals in these companies recalled grabbing their "go kits," which were located on the backs of their chairs, for example, before running to the stairs. These kits contained flashlights, water bottles, whistles, and other items to keep occupants safe during a long, possibly dark stair evacuation. Others who recalled the smoke-filled stairs during the 1993 bombing took time to wet paper towels, cloths, napkins, and even their own clothing in case they encountered smoke in the stairs during their evacuation.

While most took a few minutes to grab their personal items, some also had certain time-intensive tasks to attend to before leaving. These occupants prepared their offices or cubicle spaces for their departure from the floor -- shutting down equipment, powering down computers and laptops, logging out of computers, closing or locking the office or company doors, and putting items into their proper locations (e.g., placing valuables in the safe of a bank).

At this point, many occupants were ready to evacuate. Evacuation is typically driven by an adaptive plan (Lindell and Perry 2004). As mentioned earlier, an evacuation plan includes the destination of the individual, the means of travel, and the route of travel. The same is true for occupants in the WTC. Although their destination was out of the building, which type of exit would they choose as their means of evacuation, stairs or elevators? Which route would they use to reach that exit? And how would they ultimately leave the building?

The evacuation plan

In WTC 1, most occupants thought that they should use the stairs for evacuation. They were convinced that an emergency was taking place in their building, and in any emergency, they were taught to use the stairs and not the elevators. Additionally, fire wardens and managers were directing occupants to the stairs that were closest them. Those who considered elevators as an option were quickly discouraged when they saw white, heavy smoke rising from the elevator shafts. WTC 1 occupants had three stairwells to choose from – Stairs A, B, and C. Seas of people began moving to one of the three stairs together, as described by an individual on the 40th floor of WTC 1:

> …people were running towards the exits, and the fire warden who normally works on the other side of the floor was for some reason on my side of the floor, and he was already getting people together... (WTC1/040/0001)

However, evacuation was not always possible. WTC 1 occupants on higher floors in the building were faced with such dangerous conditions that they feared being trapped on the floors indefinitely. A group on the 89th floor of WTC 1 knew very early on that they needed to evacuate when they saw "black, just incredibly dense, thick smoke with a, a smell and odor…just a very sourer, acrid type of smell" in the back offices (WTC1/089/0001). However, when the stair door knob would not turn, they were forced to consider other options for protection. Since incapacitating smoke had been filling the office, from which they thought they had no way out, they starting shoving towels, suit jackets and any kind of materials that they could find under the doors to block the smoke. An occupant admits that "the only thing that I could conclude was that it would end in our burning to death or dying of smoke inhalation, there was just no possible way ..." (WTC1/089/0001). They were sure that the end was near -- until, that is, they heard what sounded like someone pounding on the door. Two men with flashlights, described as maintenance or service workers, walked through the floors higher in WTC 1 to rescue any survivors. They saved lives that day – people who would not have made it to the stairs without them. The two men told each group to follow them, and people listened. They had no choice if they wanted to survive. Here again, the

appearance of these rescuers shifted the collective definitions of the situation, from a focus on almost certain death to a new definition indicating that escape was possible.

The availability of means of egress -- stairs and elevators -- was a different story in WTC 2, at least initially. Between 8:46 am, when WTC 1 was hit, and 9:03 am, when the second plane hit WTC 2, the elevators remained available and functional in WTC 2. Nonetheless, the majority of the respondents in WTC 2 used stairs to evacuate. Many mentioned that they knew not to use an elevator in an emergency and that stairs were the appropriate or safer option. An occupant on the 50th floor of WTC 2 remembered that:

> …one of the things that they always drill into your head during fire drills, never take the elevators; it never even entered our mind [to take the elevators] (WTC2/050/0002)

Fire wardens and managers also helped to influence this decision by, in some cases, standing in front of the elevators specifically to tell respondents not to use them (WTC2/073/0001).

Thankfully, some occupants in WTC 2 did not get this message and successfully used elevators to reach safety. They saw that the elevators were available to them, and while their colleagues used the stairs, a few used the elevators.[21] These decisions saved many lives. According to the NIST Investigation of the 2001 WTC disaster, "that so many evacuated was largely due to occupant use of the elevators in WTC 2 to evacuate prior to impact" (Averill et al. 2005:125). Analyses comparing a hypothetical situation in which occupants in WTC 2 began evacuation only when that tower was hit, and thus, when elevators were not available, showed that self evacuation (starting to evacuate prior to 9:02:59 am) and the use of elevators saved roughly 3,000 lives in WTC 2 on September 11.

The effect of the early responders on others

Within minutes of the first plane's impact, most occupants in WTC 1 and 2 were fully engaged in protective actions. They were running back to their offices for personal items, gathering things from their desks, and then running to the stairs. Not just a few people here and there – but crowds of people running

[21] The NIST Federal Investigation of the WTC Disaster found that 16% of WTC 2 occupants used the elevators for evacuation. The HEED sample provides a similar result (18/121 or 15%), even though it was collected using a convenience sampling technique.

together to the stairs. An occupant on the 73rd floor of WTC 1 saw a "sea of people coming towards [him]" that looked "freaked out" as they moved toward the exit (WTC1/073/0007).

As the crisis progressed, the news of the need to evacuate had not reached everyone yet, but luckily, occupants were persuaded by the actions of others. Seeing others performing protective actions was a very convincing argument to begin evacuation: "…everybody started running for it. I'm sure I wasn't the first one there. I probably just saw everybody going for the stairs, and just kind of followed everybody" (WTC2/103/0001). Just the sight of a large number of colleagues evacuating was enough to influence others to evacuate. An occupant on the 80th floor of WTC 2 noted that "…everybody was leaving, so I, why would I stay behind?" (WTC2/080/0003).

In addition to instructing people to evacuate, some leaders saw to it that people who needed assistance could begin their evacuation. Depending upon the floor and the needs of the occupants on that floor, individuals took time to physically guide persons with visual or mobility impairments to the stairs. In one instance in WTC 1, a manager and a team of occupants spent time assisting a mobility-impaired occupant into an evacuation chair so that he could evacuate with the rest of his colleagues. The team took time to find the evacuation chair, strap the individual into the chair, guide him to the stair, and begin evacuation movement.

As their floors emptied and they collected personal belongings, occupants eventually made their way to the exits for evacuation. As long as they still felt that their lives were at risk, they evacuated as well. However, for those who considered that it was safer to remain in the buildings, their evacuation was a much different experience.

Minutes before WTC 2 is hit

There were people in both towers who remained on their floors waiting for official information from the building's public address system. Instead of deciding on their own, they wanted to follow the building's procedures and wait for instructions on what to do. According to an occupant on the 44th floor of WTC 1, prior to 9/11, "every time there was a puff of smoke anywhere in the building they'd come on this loud speaker and they'd say 'Not to worry, everything's fine. It's under control, nothing's wrong…'"

(WTC1/044/0002). Surely they would do the same this time. They were hoping so, at least. So, groups waited to see what the building authorities would instruct them to do. An occupant on the 25th floor of WTC 1 was told by his boss to wait for further information. His boss did not want anyone to go anywhere until they knew the official story of what was going on (WTC1/025/0001).

WTC 2 occupants were also hoping for more information, especially those who knew that something had gone wrong in WTC 1 and that their building was fine. Some had already seen the damage, the gaping hole in WTC 1, and the flames and black smoke surrounding the building. But what was going on in their building? WTC 2 occupants who scanned the radio and internet-based news outlets or spoke to loved ones outside the building, found out that a plane had hit WTC 1. An occupant recalls the Bloomberg News Service reporting that a twin engine plane had hit WTC 1 (WTC2/055/0001). A facilities manager on the 84th floor was listening to CNN, which had also reported a small plane crashed into the tower next door (WTC2/084/0011).

Even though these individuals did not see an immediate need to evacuate, they found it impossible to just sit at their desks and continue working. They engaged with others, witnessing the event unfolding around them. As they stood by the windows in both towers, looking for evidence, occupants saw something that they may never forget. Among the grayish, white and charred pieces of debris that continued to fall, larger, more colorful shapes were seen floating by. Sometimes, these shapes fell alone and other times, they were connected together. The concourse in between the buildings was covered in red blotches. Soon it became clear that they were witnessing people, human beings, falling to their deaths. An occupant on the 84th floor of WTC 2 stood by as a colleague shouted that "'People are dying'" (WTC2/084/0001). Yet, they could not look away.

Protection of people continued

Even 10 minutes after WTC 1 was hit, some leaders continued to persuade people to evacuate. In the larger offices especially, these individuals invested a significant amount of time in ensuring the safety of others. They continued to search offices, cubicles, bathrooms, kitchen areas, computers rooms, conference rooms, and any other area where people might have been located. Sometimes, just to be sure,

they circled the floor or sections of the floor multiple times searching for people who had not yet evacuated. If the floors were larger in area, teams of leaders were given assignments of certain areas to clear. A fire warden on the 71st floor told people in his section to leave, to move on – even running after people who were going the wrong way and instructing others to stop what they were doing and evacuate (WTC2/071/0003).

The public address announcements

At 9:00 am, all action stopped in WTC 2. People stopped alerting others, looking out the windows, and talking to one another to listen to the first building-wide public address announcement.[22] This was because a voice on the intercom confidently stated that: "There is a fire condition in WTC 1. WTC 2 is secure. Please return to your offices" (Averill et al. 2005).

This was a welcomed message for the occupants who were on the fence about evacuating and those who had already decided that evacuation was unnecessary. They now had official confirmation to remain in the building until further instructions were given. An individual on the 55th floor noted that: "[w]e were actually happy to hear it. Because it gave us some direction. It gave us something, you know, concrete. …" (WTC2/055/0001).

The public address announcement even prompted individuals who were in the process of protecting others to reassess their original course of protective action. Leaders stopped searching for people and instead talked about whether they should listen to the announcement or continue to evacuate others. Many decided to ignore the announcement and continued to clear their floors, gather their things and evacuate. However, a few actually changed their minds. A group on the 70th floor of WTC 2 discussed the situation as soon as they heard the announcement. After seeing all of the people running

[22] Occupants in WTC 2 received a second building-wide public address announcement at 9:02 am. This announcement stated the following: "May I have your attention please. The situation is in Building 1. However, if conditions on your floor warrant, you may wish to start an orderly evacuation" (Averill et al. 2005). A description of the second announcement is provided here only as a footnote, rather than in the text of this chapter, because it did not receive the same level of occupant attention as the first announcement. Rather, for WTC 2 occupants who remained on their floors during the announcements, some individuals did not mention hearing the second announcement at all, some thought the first and second announcements were similar messages repeated more than once, and others focused only on the fact that the second announcement gave information about the conditions in WTC 1 (which was similar to the message in the first announcement) without mentioning the suggestion to evacuate.

around outside of the building and the first responders' trucks and cars rushing to the building, they did not want to put themselves in the midst of the crisis that had originated in WTC 1. They never considered that another plane was on its way. They never considered that they were in the midst of a terrorist event and that they were about to be struck by a commercial airliner as well (WTC2/070/0001).

The attack on WTC 2

Three minutes after the first building-wide announcement was given, at 9:02:59 am, WTC 2 occupants heard and felt a thunderous explosion that rocked the building so hard that some were knocked to the floor. An occupant on the 67th floor felt intense heat from the fireball that raced through his floor, luckily without catching anything around him on fire (WTC2/067/0003). The ceiling on the 71st floor began to collapse onto the occupants who remained: "All the sheet rock, the light fixtures, fell down on us" (WTC2/071/0002). "…We lost all phones, all the TVs, everything. So we were completely in the dark, except for the emergency lights" (WTC2/055/0001). And, as the building swayed back and forth, occupants once again looked to the windows and to one another for help. The building was shedding itself like its sister building had done 16 minutes before, presenting occupants with showers of heavy debris and flames outside the windows.

WTC 1 occupants on the 83rd floor who had not yet been rescued by the men with flashlights also witnessed the aftermath of the plane's crash into WTC 2. They heard a massive explosion. When they turned to the windows for any clues to explain the sound, the "… the whole sky was orange…" with flames and falling debris (WTC1/083/0004).

Not many were aware that United Airlines Flight 175, also a Boeing 767, had ripped into WTC 2 at such an angle that floors 78 to 84 were heavily damaged. Due to the angle of the aircraft's impact, however, large regions of survivability remained on some of the floors directly affected by the impact, and there was even one intact stairwell that remained passable throughout the disaster, although this was not completely evident to the occupants at or above the impact area. Eighteen occupants were fortunate enough to both find and use this stair to evacuate the building (Averill et al. 2005). At this point, almost a

quarter of the eventual survivors of the attacks had already exited WTC 1 and almost half of the survivors had already exited WTC 2 (Averill et al. 2005).

The WTC respondents who were still on their floors almost unanimously interpreted the situation in the same way. They did not necessarily know that a commercial airliner had struck again. However, they were sure that their building and the building next door were under attack. They now knew that they were involved in a terrorist event. The events were no longer an accident, but instead a serious incident that put their lives in danger. They now knew without a doubt that they were in serious trouble. An occupant on the 16th floor who initially interpreted the attack on WTC 1 as a bombing said that "… it wasn't until the plane was going over my head, then I said we are being attacked, then it was different…" (WTC2/016/0002). A respondent on the 58th floor of WTC 2 noted that "…two in a row like that can't be a coincidence" (WTC2/058/0003). After such an intense series of cues, it took respondents only a short time (sometimes a matter of seconds) to realize that they were in danger and that protective action was necessary. An occupant on the 83rd floor of WTC 1 and many like her throughout the towers instantly realized that:

> …this is real, that is no accident, something happened there, something happened here. But I can see that one and if this tower looks as bad as that tower does, I gotta get out of here. (WTC1/083/0002)

They began to believe that they were no longer in a safe area, and rather than trying to stay and figure out exactly what happened, it was more important to get themselves and the others around them out of the building.

People in both towers started grabbing whatever they could: coats, laptops, briefcases – whatever they were going to need just in case they were not going to be back to the building for a while. And they were determined to travel to the stairs together. They did not want to leave anyone behind. In the darkness of the 84th floor of WTC 2, a manager and fire warden switched on his flashlight and "….sort of waved it around the room…" to get the attention of his staff and colleagues (WTC2/084/0001). Once they assembled together, they ran, and sometimes climbed over debris, to reach the stairs.

Now that an event had obviously occurred in their building, occupants in WTC 2 realized that elevators were no longer a possibility. Even if they were, occupants knew to never take elevators in an emergency (WTC2/058/0003). And, after the 1993 bombing, many of them knew to prepare themselves for what may be a very lengthy evacuation. In case of smoke, "a lot of people took off their shirts and covered their noses and …just started down the stairwell…" (WTC2/071/0001). A 1993 bombing survivor on the 70th floor who wished he had brought water for the evacuation in 1993 remembered to grab bottles of water before his evacuation in 2001 in case he encountered smoke in the stairs (WTC2/070/0003).

When the plane hit WTC 2, the crash twisted the building in such a way that some of the stair doors were jammed and severely damaged. Occupants rushed from one stair to another in search of one that would let them into a stairwell. Sometimes they were forced to dig through debris to reach the stairs or open the doors, even kicking in the doors to get inside. But, once they did, they were free. They entered the clear air in the stairs and began their journey to safety.

Discussion of Results

The decision process of WTC occupants, originally outlined in Figure 3-2 and described in this chapter, is consistent with both emergent norm theory (ENT) and the PADM (Lindell and Perry 2004), which is based on ENT. As discussed in Chapter 1, ENT posits that in situations where an event occurs that creates a normative crisis, individuals interact collectively to create an emergent situationally-specific set of norms to guide their future behavior. The central process that takes place in collective behavior episodes is the construction of a novel definition of the situation through symbolic interaction (Turner and Killian 1987; 1972; 1957). Individuals work together to redefine the situation and propose a new set of actions during processes labeled as milling and keynoting.

Consistent with ENT and Stages 1 and 2 in the PADM, WTC respondents worked individually and collectively to assess the risk and decide whether protective action was necessary. Consistent with the sensemaking literature (Rudolph and Raemer 2004; Klein 1999; Weick 1995; Gioia and Poole 1984),

individuals developed their own mental models of the events immediately after WTC 1 was hit. Initially, WTC occupants likely engaged in individual sensemaking because social groups had not yet formed around the event. Since these models were in most cases inconclusive, occupants engaged with their environment during the milling process to collectively develop definitions of the situation and the risk. Individuals continued to inquire whether the event posed a threat to them and whether protective action was necessary. A small percentage of individuals in WTC 2 (15%) decided quickly after 8:46 am that the event posed no risk or threat. In this scenario, consistent with the PADM, these individuals did not interrupt their current activities and continued working. However, when occupants were unable to answer questions regarding risk and safety (i.e., Stages 1 and 2 in the PADM), they engaged in information-seeking actions. Table 3-1 contains a rough breakdown of the number of information-seeking actions reported by respondents in each tower.

Number of Information-Seeking Actions	WTC 1 (124)	WTC 2 (121)
0	6 (5%)	4 (3%)
1	63 (51%)	34 (28%)
2	32 (26%)	39 (32%)
3	7 (6%)	18 (15%)
4	9 (7%)	11 (9%)
5	3 (2%)	7 (6%)
6 – 9	4 (3%)	8 (7%)

Table 3-1: The frequency of information seeking in the WTC

The majority of WTC occupants required at least one act of information seeking before positively identifying and assessing the risk, sometimes taking up to nine actions to decide. Information seeking was more extensive in WTC 2, since some individuals returned to the milling process even after beginning

protective actions because they received status updates about the event (e.g., the 9 am announcement that the event was taking place in WTC 1). Updates often prompted additional rounds of milling and information seeking.

For many, the sensemaking and milling processes were extensive, iterative processes. Each time they obtained information, they further developed and redeveloped interpretations of the situation and the risk. This is also consistent with the PADM, which allows for feedback loops that begin the decision-making process over again each time individuals receive new information or attend to cues.

An example of this iterative process is the way in which occupants interpreted the event over time. Initially, after the plane struck WTC 1, interviewees reported developing as many as eleven different understandings of the situation. However, as occupants continued to engage with others about the event, cycling through the sensemaking and milling processes multiple times, their understandings of the event seemed to narrow. As time went on, more and more people began to receive information from outside news sources and phone calls claiming a plane had crashed into WTC 1. People often discussed the things that they saw or heard, and although many were still uncertain, people began to believe that something very serious had taken place – even that a large airliner had hit WTC 1. As shown in Figure 3-3, their interpretations of the situation converged from eleven to only four different event interpretations over time.

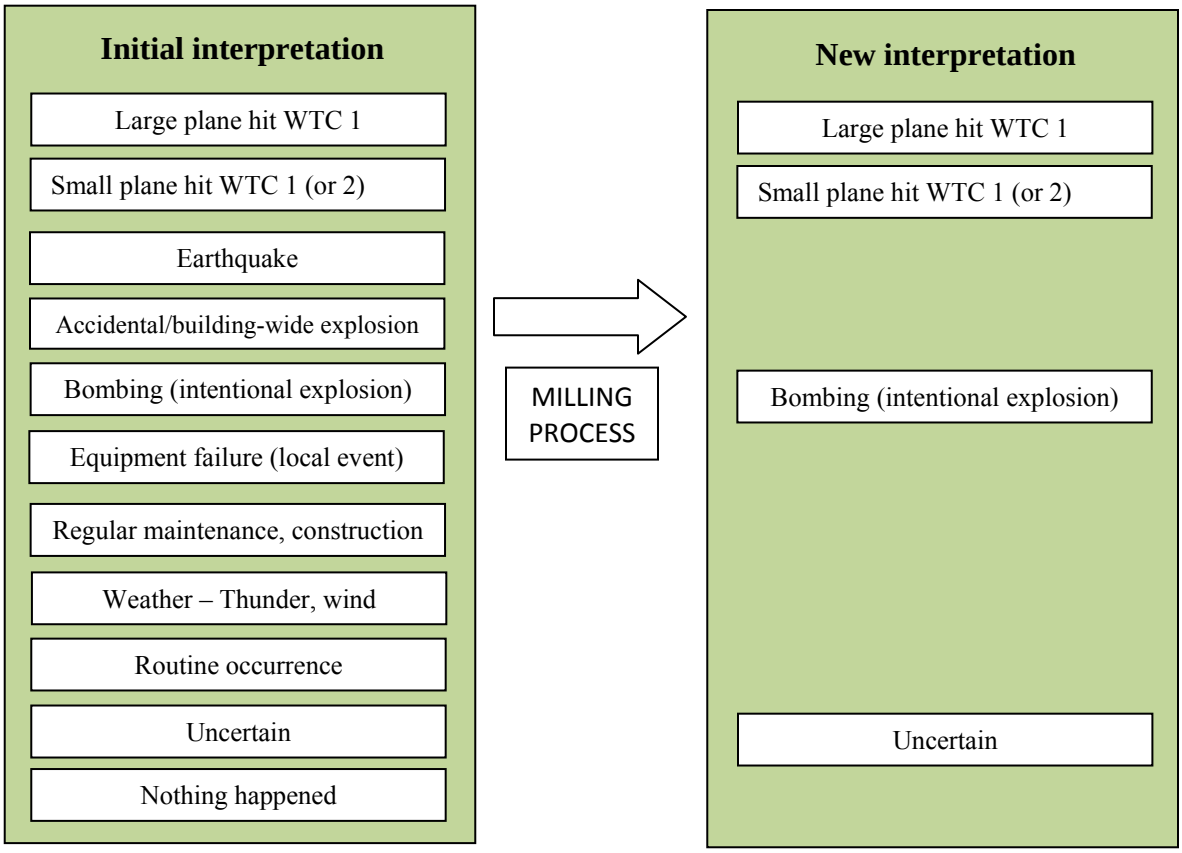


Figure 3-3: The convergence of situation interpretations over time during the WTC pre-evacuation period

Risk perceptions also changed over time as a result of cyclical engagement in milling and sensemaking processes. Instead of remaining constant, occupants' perceptions of risk alternated between uncertain, no/low risk and higher risk until they entered the stairs. Figure 3-4 displays three different categories of WTC occupants: rapid perceivers, or people who perceived that they were at risk almost immediately after WTC 1 was hit; delayed perceivers, or people who perceived risk after extended engagement in the milling process; and non-perceivers, or people who did not perceive risk at all throughout their time in the pre-evacuation period. Each category is placed along a timeline within the pre-evacuation period, identifying when respondents in each category felt they were at risk, if at all. Also, the percentages of respondents in each category are included in the figure.[23]

[23] Note: Percentages do not add up to 100 because risk was not always reported by respondents in the sample.

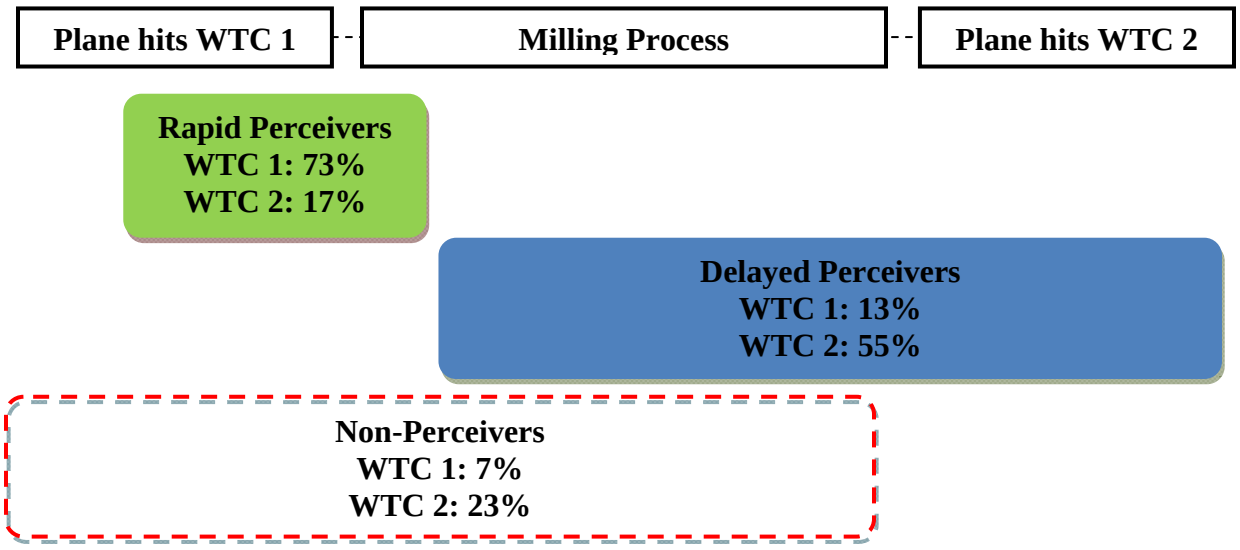


Figure 3-4: Cyclical nature of risk in the pre-evacuation period of the 2001 WTC disaster

Rapid perceivers are individuals who perceived risk directly after the place struck WTC 1. These individuals developed a perception of danger either immediately after hearing the loud boom or feeling the building shake or shudder, or soon after engaging with the environment around them, sometimes seconds after the impact. The majority of rapid perceivers were in WTC 1; however, a small percentage were located in WTC 2. It should be noted that some rapid perceivers subsequently developed decreased perceptions of risk (often followed by increased perceptions again) as they continued to receive additional cues during the sensemaking and milling processes, providing further evidence of the iterative nature of occupant interpretations.

Delayed perceivers felt little or no risk initially after WTC 1 was hit. These individuals began to feel more at risk only after engaging in the milling process for some time, encountering cues that seemed more and more serious to them and information that convinced them that they were in trouble. Sometimes, delayed perceivers in WTC 2 did not perceive risk until their own tower was hit. Compared with occupants in Tower 1, more respondents in WTC 2 were delayed perceivers.

Finally, even though they evacuated the building, non-perceivers did not perceive risk at any time during their pre-evacuation period. Non-perceivers represented only a quarter of the occupants in WTC 2 and less than ten percent of WTC 1.

In order to take protective action, it was not sufficient to merely perceive some level of risk regarding the event. In other words, individuals may have felt that the situation was serious or potentially dangerous; however, it was not until WTC occupants personalized the risk or felt that they were personally in danger from the event, as highlighted in Stage 2 of the PADM, that they ultimately decided that protective action was necessary for them.

Consistent with ENT, occupants next engaged in newly-proposed lines of action based on their understandings of the situation, specifically that the situation was serious enough to warrant exploring protective action. Consistent with Stages 3 and 4 of the PADM (protective action search and assessment), the new action plan involved protecting themselves and others. The protective action decisions made by WTC occupants resembled the process of satificing (Simon 1956), in which stages 3 and 4 are combined. Individuals did not consider a series of options for achieving safety. First, there are not many protective options available to high-rise occupants other than evacuation, defending in place, or moving to another location in the building. Also, for most occupants, evacuation was the most obvious or mentally-available protective action, since they had been told how to evacuate the building many times in the past, and some had evacuated in the most significant event in WTC history, the 1993 bombing. Because of this, following the availability heuristic (Tversky and Kaheman 1974), occupants automatically considered evacuating the building, and if evacuation was seen as an effective response, they did not need to entertain any other options. In the cases where occupants thought that they were trapped on their floors, they considered the only other available option: defending their spaces from toxic smoke.

Consistent with theories of social influence (Latane and Darley 1970) and high stakes decision-making heuristics (Kunreuther et al. 2002), occupants followed the instructions, suggestions, and actions of others when deciding what they were supposed to do themselves. Many did not even need to search for protective options. Since they were often surrounded by others suggesting or achieving protection, they

relied on these examples for their own actions. When evacuation was suggested for them or given as an instruction, for example, they followed others and left the building. Sometimes the actions of others were so convincing that occupants evacuated without even having to personalize the risk themselves.

Also consistent with the protective action process outlined in the PADM, many WTC occupants engaged in a series of actions to protect people and property. Many engaged in helping and preparation actions in addition to evacuating. There were people or property that individuals were committed to protect before leaving.

Once these actions were completed, the act of evacuating required the development of at least a rudimentary evacuation plan (Lindell and Perry 2004). Each individual developed an evacuation plan which consisted of their destination, means of travel, and route of travel to reach the final destination. For all occupants in this study's sample, their destination was out of the building. However, their means of travel varied between the stairs and elevators; for those who used the stairs, their route of travel differed depending upon which of the three stairs they chose for evacuation. Routes did not vary for elevator users, since all elevators were located in the same area on each floor (the core or center of the floor).

Although there are commonalities, there are also differences between behavior as characterized in the PADM and the 2001 WTC decision-making process described in this chapter. First, the PADM is presented as a model that is simple and stage-like, suggesting that individuals move sequentially from one stage to another until protective action is taken. However, the experiences of WTC occupants demonstrate the fluidity with which occupants developed situation assessments and risk perception, made decisions, and performed actions. Instead of moving steadily through the stages, occupants often would be involved in multiple stages at one time or shift back and forth between stages. The blending of Stages 1 and 2 was a good example of this. Occupants would often assess the threat and personalize the risk at the same time, or alternate between these stages. Similarly, the path from Stage 2 to 3 was also blurred. Once an individual personalized the risk (Stage 2), the assessment might have been directly linked to only one type of adaptive plan (Stages 3 and 4). For example, if an occupant visualized succumbing to toxic smoke that was seeping into his building through the elevators shafts, and thus felt at risk, the only option possible to

achieve safety from this scenario was to leave the building. In turn, there was no need for any in-depth search and assessment of protective actions. And, even when Stages 2 and 3 were not linked, Stages 3 and 4 were often combined through satisficing. Many times, it was unnecessary for occupants to consider a range of protective actions and then select one among the options. Rather, they would consider the first option that came to mind, and if it was deemed effective, they would attempt the action. Moreover, if an option was suggested, for example, to evacuate, occupants often skipped the protective action search and assessment (Stages 3 and 4) altogether and performed the suggested action.

The PADM also treats stages as unproblematic, while data from this study show that decisions and subsequent actions can be separated in time, with the time lapses filled with other types of activities. An example of this is shown between PADM's Stages 2 and 3. There was a group of occupants in both towers who decided early on that there was a risk and that they were personally in danger. At this point in the decision process, they completed Stage 2 in the PADM, and based on the model, should have begun searching for protective action options (Stage 3). However, they continued to search for additional information from the event or waited on their floors (i.e., inactivity) until someone told them to evacuate. They relied on other people to make the protective action decision for them, which sometimes took several minutes, even up to 15 minutes, before the message to evacuate was disseminated.

Third, the PADM provides a more abstract view of pre-evacuation actions than the one presented here from the WTC. Almost no detail is provided by this model on what is meant by information seeking or protective actions. In the WTC, there were two main types of information seeking: looking around the environment and talking with others, each of which was carried out based upon various motivations. Since the actions are different based on the physical exertion and completion time required, it is important to distinguish between one type of action and another. The model also does not provide detail on the full range of protective actions that are undertaken during disasters. Even though empirical studies of both disasters and fires have shown that individuals also are likely to protect others and property, the model is silent on the decision processes required for each specific action type. Helping does occur during building fires (Bryan 2002; Fahy and Proulx 1997; Canter, Breaux and Sime 1980) and during disasters, such as

tornadoes (Nelson 1973; Marks and Fritz 1954) and hurricanes (Michel 2007; Rodriguez, Trainor and Quarantelli 2006). Preparations are also undertaken to protect property (Gwynne et al. 2003). In some cases, people attempt to protect houses from fire spread by closing doors (Bryan 1983) or from potential flooding by moving important documents to higher ground (Morrow and Enarson 1996). In other situations, people prepare themselves for the upcoming evacuation by packing up needed supplies such as face masks, appropriate shoes, or flashlights, in the case of a building evacuation (Bryan 1983; Canter Breaux and Sime 1980) and enough food and clothing to last for days in the case of a community evacuation (Enarson and Scanlon 1999).

On a practical level, one reason that this chapter focuses on the specifics of the pre-evacuation period is because more data of this kind are needed to improve efforts to simulate pre-evacuation actions using computer evacuation models. One purpose of this research project is to begin to model pre-evacuation actions in building disasters. This modeling requires a more specific understanding of the types of protective actions performed by building occupants, as well as the time that occupants take to perform those actions.

Finally, differences exist between the experiences of WTC occupants and how behavior is characterized in other types of models of evacuation behavior. The slow, often deliberate processes described by WTC occupants differ sharply from behavior as characterized by the panic or conflict model (Janis and Mann 1977). According to the latter, in hopeless situations, occupants can go into states of denial or fear of entrapment and even reach the extreme form of fear known as panic. However, these types of responses were not mentioned in the WTC data, even by occupants who thought that they were trapped and began defending their offices from toxic smoke and flames. Occupants remained calm and continued to discuss options, seek additional information, and call others outside of the towers to inform them of the conditions on their floors. They maintained hope that they would be rescued and attempted actions designed to provide safety (i.e., placing clothing around door frames), rather than making hasty or dangerous judgments, as suggested by the panic model.

The collective sensemaking and decision-making performed by WTC occupants is consistent with the work of researchers such as Karl Weick (1995), Turner and Killian (1987) and others (Lindell and Perry 2004; Mileti and Sorensen 1990) and inconsistent with assumptions underlying current computer and hand-calculation evacuation modeling efforts (Kuligowski, Peacock and Hoskins 2010; Santos and Aguirre 2004). As mentioned in Chapter 1, evacuation models represent groups engaging in protective behavior as homogeneous masses efficiently "flowing" like water toward building exits or acting autonomously as specified by pre-determined probabilistic behavioral rules. Such models neglect to incorporate the social psychological and group processes that predict subsequent evacuation behavior. For example, evacuation models do not account for the influence of individual perceptions of threat, or the influence of personalization of risk on protective action. Even more important is the lack of appreciation for collective behavior and leadership and its effects on the perceptions and actions of others (Santos and Aguirre 2004). Because there is a tendency for individuals initially to misinterpret the situation as safe until they engage with others around them, perceptions of danger and the need for protective action are largely socially determined. Almost exclusively, evacuation models have yet to incorporate processes of information flow, the emergence of leadership, and collective action among groups during an emergency evacuation. Because such factors are largely ignored, most of the evacuation models that are currently in use seriously mischaracterize the evacuation process.

Conclusions

This chapter set out the general decision-making process model for WTC occupants who evacuated the Towers on September 11, 2001. I used the PADM model to structure the chapter, and within each section, I provided a detailed description of the types of cues that respondents perceived, interpretations that they developed of the situation and the risk, information-seeking actions in which they engaged in the process of developing these interpretations, and protective actions that they performed after deciding to evacuate. This process was supported by actual quotes of occupants' experiences on September 11, 2001.

This model of WTC experiences is consistent with ENT and the PADM, in that occupants engaged in collective behavior to develop new norms as soon as the first plane struck WTC 1. Each time occupants obtained new information from the environment, they engaged in the milling process to develop and redevelop understandings of the threat and what it meant for their personal safety. As they continued to engage in milling, their interpretations were constantly changing, and then converging to resemble the interpretations of others around them. As they began to personalize the risk, they decided that protective action was necessary and engaged in actions to protect themselves or others. Whereas differences were found between how behavioral responses are characterized in the PADM and the behavior of WTC occupants, the overall decision-making process was consistent with the stages presented by Lindell and Perry (2004) as well as with empirical research on behavior in building fires.

In describing the experiences of WTC occupants on September 11, 2001, Chapter 3 sets the scene for the following chapter. Since the purpose of this study was to predict pre-evacuation actions, Chapter 4 identifies the factors that influenced the performance of milling and protective actions. For example, what influenced perception of risk? Who were the early responders and what made them decide to evacuate before others? Similarly, who were the leaders and what influenced them to help others before evacuating themselves? Why did some decide to use the elevators even though most of the WTC population used the stairs? These questions and many others will be answered in the following chapter, in which I identify the factors that influenced each stage of the decision-making process and resulting pre-evacuation actions.

Chapter 4 - "… [A]t that Moment, I Knew that We Were in Danger": Predicting risk and subsequent pre-evacuation actions in the WTC attacks

No two individual experiences in the 2001 WTC disaster were exactly the same. However, as shown in Chapter 3, trends were found among groups of individuals. While some occupants thought that the plane crashing into WTC 1 was a thunderstorm, others imagined that a bomb had been detonated somewhere in the building. Some immediately felt safe from harm – that nothing could ever happen to them in the confines of their comfortable, familiar offices – and others thought that they were going to die as the building swayed ten feet in each direction. Even in the same building, some WTC 1 occupants left seconds after their building was struck, while others delayed in their offices until the tower next door was hit 16 minutes later. Based on a variety of information from the environment, occupants engaged in a number of different actions during the pre-evacuation period, both during the milling process and in an attempt to seek protection.

What caused such differences in experiences among WTC occupants? Why did some people start to evacuate in a matter of seconds, while others delayed for up to 16 minutes? Why did some people go back to work, when others ran around the floor searching for clues? Who were the leaders that advised people to evacuate?

The SI perspective, as described in Chapter 1, characterizes an individual act as the result of the following cognitive and behavioral processes: perception of the environment, interpretation or meaning-making regarding the current environment, and decision-making (Blumer 1969). Expanding that notion to the realm of collective behavior, ENT posits that a disaster can create a normative crisis in which individuals must interact to construct a new definition of the situation and propose new lines of action (Turner and Killian 1987). The new norms developed within a collective do not emerge in a social vacuum, however. Rather, individuals within a collectivity bring their social stock of knowledge to the situation, as well as conventional norms, which are likely to influence the norms that are developed during collective behavior episodes (Weller and Quarantelli 1973).

The purpose of this study is to develop a predictive model of individuals' pre-evacuation actions in the WTC. Since occupants' experiences were so different, it was necessary to identify what accounts for those differences. Therefore, I performed the associative analyses described in Chapter 2 to identify the factors that influenced pre-evacuation actions. From this analysis, I developed a predictive model of pre-evacuation actions. The model identifies the factors that influenced the occupant decision-making process, which in turn predicted subsequent protective actions. Those factors included environmental cues, an individual's social stock of knowledge, and interpretations developed during the event.

This chapter begins with a discussion of the factors identified in empirical studies of disasters and building fires that influence the performance of protective action during an emergency. This is followed by the presentation of the WTC pre-evacuation action predictive model. The focus of this section is to explore the manner in which occupants' interpretations influenced actions taken. Specifically, how influential was the individual's prior social stock of knowledge in developing an interpretation of the situation or the risk, labeled earlier as the individual's situational reality? Additionally, how did an individual's interpretations then influence the performance of specific types of actions? At the end of this chapter, I review a series of theoretical perspectives that shed light on both interpretive and behavioral processes in which WTC occupants engaged.

Predicting Action in Emergencies

Research into community disasters and building fires identifies individual and process-related factors that influence various stages of the emergency decision-making process. Lindell and Perry (2004), Mileti and Sorensen (1990), and others (Mileti et al. 2006), have identified factors that influence risk identification and assessment and the development and selection of protective actions. A diagram displaying the factors that influence each stage of the PADM (Lindell and Perry 2004) is shown in Figure 4-1, and will be discussed in the following section.

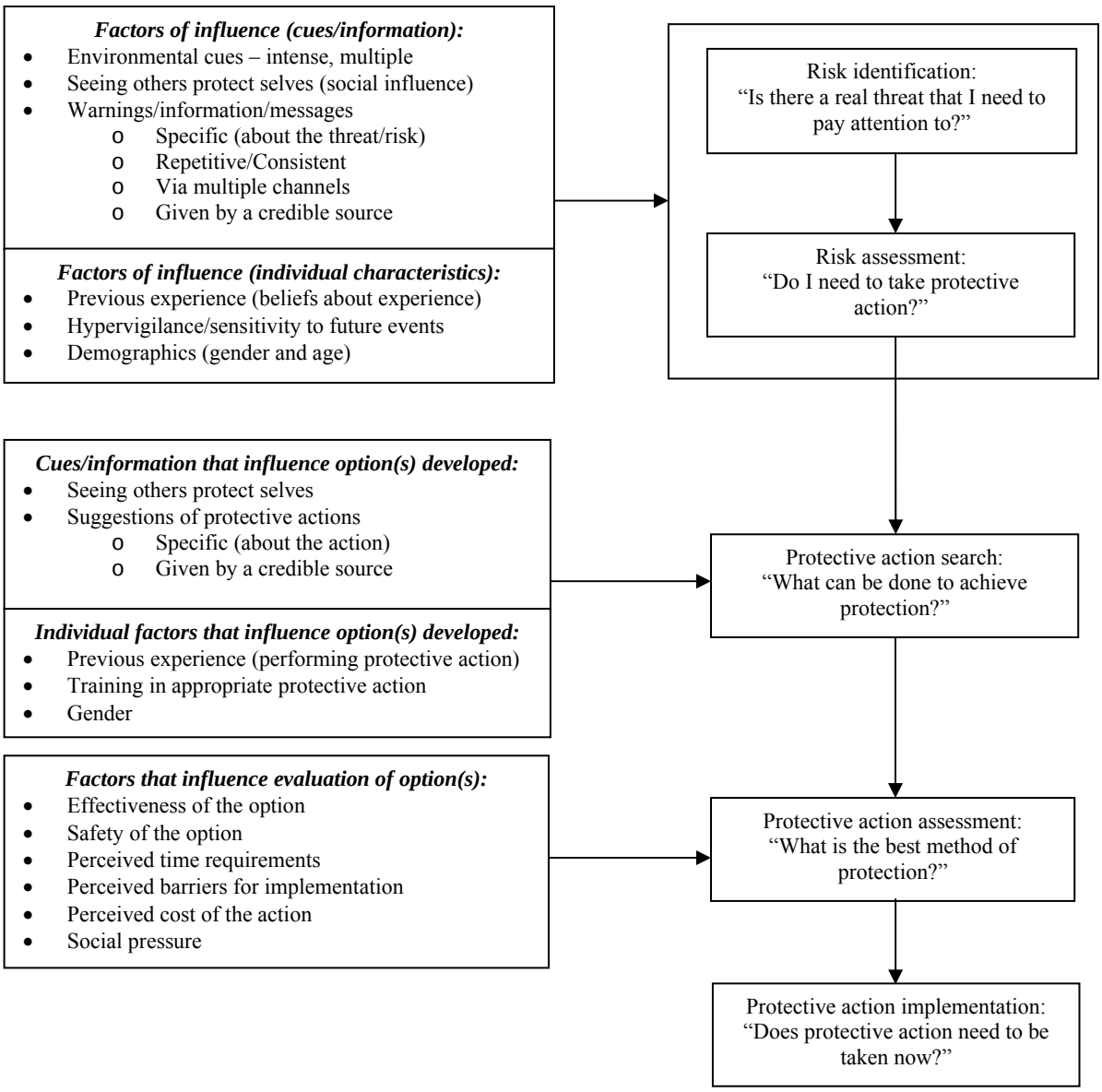


Figure 4-1: Influential factors at each stage of the PADM

Risk identification and assessment

As noted in Chapter 3, the first two stages in the PADM are labeled as risk identification and assessment. In the risk identification phase, the person inquires whether there is a threat to which he will need to pay attention. If the answer is yes, he then moves to the risk assessment phase, which involves choices regarding personalization of risk. An individual may believe that a threat does exist, but still not feel personally in danger, and thus may not consider taking any protective action.

Empirical research on community-wide disasters and building fires identifies a list of factors that influence Stages 1 and 2 of the decision-making process (Lindell and Perry 2004). Since almost all of the factors that influence Stage 1 also influence Stage 2, they are presented together here in the same discussion.

Risk identification and assessment are influenced by both cue-related factors and individual characteristics. First, individuals are more likely to identify and personalize the risk if they perceive a larger number of cues (Kuligowski and Mileti 2009; Connell 2001; Aguirre 1991) that are intense or extreme in nature (Mileti and Fitzpatrick 1993; Tong and Canter 1985). In building fires, for example, occupants who witness heavy, thick, black smoke that decreases visibility and irritates the eyes are more likely than those noting less intense cues to realize that a serious event has taken place that puts them in danger (Brennan 1995). Also, if individuals see others around them protecting themselves or preparing to do so, they are more likely to take the event seriously (Mileti and O'Brien 1993; Edelman, Herz and Bickman 1980).

Characteristics associated with warning messages, if issued, also influence perceptions of risk. A warning message is most effective in influencing risk identification and assessment if it is specific about the threat and the risk involved (Mileti and Darlington 1997; Drabek and Stephenson III 1971; Fritz and Marks 1954), repetitive (Lindell and Perry 2004), consistent (Mileti and Fitzpatrick 1992), disseminated via multiple channels (Mileti 1975), and provided by a credible source (Lindell, Perry and Greene 1983; Perry and Greene 1982; Perry, Lindell and Greene 1981; Mileti, Drabek and Haas 1975). Source credibility is defined in terms of the source's expertise, including access to special skills or information, and trustworthiness, or the perceived ability to communicate information about the disaster without bias (Lindell and Perry 2004; Hovland, Janis and Kelley 1953). Source credibility can differ depending upon a number of factors, including the type of disaster, characteristics of the source, such as social role and believability, and characteristics of the warning receiver, such as past experience in disasters and social location (Peguero 2006; Trumbo and McComas 2003; Flynn, Slovic and Mertz 1993; Burkhart 1991; Perry and Nelson 1991; Drabek and Boggs 1968). For some warning receivers, credible sources may be

friends and relatives, and for others, credible sources may be disaster authorities, such as government officials (Mileti and Sorensen 1988; Greene, Perry and Lindell 1981).

An individual's social stock of knowledge also influences risk identification and assessment. Past experience (Gershon et al. 2007; Nigg 1987; Perry and Greene 1982; Perry, Lindell and Greene 1981; Perry 1979) and hazard knowledge (Perry and Lindell 1986) have been shown in many studies to influence risk identification and assessment, but the relationship is often not a straightforward one. Further research on the subject indicates that people find it difficult to imagine experiences (in the present) that are more dangerous than previous experiences (Lindell and Perry 2004). Therefore, instead of being a function of experience per se, risk identification and assessment are more likely driven by people's interpretations of those experiences (Lindell and Perry 2004). This distinction can be explained by re-introducing heuristics or cognitive "short cuts," first described in Chapter 3, and their impact on interpretations of threat and risk (Kunreuther et al. 2002; Kahneman, Slovic and Tversky 1982; Tversky and Kahneman 1974).

Availability operates when, even before an emergency occurs, "people estimate the likelihood of an event by the ease with which they can imagine or recall past instances of the event" (Kunreuther 2002:658). For example, if individuals experienced a specific type of emergency or have been exposed to others' experiences in an emergency, such that memories of the event remains vivid or emotionally salient (DeJoy 1999; Lichtenstein et al. 1978), those experiences can result in heightened risk perceptions for such events. Memories of past events also surface in actual emergencies, causing individuals to think that the same event that happened before is happening again. In addition, and specifically related to the assessment of risk, these memories are accompanied by elements that are crucial in decision-making -- affect and emotion (Slovic et al. 2004). When an emergency does occur, individuals also employ the anchoring-and-adjustment heuristic to develop interpretations of the danger, in that they "start with information one does know and then adjust until an acceptable value is reached…" (Epley and Gilovich 2006:311). In other words, individuals will anchor upon the positive or negative emotions associated with memories of a previous event when developing an understanding of a danger in the present.

One can see how simply linking previous emergency experience with risk identification and assessment is insufficient. Instead, the experiences and the emotions associated with them act as an anchor from which people adjust to identify or assess the current risk. Even more problematic is that people often misinterpret the current threat and risk when using these heuristics. Adjustments from self-generated anchors, such as personal experiences, tend to be insufficient because they terminate once a plausible value or judgment is reached (Epley and Gilovich 2006); this is especially the case under cognitive load. In other words, people find it difficult to imagine emergencies in the present that are more dangerous than previous experiences because they do not stray far from their original experiential anchor.

Following this logic, research indicates that extreme risk perspectives regarding future emergencies also influence risk assessments in current emergencies (Lindell and Perry 2004). At one extreme, hypervigilant[24] individuals dread that a future emergency with life-threatening consequences will happen to them (Slovic et al. 2004; Kunreuther 2002), possibly because they have endured severe or life-threatening emergency experiences in the past. On the other extreme, individuals may be confident in their abilities to withstand danger, independent of the emergency. Individuals who are primed with pre-emergency risk perceptions are likely to anchor upon these perceptions when an emergency actually occurs (Perry and Lindell 1986; Turner et al. 1981). In other words, hypervigilant individuals are more likely than others to assess danger when an emergency occurs.

Finally, while some research has found that certain demographic characteristics, such as gender and age, significantly influence risk assessment (Fothergill 1998; Fahy and Proulx 1997; Proulx and Pineau 1996; Flynn 1979; Friedsam 1961; Mack and Baker 1961), here again relationships can be complex (Lindell and Perry 2004; Quarantelli 1980). Earlier studies using bivariate models found that certain demographics predicted risk; however, more sophisticated methods, such as regression modeling, do not find such effects (e.g., Aguirre 1991). Rather than stating that all women or older adults perceive higher levels of risk in response to emergencies, what is more likely to be the case is that situational or

[24] The term hypervigilant is used here to describe a pre-disaster state of mind in which an individual is overly aware and anxious about future threats to his or her safety. This is different from Janis and Mann's (1970) use of the term hypervigilance, used in Chapter 3, which refers to the fear of entrapment during a disaster.

emergency-related variables, such as environmental cues, serve as mediators between these demographic variables and risk identification and assessment (Lindell and Perry 2004).

Protective action search

The third stage in the PADM involves an individual's search for ways to achieve protection once a decision is made that protective action is necessary. Both cue-related factors and individual characteristics influence the options developed. First, research has shown that witnessing others performing particular actions or hearing suggestions from others about what to do influences the selection of options that at-risk individuals develop (Dash and Gladwin 2007; Connell 2001; Gigerenzer and Selten 2001; Brown and Miller 2000; Brennan 1995; Canter, Donald and Chalk 1992; Chaiken 1987; Hermann 1963). Following the actions or suggestions of others is not simply imitation behavior, but rather a matter of responding to emergent norms that appear to be accepted by the collectivity (Turner and Killian 1987). When others provide suggestions or perform a behavior, the individual no longer has to search for possible action options. Instead, options are presented to her just by being around others during an emergency. If warnings or instructions contain specific information as to what to do, especially if it is offered by a credible source, people are likely to develop similar options for their protective actions (Fitzpatrick and Mileti 1991; Drabek 1986; Perry, Lindell and Greene 1981; Mileti and Beck 1975).

Also, an individual's past experiences in emergencies, specifically the actions that he has performed previously, can influence the actions that he considers as options during the current emergency (Lindell and Perry 2004; Klein 1999; Gioia and Poole 1984). Again, the influence of an individual's social stock of knowledge becomes apparent. The individual uses previous memories of the protective actions he performed in the past as options for actions to perform in the current emergency. Similarly, an individual's emergency-based training and knowledge, for example, knowledge about evacuation procedures, can influence the options that he develops during an emergency (Fahy and Proulx 1997; Brennan 1996; Levin 1984; Sime 1983; Canter, Breaux and Sime 1980). Finally, research has found that gender influences the performance of particular protective actions (O'Brien and Atchison 1998; Morrow and Enarson 1996; Bryan 1977). For example, in disasters, women are more likely than men to protect

personal property in the home (Enarson and Scanlon 1999; Hoffman 1993; Szalay et al. 1986) and during building fires, men are more likely to fight the fire or rescue others while women warn family members (Bryan 2002; Canter, Breaux and Sime 1980).

Protective action assessment

In the fourth stage, individuals evaluate the options considered in the previous stage. As stated in Chapter 3, due to tendencies toward bounded rationality, as suggested in work on satisficing (Simon 1956), it is likely that individuals consider each option developed, one at a time. If that option is not satisfactory, based on a set of criteria, they continue to develop additional options.

Disaster and fire research suggest that options are evaluated based on the following criteria: perceived efficacy and safety, perceived time requirements, perceived implementation barriers, perceived costs of performing the action (Lindell and Perry 2004), and social pressure (Latane and Darley 1970). First, individuals attempt to judge the effectiveness of the potential protective action. If people believe that the action will enable them to protect themselves, the people around them, or their property, they are more likely to engage in that action. Similarly, if they perceive the action as one that will reduce their risks and increase their safety, they are likely to choose it. On the other hand, if they perceive that the action will place them in danger, for example, if they will be evacuating by means of long, congested routes (Fahy and Proulx 1997) that will put them in the midst of toxic smoke (Fahy and Proulx 1997; Brennan 1995), they are less likely to choose the action. Third, individuals evaluate actions based upon perceived time requirements. If they think that they have sufficient time to complete the steps required to perform the action, they are likely to choose the action. Fourth, any resource constraints that people have with respect to particular actions -- for example, a lack of knowledge, skills, equipment or ability to perform the action -- will influence the consideration of other alternatives. Additionally, people evaluate actions based on their perceived costs, including out of pocket expenses and opportunity costs, such as lost pay due to missing work (Lindell and Perry 2004; Sorensen and White 1980; Fritz 1961). Finally, people are likely to choose an option because others are performing it (Lindell, Lu and Prater 2005; Fahy and Proulx 1997; Canter, Donald and Chalk 1992; Mileti and Fitzpatrick 1992). Conversely, others'

inaction can cause individuals to shy away from performing an action for fear of embarrassing themselves in front of others (Proulx 1997; Latane and Darley 1970).

One difficulty with predicting protective actions is that the evaluation factors are based on individuals' perceptions, which may be incorrect and which can differ across individuals, groups, and disaster phases. For example, individuals may have misconceptions about the perceived costs of the action versus its safety benefits. Therefore, it is important to understand what influences these perceptions, which will then lead to a better understanding of the protective actions selected.

The pace of the decision-making process

An important aspect of the decision-making process, not captured in Figure 4-1, is the speed at which interpretations are developed and actions are undertaken during a disaster. The speed of the decision-making process is important because the longer people delay in some types of emergencies, the higher the likelihood that they will encounter dangerous conditions.

Empirical disaster research has found that being a part of an informal network influences the speed of information flow. If people are surrounded by informal networks, for example, their families, friends, coworkers, peers, or neighbors, before or during the emergency, they are likely to receive information at a faster pace. Informal networks can disseminate any information related to the event, including what is going on or the protective actions that people should take. If one member of the informal network receives information about the event, she is likely to disseminate, confirm and evaluate the message with others (Lindell and Perry 1992; Mileti and Beck 1975; Drabek 1969).

Informal networks can also influence the speed with which actions are performed. A group of researchers who performed a quantitative study of the 1993 WTC bombing using the timing of evacuation behavior to test predictions from ENT, and more specifically, the importance of enduring social relationships as determinants of collective behavior, found that in an office setting, the stronger the social relationships, the longer the group delayed in initiating evacuation (Aguirre, Wenger and Vigo 1998). Research has also found that family members work together to protect one another during an emergency (Quarantelli 1960) and perform actions together as a unit (Drabek and Boggs 1968). One example of this

is searching for one another before evacuating and leaving as a family unit. Therefore, social network ties may decrease the time spent disseminating information about the event, but can also increase the time spent taking action before evacuating or reaching safety.

What's missing?

Although empirical research establishes several factors that influence emergency decision-making and protective actions in general, little research was found that links specific factors to specific protective actions. Also, much of the research that establishes influential factors for emergency decision-making is based on human response to community-wide disaster warnings. It is important to understand what influences human response in a variety of different scenarios, including building events as well as events where an official warning is not provided, both of which were the case in the 2001 WTC attacks. Similarly, since much of the research comes from community disasters, it is important to outline what factors such as previous experience, training, and social roles, represent in a building scenario and if these factors operate in the same way in building fires as they do in community disasters. For these reasons, this study of the factors that influenced decision-making in the 2001 WTC evacuation expands the current theory of human behavior during emergencies to incorporate a terrorist attack in a high-rise building in which occupants responded by taking specific protective actions in the absence of official warning directives.

This study also expands current theory to incorporate the factors that influence occupants' evacuation plans. Even though previous research discusses the influence of pre-existing plans on evacuation (Drabek 1994; Perry, Lindell and Greene 1981), I found no disaster-based research that identifies the factors that influence the creation of adaptive plans for evacuation, including how people choose a means of evacuation and their routes of travel, especially in a building evacuation.

Fire research does, however, shed some light on the factors that influence adaptive plan development. Even though stairs are often the default option for building evacuations, recently developed elevators standards (e.g., ASME 2010) and new code provisions have increased research interest in the use of elevators during building emergencies. Studies of actual emergencies, drills, as well as behavioral

intention surveys find that perceptions of the situation and of the elevators themselves influenced their use (Heyes and Spearpoint 2009; Levin and Groner 1994). If occupants believed that there was no emergency in their building, they were more inclined to use the elevators as a means of evacuation. Additionally, they were likely to use elevators if they perceived them as a faster route or a more reliable system for evacuation.

Research in building fires has also identified factors that influence why one exit stair is chosen over others for evacuation. Occupants are likely to use the stair (or exit) that is the most familiar, both structurally and socially (Grosshandler et al. 2005; Horiuchi, Murozaki and Hokuso 1986; Sime 1983). Structurally, the stair can be a route that individuals used before, were trained to use (Klein 1999), or one to which they had visual access on a daily basis (Sime 1998). Such access meant that they were familiar with the location of the stair prior to the occurrence of an emergency. Socially, this can be a route that others with whom the individual is familiar are already using. In this case, the occupant will follow others because she has social ties with others using the exit. However, social influence can also inhibit evacuation, and thus route choice. If an occupant observes an exit that no one is using, she may be less likely to use that exit as well (Latane and Darley 1970).

Categorizing Experiences in the WTC

Chapter 3, which established the general decision-making process for respondents who evacuated the towers on September 11, 2001, sets the scene for this chapter, which presents the predictive model of WTC pre-evacuation behavior. The predictive model identifies the factors, including environmental cues, an occupant's social stock of knowledge, interpretations of the situation (or the threat), and perceived personal risk, that influenced the performance of each pre-evacuation action.

I described the WTC decision-making process and subsequent actions in significant detail in Chapter 3. To make it possible to present the predictive model, I needed to perform additional abstract analyses by assigning the specific data to more abstract categories. In the following section, I group the experiences of WTC occupants into the categories that will then be used in the predictive model.

Cues and information

WTC occupants experienced a variety of cues and information during the pre-evacuation period. As mentioned in Chapter 2, the cues varied in both type and intensity.

Research often distinguishes between cues that people perceive from their physical environment and cues received from the social environment. In the WTC disaster, much of the information that people received originated from the physical environment – the fireball, the heavy debris, fires burning on their floors, and the smell of jet fuel, for example. As time went on and people began to communicate with one other about the event, social cues also became important. Occupants communicated with others about the event; however, they also watched others' actions for any sign of what was going on and what they should do about it. Table 4-1 categorizes cues based on their type (physical or social cues).

Type of cue / Intensity	High Intensity	Low(er) Intensity
Physical Cues	• Building movement (jolt, sway, shudder/shaking) • Loud boom, sounds • Seeing the plane (before it hit) • Floor damage (ceiling tiles, furniture damaged) • Flames, smoke on floor • Fireball, smoke, debris outside of windows (heavy, large pieces) • Smell/scent – jet fuel • Electricity/lights out (only emergency lights on the floor)	• Muffled sounds (low volume) • Lights flickering • Computer screens flickering • Debris outside window (light debris, only papers) • No additional cues/no cues • Seeing the damage done to WTC 1 (from WTC 2)
Social Cues	• Screaming, yelling; urgent tone to relay information/instructions • Fearful facial expressions • Others' emergency actions - reacting/running around/evacuating • Information about an emergency <u>in</u> the building	• People not reacting or acting as if nothing happened • Information – something happened • Information about an emergency outside of the building • No additional cues/no cues

Table 4-1: Categorization of WTC cues by type and intensity level

It is also important to take into account cue intensity, which varied considerably. At the time of the attack on WTC 1 at 8:46 am, for example, occupants in WTC 1 heard loud booming sounds, felt the building sway back and forth, and saw a large fireball outside the window, while those in WTC 2 may

only have seen the lights flicker on and off. Cues continued to vary as time went on, ranging from physical cues, such as heavy debris falling outside the windows, to the message issued in Tower 2 just after 9 am that the tower was secure and that occupants should remain in place. With these kinds of distinctions in mind, I categorized the cues that occupants perceived based on level of intensity – ranging from high to low, as shown in Table 4-1.

Overall, cues and information were categorized as high or low intensity based upon the danger that they appeared to pose to occupants, the level of difference from normal conditions, and the meaning occupants assigned to the cues. First, there were physical cues witnessed by respondents in both towers that threatened their lives. Exposure to toxic products from smoke and the heat from flames can incapacitate or kill people. Therefore, these types of cues were rated as higher in intensity. Many more occupants perceived cues that were exceedingly different from normal or stable conditions, such as feeling the building jolt, shake or sway; hearing loud or booming sounds; seeing a commercial airliner flying at building height; being surrounded by building damage; seeing a giant, hot, orange fireball outside of the window; smelling jet fuel fumes; and being surrounded by darkness. Intense social cues included people screaming, yelling or crying, especially yelling or screaming instructions on what to do; seeing fear on the faces of people running around the floor; and hearing information indicating that the occupant (i.e., the receiver of the message) is personally in danger.

Some cues I classified as lower intensity, based upon their similarity to normal or stable conditions in the WTC. Occupants heard or saw things that they were used to witnessing in the WTC, an office building situated in a busy urban area. Low intensity cues included hearing lower (muffled) sounds, seeing the lights or computer screens flickering, and seeing light debris or even pieces of paper flying outside (since this reminded many of a tickertape parade). Social cues can also be categorized as less intense, including being surrounded by other people not reacting to the event, hearing information that something happened without any specifics, and hearing information that something happened to the tower next door, and in turn, that nothing had happened to their own building. Finally, some occupants initially did not receive any cues or information about events going on in the towers.

Since many occupants received multiple cues over time, it is important to categorize the *sequence* of cues received throughout the pre-evacuation period. Over time, from the perspective of different occupants, cues could have tended to increase in intensity, decrease in intensity, stay consistent, or alternate back and forth. Instances where occupants received lower intensity cues at the beginning of the incident, and then over time received information that was higher in intensity can be labeled as "cues with increasing intensity." Conversely, when occupants received higher intensity cues initially, followed by lower intensity cues, these experiences were labeled "cues with decreasing intensity." For example, an individual in WTC 2 who received high intensity cues after WTC 1 was hit, but was later told that his building was secure and not to evacuate, received "cues with decreasing intensity." Cues that remain in either the lower intensity or high intensity category over time were labeled as "consistent"; cues that wavered between high and low intensity were labeled as "conflicting."

Finally, whereas most environmental cues from the event were ambiguous in nature, at least initially, some cues were labeled as unambiguous, meaning that occupants were able to understand the source and nature of the cue. An example of an unambiguous cue was actually seeing the plane hit WTC 1, which provided occupants with information about the size of the plane and the cause of the initial explosion sounds, building shake, and debris falling outside the windows. Also, one could consider other cues as unambiguous with regards to the presence of a dangerous fire condition in the building, including seeing flames and thick, black smoke on a floor.

Interpretations of the situation

Chapter 3 noted how occupants attempted to interpret what was going on. Initially, interviewees came up with a total of eleven different interpretations of what had occurred in New York City, their tower, or the tower next door. Over time, these descriptions converged as a consequence of the milling process.

The main way that interpretations varied is based on the seriousness of event type, as shown in Table 4-2. Sometimes the event was interpreted as a building-wide emergency in the occupant's tower. Building-wide emergencies were interpreted as events that could potentially cause harm to the occupants

in the tower, and even the tower next door. Therefore, if the event was interpreted as an emergency, occupants thought it could potentially cause harm to them and their colleagues. The emergency events included the following interpretations: an earthquake, a bombing, or terrorism, a large plane hitting the building, or an accidental building-wide explosion. The earthquake was perceived as a city-wide event in which the WTC towers were a part, and the other emergency events were perceived as occurring in the tower in which the occupant was located. Occupants began to consider the event as a terrorist attack only when WTC 2 was struck at 9:03 am, whereas all others were interpretations developed throughout the entire pre-evacuation period (beginning at 8:46 am).

Event Type	Examples
Emergency event	Earthquake Bombing (Intentional explosion) Large plane hitting the building Accidental, building-wide explosion Terrorism
Non-emergency (or Routine) event	Small plane hitting WTC 1 (for WTC occupants) A small or large plane hitting WTC 1 (for WTC 2 occupants) Equipment failure (local event) Regular maintenance, construction accident/efforts Weather - Thunder, wind Routine occurrence (air conditioning, NY/building noises, power surge)
Uncertain	What happened in the building?
Nothing	There is nothing unusual taking place

Table 4-2: Categorization of WTC situation interpretations by event type intensity

Events were also interpreted by many as non-emergency or routine situations, either local to a remote place in the building or frequent occurrences that did not necessarily threaten occupants. Interpretations included a small plane hitting their building; a small or large plane hitting the building next door (i.e., not the building in which they were located); equipment failure in their building, including an elevator crash or plumbing failure; a construction or maintenance accident, such as a worker dropping equipment on the floor above; severe weather, including high winds; and a routine occurrence, such as regularly witnessed sights and sounds inside or outside of the building. Initially, most occupants were unable to develop a clear idea of what was going on. Their cognitions are labeled in Table 4-2 as "uncertain."

Finally, there was a small percentage of the population in the towers that did not think that anything unusual was going on. Their interpretation is labeled as "nothing" in Table 4-2. At first glance, it may seem that the cognitions of "nothing" and "routine" events are the same. However, an understanding that nothing was going on meant that the occupants' initial activities were not interrupted at all. Instead, they recalled not hearing, seeing or smelling anything unusual until someone else told them that something was going wrong. In contrast, individuals who interpreted the event as routine did perceive cues from the incident in WTC 1 and interpreted the event as unusual, but harmless.

Perceptions of the risk

Levels of perceived risk varied among occupants at different points in time as events in the towers unfolded. As indicated in Chapter 2, risk perception was measured by Project HEED on a Likert scale from 1 to 7, where "1" refers to no risk and "7" refers to very high risk (Galea et al. 2006). However, when categorizing risk perception over time, it became difficult to track very small changes in risk increments, for example, a respondent's change from high risk to very high risk, or a "6" to a "7." Therefore, in the risk categorization, occupants' perception levels were labeled as either perceiving no (or very low) risk or perceiving some level of risk (from moderate risk to very high risk). In the first case, risk perception would be labeled as "no risk perceived" and in the latter case, as "risk perceived." There is also a third category. Especially in the beginning of the event, occupants noted the difficulty assessing risk due to event uncertainty. Risk was then labeled as "uncertain."

In addition to providing information on perceived risk, people also described why they chose one level over another, which was used more often than the reported Likert scale values to categorize risk perception in this analysis. For example, an occupant on the 30th floor of WTC 2 noted that he "had no concern for [his] personal safety" (WTC2/030/0002) during the entire pre-evacuation period. Many occupants, at some point during the event, felt that they were not in danger, and to the extent that they also thought that no one else in their building was in danger, they were rated as having no or a low perception of risk. Another example is occupants who perceived some level of risk regarding the event, but did not necessarily feel at risk themselves. These occupants noted that something dangerous was

taking place or that the event was very serious for other people in the towers. If they provided these types of descriptions regarding their risk perception, they were categorized as perceiving risk. However, it was not until they began to believe that their own lives were in danger or that they were personally at risk in other ways, that they were categorized as having "personalized" the risk. An occupant on the 89th floor of WTC 1 who could not access the stairs provides an example of personalizing risk:

> So I thought to myself, well, I am going to die here anyway so let me try anything. Let me try to go to the fire exit, down the hall and through all of that black smoke, and I am probably going to die doing that, but I'm going to die anyway, so what difference does it make? (WTC1/089/0001)

As described earlier, if occupants stated that they did not have enough information or time to formulate their understanding of risk, then they were categorized as "uncertain."

Pre-evacuation actions

Since the main purpose of studying the WTC disaster is to predict the types of actions taken during the pre-evacuation period, it was important to categorize actions. Overall, there were six categories of actions taken during the pre-evacuation period: continuing to work, information seeking, helping, preparing, defending in place, and evacuating. These took place during various periods in the decision-making process. Figure 4-2 presents a flow chart of the WTC decision-making process, originally presented in Chapter 3, that associates each of these actions with the appropriate stage in that process.

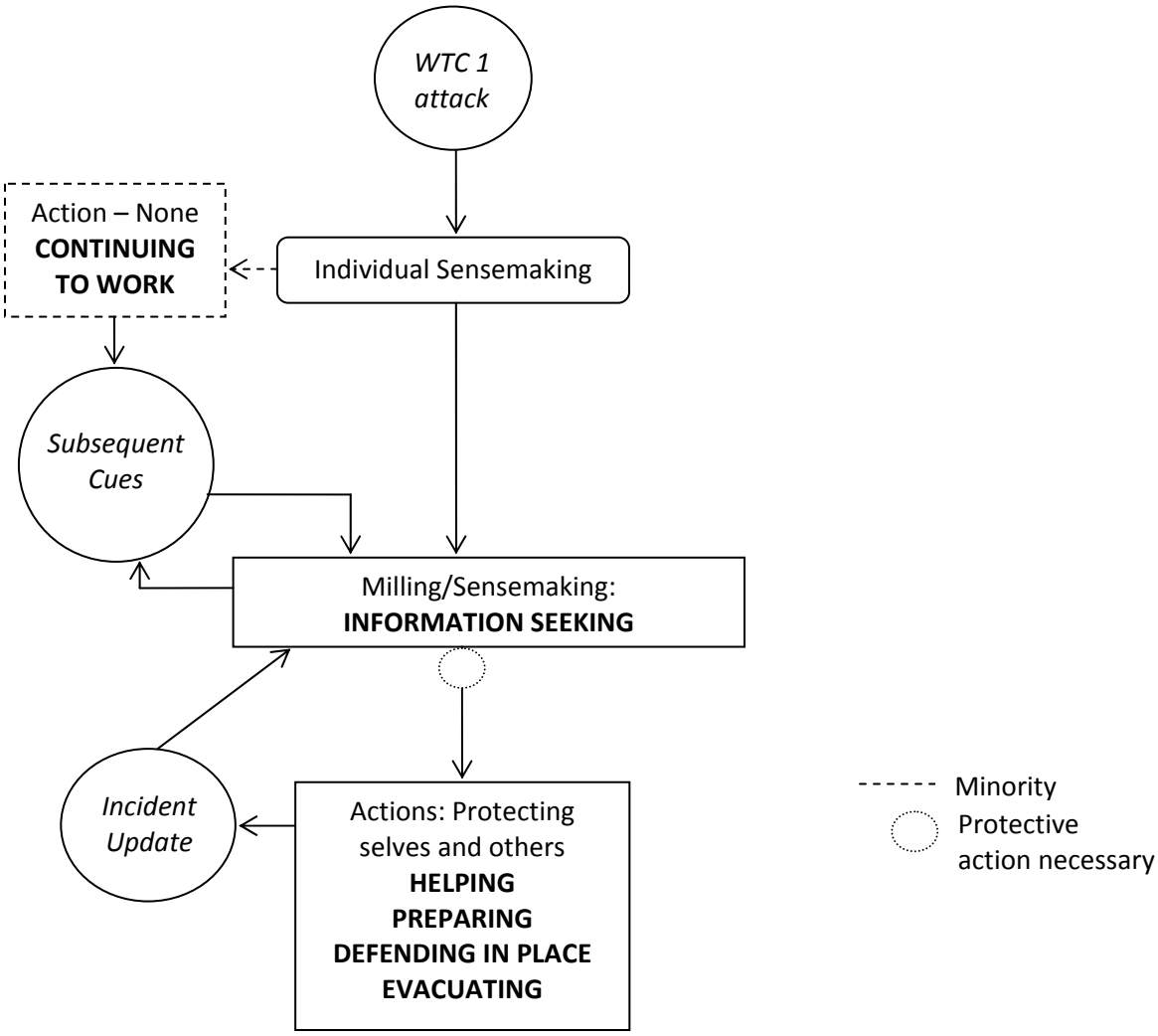


Figure 4-2: Pre-evacuation action categories located within the appropriate decision-making stage

Directly after WTC 1 was hit, some individuals (15%) *continued previous work activities*. In these instances, the individual decided that there was no threat to anyone, and thus, went back to work. This decision terminated her engagement in the emergency decision-making process -- that is until she was alerted as a result of subsequent cues that something might be awry.

During the milling and sensemaking processes, the most common response was *seeking additional information*. There were two main ways that WTC occupants sought additional information: by physically looking around their environment and talking with others. The action may not have been any more complicated than visually scanning the floor from their original locations, standing up and

looking around, or turning to the person next to them and asking a question. These were fairly low-commitment activities that may have taken only a few seconds to accomplish. On the other hand, some occupants invested a larger amount of time and considerable effort to walk to the windows, move around the floor (sometimes making several rounds), seek out other people, or engage in some combination of those actions. Once people were stationed at the windows, they often stood there watching for several minutes. This was especially true for occupants in WTC 2.

Individuals engaged in multiple information-seeking actions either in a sequential or simultaneous manner. For the most part, occupants sought information, perceived cues, and engaged in another search for more information (sequential information-seeking). However, especially when others were around, groups of people would walk around the floor or to the windows while hypothesizing about what was going on (simultaneous information-seeking).

Once occupants decided that protective action was necessary, they engaged in different types of actions to protect others, their property, and themselves. Almost half of the sample, (56/124) in WTC 1 and (61/121) in WTC 2 engaged in actions to protect others, which I categorized as *helping* actions. Most often, helping consisted of giving information to others related to what they should do next, such as instructing people to prepare for evacuation or to evacuate the building. This instruction varied in intensity -- from simply suggesting to a friend or colleague that he or she should evacuate to a very firm and intense set of instructions meant for anyone within earshot. Less frequent, but still categorized as helping, were any actions in which occupants physically assisted others to the elevators or stairs. The third type of helping was searching for others on the floor. Searching for others was categorized as helping when the action was performed with the intention of giving people instructions to evacuate or offering physical assistance to the exits.

Occupants also engaged in actions to protect their property, which I labeled *preparing*. A majority of the respondents in WTC 1 (75/124) and WTC 2 (84/121) engaged in some type of preparatory action before leaving. This action involved gathering work or personal items from their offices or cubicles before evacuating.

Finally, individuals engaged in actions that directly related to their own protection. All of the occupants in the study's sample eventually *evacuated* the towers on September 11, 2001. However, some on the higher floors in WTC 1 encountered extreme conditions, such as toxic smoke pouring into their offices, and since they thought that their exit pathways were inaccessible, they engaged in defensive actions, labeled as *defending in place*. Occupants who defended in place usually gathered in one area on the floor and placed towels and clothing around door frames to decrease the amount of toxic smoke that could penetrate their space. There they waited, calling authorities and other people for help. Once occupants were aware of an accessible exit, which was not as difficult to locate on non-damaged floors, occupants sought safety outside of the building using either stairs or elevators. The pre-evacuation period ended as soon as occupants entered the stair shaft or the elevator car, and thus, the examination of their behavior for this study ended as well.

The Predictive Model of Pre-evacuation Actions in the WTC

The predictive model of the pre-evacuation period of the 2001 WTC disaster is included here as Figure 4-3. The model displays the factors that influenced stages of the decision-making process resulting in the five specific actions taken during the pre-evacuation period: continuing to work, information seeking, preparing, helping, and evacuating.[25] As shown in Figure 4-3, the predictive model begins with "Event/Cycle Start," which represents the beginning of the event. For some occupants, the event began when they saw the plane flying low and straight for the towers. However, for most, the event started with the sounds and building movement produced by the first plane's impact. The model ends when occupants entered the stairs or elevators. The following section describes the predictive model in detail.

[25] A submodel later in the chapter depicts the factors that influenced the sixth action, defending in place.

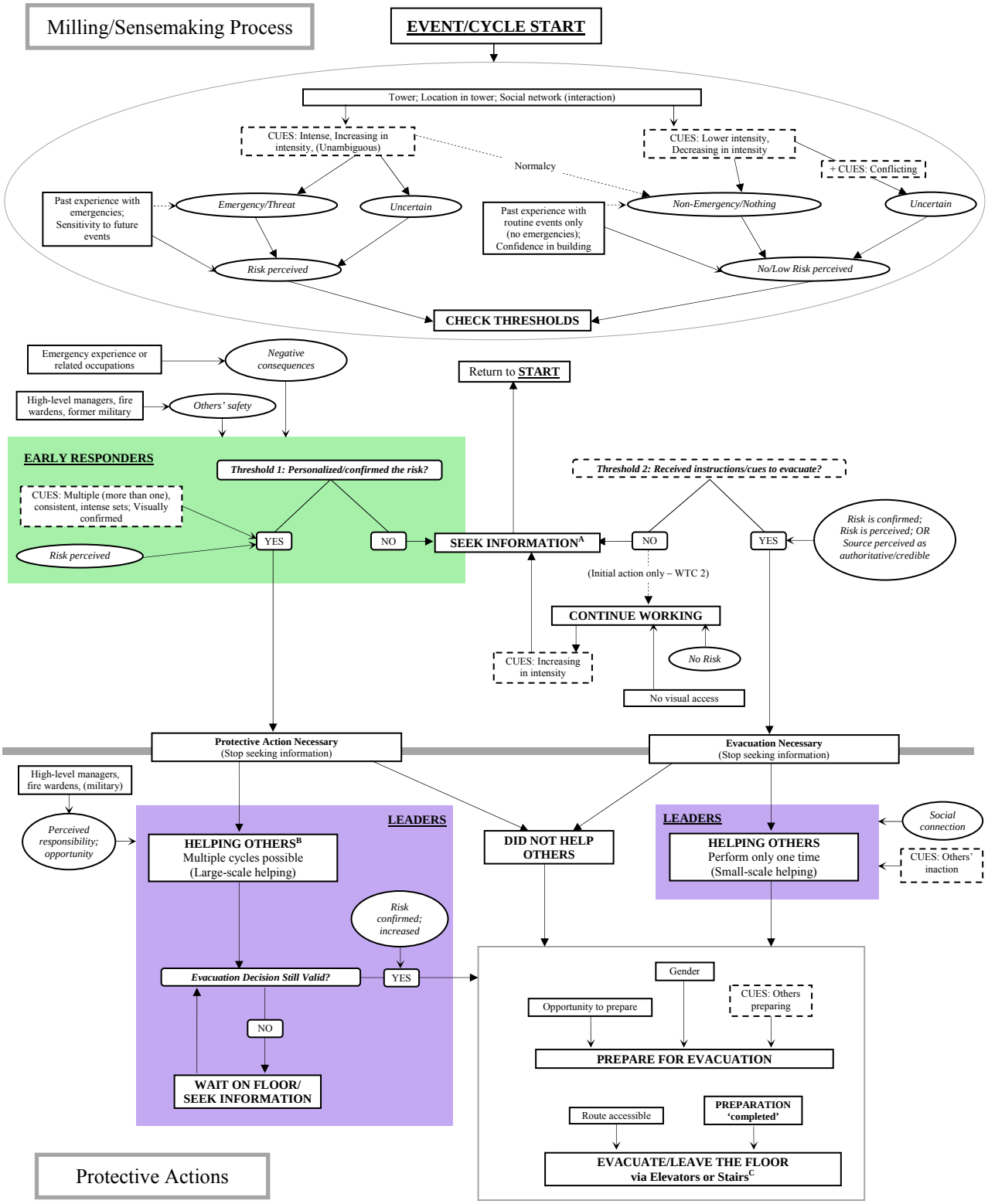


Figure 4-3[26]: The predictive model of pre-evacuation actions in the 2001 WTC disaster (Subscripts A, B, and C identify submodels presented later in the text to support Figure 4-3)

[26] A larger version of this graphic is found in Appendix B of this document.

I created a key to aid in the comprehension of the predictive model. The key displays descriptions of the entries in the model, differentiating between the types of entries (factors) and the linkages (arrows) between the factors. The key is included here as Table 4-3.

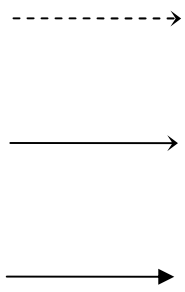
Factor Type	Example Display	Description
Individual-based factors	Past experience with emergencies	Factors included in lined text boxes represent an individual's social stock of knowledge and occupant-based situational conditions.
Environmental cues	CUES: Increasing in intensity	Factors included in dotted text boxes are external, environmental cues created by the event.
Interpretations	*Risk perceived*	Factors included in ovals are interpretations created by the individual during the emergency.
Actions	**CONTINUE WORKING**	Text included in bolded capital letters in lined text boxes are the pre-evacuation actions.
Thresholds and Decisions	YES	Pivotal thresholds or decisions made during the decision-making process are included as curved text boxes.
Linkages		Three different types of arrows are used to link factors, decisions and actions together. The dotted arrows refer to factors influential only in the beginning of the event. The lined arrows refer to more stable linkages – the winged lined arrows refer to links between factors and the decision-making process and triangle lined arrows link the stages of the decision-making process together.

Table 4-3: Key to deciphering the predictive model displayed in Figure 4-3

Sensemaking – The threat

At the start of the event, labeled in Figure 4-3 as "Event/Cycle Start," occupants were alerted to the event by cues from the environment. Based upon the *occupants' tower* and their *location in that tower*, they either perceived high or low intensity cues. Occupants in WTC 1, especially those located higher in the building, and those located higher in WTC 2, were more likely to experience higher intensity

cues. However, as time passed, the types of cues received through occupants' *social networks* (i.e., the people around them) were more likely to dictate the cues occupants received, since milling was so prevalent in the WTC.

As indicated in Figure 4-3, cue type and past disaster experience influenced event interpretations. WTC occupants either considered the event to be an emergency or threatening event, a non-emergency or routine situation, or were uncertain about what was going on.

Emergency/threat event

Occupants were more likely to believe an emergency was taking place after receiving *intense cues and information*, especially if they had *previous experience* with emergencies or *sensitivity* to the possibility of emergency events (i.e., they considered an emergency event in the WTC to be likely). An example of this is interpretations developed by earthquake survivors in WTC 1. Almost all earthquake survivors in WTC 1 initially interpreted the 2001 event as an earthquake, due to the swaying or shaking of the building. For example, one occupant on the 49th floor recalled experiences living in Tokyo and California, where earthquakes were frequent:

> … when I put the rumbling sound and the trembling together, it resembled an earthquake. I've been in earthquakes in the past and so the initial moment that felt like, exactly like an earthquake… (WTC1/049/0002).

Another example was probably the most memorable event for WTC occupants: the 1993 WTC bombing. Many survivors of the 1993 bombing were likely to interpret the 2001 event as a bombing after witnessing intense cues. Some occupants who were not involved in the 1993 bombing reached the same conclusion, however. The 1993 bombing was such a momentous event that survivors were likely to have spoken with others about their experiences, creating mental models of the event even in the minds of non-survivors.

Another consequence of the 1993 bombing was that it instilled a *sensitivity* or feeling of *hypervigilance* for future terrorist attacks in some of the people who worked in the WTC on a daily basis. Some WTC occupants admitted that since 1993 they had been fearful that another terrorist event would happen in the towers. An individual in WTC 1, who initially thought that a bomb had been detonated in

the building, immediately envisioned a threatening scenario in 2001 because he was "…always very nervous about being in the building and [he] always thought that it would be real easy for something to happen and then you couldn't get out" (WTC1/077/0002). Occupants sensitive to potential future events found it easy to imagine another terrorist event once the building began to sway and the loud booming noises pierced the air.

The receipt of intense cues seemed to elicit memories of previous emergencies as well as sensitivities to emergency events. Even before these occupants had the chance to discuss the event with others, they began to interpret the situation as dangerous.

However, as individuals began to participate in the milling process, *interacting with others* and receiving *cues that increased in intensity* also influenced the development of emergency interpretations. An occupant on the 38th floor of WTC 1 originally did not wager a guess about the situation. However, after seeing smoke and debris falling from the sky, he began to discuss the situation with the people around him. Together, the group developed an understanding:

> … basically that something exploded, whether it was a bomb [or an elevator explosion]…I guess there had been some people that were there probably from 1993 when they first had the first bombing, and I guess especially they were, like, more sensitive to it than anybody else. (WTC1/038/0001)

The more intense the cues and the more discussions ensued, the less influential individuals' previous experiences in emergencies became.

No one was more aware of the emergency situation that had developed than the people in WTC 1 who saw the plane flying straight for their building. They immediately developed an understanding that the event was serious when they saw the plane, felt the building shake, heard the booming sounds, and saw the flaming ball of fire outside of their windows. These *unambiguous cues* persuaded them to interpret the situation as an emergency.

Non-emergency/nothing wrong

The situation was slightly different for WTC 2 occupants who witnessed unambiguous cues from the event, including seeing the gaping hole in WTC 1 from which raging fire and black smoke were

pouring. Although these cues seemed intense, I considered these as *lower intensity* for WTC 2 occupants because interviewees often made it clear that they thought the emergency was taking place in the other building. Witnessing lower intensity cues, especially if occupants were *confident* in the protection offered by WTC 2 (the buildings were significantly far apart), caused them to consider the event as a non-emergency for their own building. Although individuals in WTC 2 recognized the dangerous situation posed by the crash, most considered the situation threatening only for their next door neighbors.

Witnessing other *lower intensity cues*, such as hearing muffled sounds or seeing the lights flickering, also influenced individuals to consider the event a non-emergency, especially if they had experience with *previous non-emergency or routine events*. An occupant on the 36th floor of WTC 2 saw the lights flicker and heard a booming sound when the plane crashed into the building next door. He discussed his subsequent thought process:

> …the sound was more like a clap of thunder or a sonic boom than anything else. And that I'm used to. And the lights flickering? Again, from being in a multi-story building, you experience them once in a while. And there's no reason to think there's anything unusual. (WTC2/036/0003)

However, even some occupants who received intense cues (e.g., hearing a loud boom) still interpreted the situation as a routine, non-emergency. Research in human response to disasters would describe this process as *normalcy bias*, in that the respondent normalized the situation as a less severe event (Okabe and Mikami 1982). The development of the normalized situation definition was usually based upon memories of a previous routine experience inside the WTC. An occupant in WTC 2 heard a very loud bang when the first airliner crashed into the building next door. Instead of considering an emergency situation, she thought that that an elevator accident had occurred in WTC 2. She explains her interpretation in the following way:

> …what I associated it with is, I would say, maybe I don't know how many months before that, but we actually had an elevator accident in WTC 2. It was one of the bank elevators where - and it was above our - where they had gone up, they had hit the top and then started to come down. And so we heard that, 'cause it happened early in the morning, so I initially associated the sound with 'Oh my goodness, we've had another elevator accident' (WTC2/061/0001)

For the most part, the respondents who normalized intense cues *did not have previous experience* with disasters, and thus did not have memories of previous emergencies available to them during the 2001 event.

Biases or heuristics were also evident during the milling process, at least initially. In WTC 1, many event hypotheses were suggested, and as time went on, more and more people mentioned that a plane had hit the building. However, that a large commercial airliner had struck WTC 1 was rarely suspected. Instead, many respondents recalled memories of smaller planes flying near the towers, which helped to create the new situation definition: a small plane must have accidentally crashed into WTC 1. Even with the receipt of intense physical cues and information from others, respondents anchored upon a less severe interpretation of the event.

Finally, the receipt of cues that were *decreasing in intensity* over time also contributed to the development of non-emergency or routine interpretations. Even occupants who had initially interpreted the situation as an emergency changed their minds after receiving lower intensity cues. They reasoned either that the situation had declined in seriousness, or that their original interpretation of events was incorrect. For example, occupants in WTC 2 re-interpreted the event as a non-emergency for them after hearing, from others as well as from the public address announcement shortly after 9 am, that the emergency was taking place in the other building.

Uncertainty

As mentioned in Chapter 3, after the first plane crashed, the majority of respondents in WTC 1 and 2 were unable to identify what was going on. They received either intense or lower intensity cues from the event and were still unable to construct an actionable interpretation of the event. The situation seemed uncertain to them for the obvious reason that they had never been in a building that was struck by an airliner before. Interpreting the event was even more difficult for individuals who *lacked previous experience* in emergencies. An occupant on the 10th floor of WTC 1 noted the following about her situational interpretation,

> And because we had no experience with, because we weren't in the Trade Center in '93 -- we were the first tenants that came after -- you don't have anything to associate that kind of noise and that kind of movement with. (WTC1/010/0001)

Also, for those who engaged in milling, uncertainty was the consequence of receiving *conflicting cues* over time. In this case, receiving multiple cues that varied in intensity and clarity was confusing, making it difficult to determine if the event posed a threat to them or not.

Sensemaking – The risk

Depending upon the types of cues that they received, their past experiences in disasters, and their understandings of the event, individuals developed perceptions of risk. As shown in Figure 4-3, WTC occupants differed in their interpretations.

Risk is perceived

The predictive model shows a natural progression of events, in that the occupants who interpreted the situation as an emergency also developed a perception of risk. An occupant on the 80th floor of WTC 1 was told by a colleague to calm down after frantically relaying information that a bomb had gone off in the building. The occupant describes the risk she felt at that moment:

> I wasn't going to calm down clearly. The building had been completed changed at that moment, I knew that we were in danger… (WTC1/080/0001)

As mentioned earlier, the majority of occupants did not develop an understanding of the situation. However, this did not prevent them from perceiving risk. Occupants interpreted the situation as risky after receiving a *specific intense cue* or *multiple intense cues* and having *previous experience with emergencies* or a *sensitivity to future emergency events*. Occupants in WTC 1 and 2 who felt the building sway or shudder perceived risk almost immediately. It was difficult for occupants to feel the floor move underneath their feet and not consider that there was at least some degree of danger. Several occupants even thought that they were going to die when the building was swaying – thinking that the building was going to fall over into the Hudson River. The building movement, specifically, can be pinpointed as a cue that directly led to perception of risk. Also, the higher the number of intense cues individuals witnessed,

the more likely they were to feel threatened. Feeling the heat of the fireball, followed by seeing heavy debris fly outside their window, followed by seeing occupants run around the floor, was enough to convince individuals that they were in danger.

Occupants with *previous experience in emergencies* who witnessed intense cues were also more likely to conclude that the situation presented a risk. Even if they could not wager a guess as to what was taking place on 9/11, they used previous experiences to realize that the current event was much more serious than the emergencies they had experienced in the past. Primarily, survivors of the 1993 bombing and non-survivors who recalled others' experiences in 1993 perceived risk when they witnessed intense cues in 2001.

Hypervigilant occupants, or those with *sensitivity to future events*, also perceived an increased level of risk. These respondents mentioned constantly being aware or ready for the next WTC emergency. Even before the event took place at 8:46 am on September 11, 2001, their risk perception level was already elevated when they walked into the building that morning. Predisposed to believing something could go wrong, these occupants simply anchored upon their pre-determined perceptions of risk to establish their current threat levels after receiving intense cues.

It should be noted that perceiving risk, as displayed in Figure 4-3, is not equivalent to personalizing risk. Individuals may have recognized the potential danger of the situation without necessarily visualizing the consequences of the event as harmful personally. The model identifies additional stages for the personalization or the confirmation of risk, to be discussed later.

Risk is not perceived

When people interpreted the situation as a non-emergency or routine event, they were less likely to believe that there was some level of risk. Often occupants easily explained away lower intensity cues as normal occurrences and, in turn, felt safe in the building. For example, an occupant on the 92nd floor of WTC 2 who saw the lights flicker and thought the building was experiencing electrical problems, did not feel at risk. She recognized that hearing noises all of the time in New York City caused her to become

habitualized to most of the environmental building sounds, and thus she "…just didn't think it was anything that unusual and the sound wasn't loud enough to be alarming" (WTC2/092/0001).

It was also easy to feel safe in WTC 2 after realizing that the real emergency was occurring in a different building. An occupant on the 33rd floor of WTC 2 saw flames shooting out of WTC 1. She did not perceive any risk to her own building or herself after realizing what had happened. Instead, all she could think about was the potential danger to the people involved in the event – the occupants of WTC 1 (WTC2/033/0001).

For individuals without a firm understanding of the event, perceiving *lower intensity cues*, *conflicting cues*, and *cues that were decreasing in intensity* caused them to conclude that the situation presented no risk. These occupants were not experienced in previous emergencies, which likely encouraged the tendency to normalize cues. They were also *confident in the building*, in that they felt that the building's structure would maintain their safety throughout the incident, no matter what was going on. Some respondents specifically expressed familiarity with the construction of the building and its ability to withstand various types of emergencies, such as earthquakes and building fires. This was especially the case for WTC respondents who were architects, employees in the building for several years (or building veterans), and those with some familiarity with building construction, particularly the construction of the towers.

Sensemaking thresholds – Is protective action necessary?

At this stage in the model, occupants have gone through at least one cycle of sensemaking, in that occupants perceived cues, interpreted the situation or not, and perceived risk or not. After each sensemaking cycle, occupants' next action was dictated by whether they met one of two thresholds shown in Figure 4-3: Threshold 1: Personalized or confirmed the risk? or Threshold 2: Received instructions or cues to evacuate? If either threshold condition was met, they then decided that protective action was necessary.

As discussed in Chapter 3, I classified as e*arly responders* those who began protective action before the others around them after deciding on their own (without waiting for official instructions) that

protective action was necessary. Early responders decided that protective action was necessary when they personalized or confirmed the risk (threshold 1). All others decided to do so when they received social instructions or cues to evacuate (threshold 2). As shown in Figure 4-3, the main factors that influenced personalizing risk were receiving *multiple*, *consistent*, and *intense* physical or social cues from their environment, *visually confirming* at least one set of cues, and already *perceiving risk* through the sensemaking and milling processes. First, the more cues received over time, the more likely that early responders personalized the risk to themselves or to others in the building. Many only needed to receive *more than one* consistent, intense cue to personalize risk. Also, as soon as early responders visually confirmed the sounds and information that they were witnessing, they were quick to confirm that they were in danger. Disaster and fire research has shown that occupants frequently engage in efforts to confirm warning messages during emergencies (Mileti and Sorensen 1990; Tong and Canter 1985). However, previous research does not specifically highlight *visual confirmation* as an influential factor in the personalization of risk. Findings from the 2001 WTC attacks show that as soon as early responders saw smoke or flames on their floors or debris falling outside of their windows, they personalized risk almost immediately. Last, confirming the danger was dependent on early responders already having *perceived risk* in a prior sensemaking cycle, in that they thought that something was awry and the event posed potential danger.

Also shown in Figure 4-3, there are two sets of cognitions that predicted whether or not someone was an early responder. The first was feeling responsible for others' safety, in addition to their own. The second was envisioning potential negative consequences associated with the 9/11 attacks.

Occupants with pre-disaster roles in their company, including *managers* and *fire wardens*, and occupants with *former military training* were more likely than others to feel responsible for the safety of their employees and colleagues on 9/11. These individuals not only personalized the risk for themselves, but for others as well, as soon as they received multiple, consistent and intense cues. Prioritizing others' safety above his own, a fire warden and 1993 survivor on the 72nd floor of WTC 2 saw smoke and debris fluttering by the windows after feeling his own building shudder at impact. Colleagues had begun

queuing by the stairs, asking him for instructions on what they should do next. Even after hearing that a plane had hit WTC 1, he still recalled the lengthy, smoke filled evacuation in 1993, and as a fire warden, he decided that protective action was necessary for his entire floor. He stated: "Somebody had to tell them to go, so I was telling them to go" (WTC2/072/0001).

Individuals with experience in or knowledge about taking protective action in emergencies, including *survivors of previous disasters or building fires* (e.g., the 1993 bombing) and others whose *occupations* were tied in some way to risks and emergencies (e.g., risk insurers or safety engineers), were more likely than others to recall memories of negative experiences from previous emergencies. These were emergencies either experienced personally (primarily from the 1993 WTC bombing) or experienced by others they were assigned to protect, in the case of people in safety-related occupations. These individuals confirmed that they were in danger on 9/11 when they received multiple, consistent and intense cues because they anchored upon vivid memories of negative past experiences and envisioned negative consequences in response to the September 11th incident. A 1993 survivor, who was also a company manager, on the 37th floor of WTC 1, looked outside immediately after his building was hit to see the sky "raining glass and metal…" and because of earlier experiences, he knew right away that he and others were in danger and had to leave "immediately, no hesitation …" According to him, many occupants had been through a similar experience before in 1993, and they knew they had to evacuate (WTC1/037/0003).

Two notes are required here. First, many WTC managers, fire wardens, and military personnel were also survivors of the 1993 WTC bombing. These individuals, when assessing the risk and deciding whether protective action was necessary, often performed both mental processes described above, in that they envisioned negative consequences of the present emergency and considered others' safety, when deciding to evacuate (or not). Second, not all WTC managers in this study's sample assumed early responder roles. Since, for some WTC companies, there were multiple levels of management, ranging from individuals who supervised a few people to individuals who supervised 50 or more people, the

higher-level managers present in that company on 9/11, those who managed larger numbers of people, were often the ones who felt responsibility for others.

The decision processes of occupants who did not have responsibility-related roles or emergency experience are shown on the right-hand side of Figure 4-3. These occupants decided to evacuate once they began to feel social pressure, including receiving instructions to evacuate or seeing a large number of people evacuating (threshold 2), which is consistent with a complimentary study of the 2001 WTC study identifying factors that facilitated evacuation initiation (Gershon et al. 2007). At this point, they decided that protective action was necessary for themselves. Additionally, since they had received instructions to evacuate, they did not feel a need to participate in the search and assessment for protective action (Stages 3 and 4 in the PADM). Instead, they automatically decided that evacuation was the appropriate protective action to achieve safety.

However, simply receiving social cues was not a sufficient condition for deciding to evacuate. Three mediating factors influenced this decision. Essentially, individuals assigned meanings to aspects of the social cues they perceived, specifically the nature and the source of the message, which then influenced whether they followed the message. The mediating factors include the *confirmation of risk*, *perception of risk*, and the perception of the source of the message as *authoritative or credible* (even absent perceived risk).

First, some occupants decided to evacuate because their risk perceptions were confirmed by social cues. Individuals viewed the social cues to evacuate as consistent with their previous interpretations of the seriousness of the event, which in turn, influenced their decision to evacuate. An occupant on the 28th floor of WTC 1 knew that she should take protective action; however, it was not until her group collectively decided and told her to evacuate that she made her own decision to leave. She felt relieved that they finally decided to leave as a group, because, as she remembered, “we were all going or we were all staying” (WTC1/028/0001). Similarly, an occupant on the 52nd floor of WTC 2 suspected that building occupants might be in danger from a bomb in their building after hearing a loud boom and feeling the

building shake. Once she heard a person of higher status in the company scream "'Run for your life," she confirmed the danger, realizing that "this wasn't just me imagining things…" (WTC2/052/0001).

Others decided to evacuate based upon newly developed assessments of risk. Occupants began to believe that there was some degree of danger when social cues were given with high intensity by the source of the information, for example, screaming or yelling the information, running around the office, relaying the message in an urgent tone, or using words that called for rapid action (e.g., "Run!"). An occupant in WTC 1 describes his thought process after receiving instructions to evacuate from his boss:

> He was one of our executives, you know, senior management, he was a friendly sort of person and usually very calm. To see him excited the way that he was and screaming to everybody … 'everybody out' was obviously enough to tell me that this was serious and that we should get out at that moment... (WTC1/035/0002)

Another example of an intense social cue was witnessing a large group of people walking, even running, to the stairs or the elevators. In this case, the possibility of danger seemed more likely because so many people were attempting to achieve protection. An individual in WTC 2 noted that: "…it does faze you to see everybody going in one direction" (WTC2/100/0001). Because of the actions of others, she decided to take protective action as well.

Finally, some individuals reached threshold 2 and decided to evacuate strictly based on the message provider, even if they themselves did not believe the situation was dangerous. Instead, occupants simply followed instructions to evacuate because they were provided by someone with perceived authority or credibility. Many times, the source of the message was someone of higher status in the company, such as a manager. If their boss was telling them to evacuate, they were going to listen (WTC2/099/0001), even if they did not feel a sense of danger. An occupant in WTC 1 reflects on the day, saying that at the time he received instructions to evacuate from his boss:

> …[t]here was no imminent reason to evacuate as far as we were concerned at this time. I mean there [was] no alarm. I don't think the alarm went off. I don't remember them going off. Otherwise there would be no reason to evacuate (WTC1/027/0002).

However, he decided to evacuate because he was told to do so by his superior. In other examples, individuals followed instructions if they were given by occupants perceived as being knowledgeable about disasters, including fire wardens and 1993 survivors.

Overall, individuals who were told to evacuate did not need to believe that the situation was dangerous to begin evacuating, although the majority did perceive some level of risk at the time they decided to leave. The timing of their evacuation decisions was based on when they received the instruction to evacuate, learned a group consensus had formed, or witnessed others evacuating.

Milling actions – Continuing to work or seeking information

Especially after their first cycle through the sensemaking process, many respondents answered "no" to both of the threshold questions. At this point, individuals had not yet received a sufficient number of cues to personalize the risk or had not yet received social cues to evacuate. When occupants answered "no" to either threshold, they continued to engage in information-seeking actions.

A minority of occupants in WTC 2 continued to work even as others were evacuating or preparing to do so after the first plane struck Tower 1. These tended to be occupants without special roles or responsibilities who heard or felt mild or less intense cues, which led to a *lack of risk perception* regarding the event. Additionally, almost all of the occupants who continued working *did not have immediate access to windows or others around them*. The initial cues and their initial interpretations of the event did not even provide sufficient motivation to seek information. Only after they received higher intensity cues from either the physical or social environment did they begin to seek additional information.

All other occupants who answered "no" to thresholds 1 and 2 engaged in information-seeking actions. This process is consistent with the processes outlined by the PADM (Lindell and Perry 2004), in that occupants *had not defined the threat or confirmed the risk* and were seeking additional information to do so. Even though seeking information is common in disasters, little is known about the factors that influence the types of information-seeking actions in which people engage. This is an important parameter because information-seeking actions influence the length of time spent prior to taking

protective action. One type of action, for example, discussing the event with others, may take a greater amount of time to complete than turning and looking outside.

Figure 4-4 is provided, as a submodel to Figure 4-3, to show the factors that influenced different patterns of information seeking. These factors are not included in the larger model due to space restrictions, however an [(A)] is provided in reference to "seeking information" in Figure 4-3 to show that another figure is provided elsewhere in the document to support the larger model.

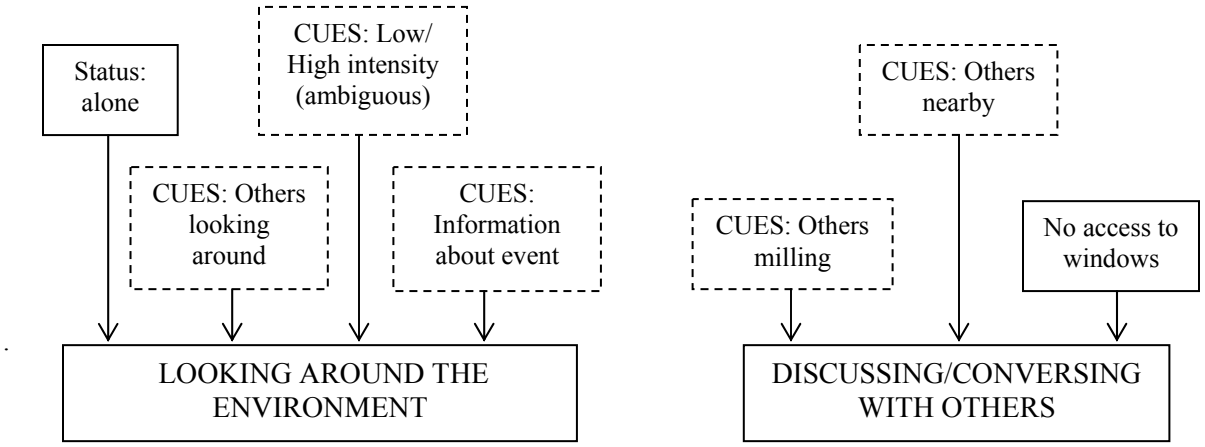


Figure 4-4: Factors influencing different patterns of information seeking in the WTC

Occupants began to look around their environment after becoming aware of three types of cues: seeing others looking around, perceiving ambiguous low or high intensity cues from the buildings and their surroundings, and receiving information provided by others. First, if others were also looking around the environment, especially if they were looking out the windows, many followed suit. People used the actions of others as a signal to initiate their own search for information. Also, many were motivated to confirm initial, ambiguous cues, especially from the attack on WTC 1, by looking for additional cues. Information from others about the event also led occupants to inspect their physical spaces to confirm the information. Last, if the person was alone, especially if she did not have special responsibility-related roles or experience with disasters, she was likely to search the environment, looking for a supervisor or fire warden who might be able to provide information.

Another common way to search for information was to discuss the event with others. This happened most often if there were others nearby, and especially if those individuals were also milling and talking about what was happening. Occupants were eager to join conversations that were already in progress. Discussions were also more likely to take place between individuals who did not have easy access to windows; after WTC 1 was hit, conversations quickly developed among occupants in windowless classrooms, training rooms, and conference rooms.

In both types of information-seeking actions, occupants frequently relied on the actions and suggestions of others when they chose their method of information-seeking. More often, individuals searched the outside environment, because in many cases, they were surrounded by windows. As time went on, more and more people engaged in conversations based on the cues that they were receiving.

Each time individuals received additional information, they re-engaged in the sensemaking and milling processes. This is shown in Figure 4-3 by an arrow that leads from "Seeking information" to "Return to START," indicating that occupants begin sensemaking all over again at the "Event/Cycle Start" text box in the figure.

Protective actions – "Yes" to threshold 1 or 2

Eventually, each occupant in the study's sample answered yes to the questions associated with thresholds 1 or 2. At this stage in the model, shown in the bottom half of Figure 4-3, individuals chose the appropriate protective action or actions to perform. For occupants whose actions are represented in the right-hand side of Figure 4-3, the decision was simple. They were told to evacuate, and thus, decided to evacuate, labeled as "Evacuation is Necessary" in the model.

Those occupants who assumed early responder roles, meaning that they decided without being instructed that protective action was necessary, next had to decide on the specific action(s) required to achieve protection. As mentioned in Chapter 3, there are three main ways to achieve safety in a high-rise building: leaving the building completely, moving to another, presumably safer, location in the building, or remaining in place on the floor. Everyone included in this study's sample evacuated the building, but why?

First, occupants considered evacuation appropriate if they felt unsafe anywhere in the building. Occupants who witnessed smoke or fire inside the building soon realized that they needed to at least leave the floor. However, affected by memories of the 1993 WTC bombing in which smoke traveled up stair and elevator shafts, they decided that the safest option was to completely and quickly evacuate the building, before similar events reoccurred. Occupants in WTC 2 even visualized scenarios in which they were in danger from events occurring in WTC 1, such as a scenario in which their building would catch fire from the fires burning next door (WTC2/092/0001), or similar to what happened in the 1993 bombing, when a truck bomb detonated in the basement of WTC 1, that " …we might get some smoke through the tunnels or something" (WTC2/068/0001). The decision to evacuate the towers was based upon mental models evacuees had developed of the event and what the event meant for their and others' safety if they remained in the building.

Also, occupants' mental models of full building evacuations, including the 1993 bombing and previous blackouts, influenced their decisions in 2001. An occupant in WTC 2 recalls having to evacuate from the top half of the building three different times prior to 2001 (WTC2/059/0002). For some, it became a rule of thumb that when anything unusual and potentially life threatening occurred in the WTC, the appropriate response was to get out and ask questions later (WTC1/035/0003). Having been in the building in 1993, a WTC 1 occupant knew that in 2001, "…the best thing to do is get out" (WTC1/073/0003).

Helping

The first protective action in which some occupants engaged after deciding to evacuate, helping others, exemplifies the altruistic nature of behavior often found in disasters (Bryan 2002). In Chapter 3, the term *leaders* was used to refer to those occupants who focused on the safety of others by providing them with instructions or suggestions to evacuate, sometimes also searching for others and assisting people to the stairs or elevators.

There were two main factors that predicted whether an occupant was a leader: perceived responsibility for others and social affiliation or ties with others in the building. First, company *higher-*

level managers and *fire wardens* (including searchers), the same managers and fire wardens or searchers who had also assumed early responder roles, were more likely than others to perform helping actions because they felt that it was their responsibility to do so.[27] Managers and fire wardens helped others because they felt *responsible* for ensuring the safety of individuals in their company or on their floors. A high-level manager on the 68th floor of WTC 2 helped because she perceived herself as the most senior person on the floor on September 11, 2001 and "felt responsible for most of those people" she worked with on a daily basis (WTC2/068/0001). Most of the people on her floor had not gone through the 1993 bombing, and many were even new to the company.

However, even if someone felt responsibility for others, that did not necessarily mean that she could help others. She had to have the *opportunity* to help, including being on the same floor with people for whom she felt responsible. If the manager or fire warden was not given the opportunity to help, he or she did not perform this act.

Individuals also helped based on their social affiliation or ties with others in the building. Whereas other helpers held roles of responsibility in the towers, these occupants were not high-level managers, fire wardens, or former military personnel and did not have previous experience or occupations in emergencies, and during the WTC attacks, began protection only after other individuals instructed them to evacuate; however, approximately 30% of them helped others in the WTC. Occupants became emergent helpers if they encountered people with whom they had *social ties* that were not yet performing protective actions (labeled as *others' inaction* in Figure 4-3). Emergent helpers provided assistance to familiar colleagues or friends who were part of their social circles. An occupant to the 71st floor of WTC 1 saw that a consultant for his project was working in the building that day. After he decided to evacuate, he suggested to the consultant that she evacuate as well, offering to escort her to the closest stair, since she was unfamiliar with the exits (WTC1/071/0005).

[27] Veteran military personnel were also likely to help others. However, the influence of this variable was difficult to determine since military personnel represented a small percentage of the WTC sample (9 out of 245), and some of these occupants also held management and fire safety roles.

Additional notes are required here as well. First, many fire wardens in this study's sample were also company managers; therefore, it was difficult to analyze which role (or responsibility) would take precedence if both a high-level manager and a fire warden were in the same company or area of the floor. Second, previous experience in emergencies, primarily the 1993 WTC bombing, and having emergency-related occupations were not highlighted as factors that influenced helping behavior. Even though most 1993 survivors were also managers or fire wardens, when describing their reasons for helping, these individuals cited their responsibilities as managers or fire wardens rather than their past experiences in emergencies. Survivors of the earlier bombing, who held no managerial or fire safety roles, did not predominately engage in helping behavior (only 36% or 5 out of 14 of these occupants did emerge as helpers on a smaller scale in that they helped one or two others begin evacuation). As for individuals with emergency-related occupations, none engaged in helping, although it should be noted that this group's size was small (less than 5% of the sample).

There were differences in the helping styles of managers and fire wardens versus emergent helpers. High-level managers and fire wardens were likely to engage in multiple (i.e., more than one) cycles of helping actions. I refer to this type of helping as *large-scale helping* because it consisted of traveling around the floor, sometimes several times and for long distances, searching for a number of people and then instructing each of them to evacuate. Some managers and wardens even instructed the same occupants to evacuate multiple times. The people who helped on a larger scale did so for significant periods of time. Emergent helpers, on the other hand, engaged in *small-scale helping*. This entailed suggesting or instructing one other person, or a small group at the same time, to evacuate with them or to use (or refrain from using) a particular means of egress.

Due to the cyclical, potentially ongoing nature of large-scale helping in the WTC, it was important to identify the factors that contributed to the termination of helping actions. An ethnographic decision tree is shown in Figure 4-5 to identify the "if-then" statements that predicted when managers or fire wardens terminated large-scale helping behavior. The decision tree accompanies the left-hand side of the larger predictive model, shown by a $^{(B)}$ in Figure 4-3.

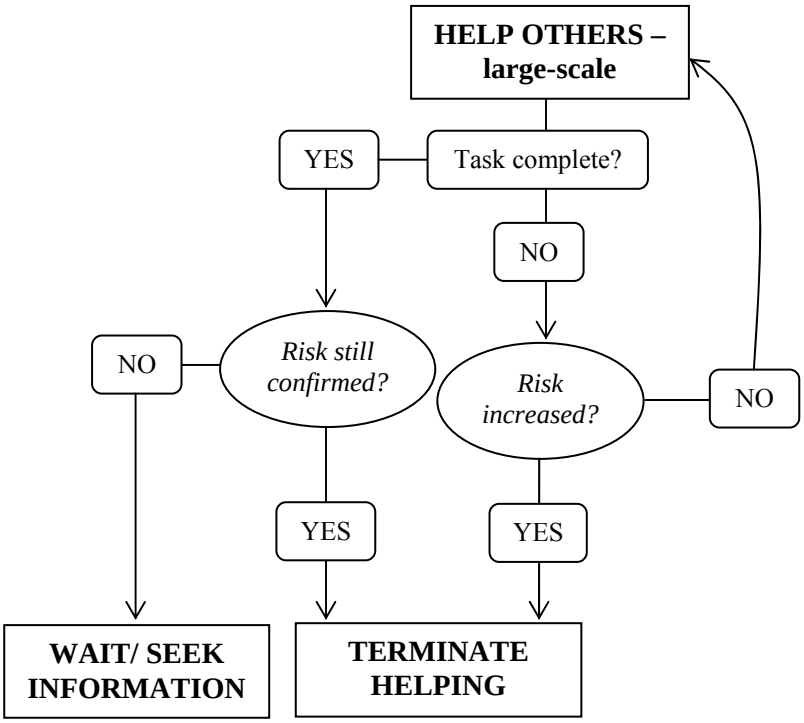


Figure 4-5: The ethnographic decision model for the termination of helping behavior

There were multiple reasons why helping was terminated. Sometimes helping was stopped short because the individuals' risk perceptions increased. If helpers witnessed evidence that conditions on the floor were deteriorating, including smoke traveling into office areas, their perceptions of personal danger increased and they terminated helping immediately. WTC 2 managers or fire wardens, who were still assisting others when their own tower was hit, for example, terminated helping immediately when the tower began to sway back and forth. It was at this point that self-protection became the top priority.

Individuals also helped others until they determined their tasks had been completed. Once managers or fire wardens felt that he had reached everyone on the floor, and especially if no one was left on the floor, helping stopped. A manager on the 29th floor of WTC 2 made sure that all of his employees had evacuated. He commented that after his helping task was completed:

> The real reason I decided to leave was just really nothing else to do. So I figured let me just go home and I wanted to call all the people that worked for me to make sure that they got home all right (WTC2/029/0001).

He had still perceived personal risk from the incident, and thus, immediately began protective action for himself. Note also that this individual remained concerned about the employees in his company, made evident by his intention to check on them even after he had evacuated the building.

There were also instances when the helping task was completed and the manager or fire warden no longer felt at risk. As shown in Figure 4-5, these occupants stopped engaging in protective actions altogether and waited for additional information, or continued information seeking, which placed them back into the sensemaking and milling processes once again. It is only when they received information that boosted their perceptions of risk again that they re-engaged in protective actions. For example, a manager on the 71st floor of WTC 2 had stopped protective actions right until the time when his building was hit. "…[A]nd then, you know, seeing everything turn black, that's when I knew...something very bad was going on" (WTC2/071/0002). Within seconds, this occupant and others remaining on the floor were running to the stair.

Preparation

As indicated in Figure 4-3, numerous occupants engaged in various kinds of preparatory behavior before evacuating. Preparations took place under several conditions. First, occupants would only prepare if they were given the *opportunity* to do so. For example, at the time of the attack, an occupant may not have been located at his or her place of work. Occupants could have been getting breakfast in the cafeteria or exiting out of an elevator on a transfer floor. Only occupants who were originally located on their destination floors had the opportunity to prepare. For those with opportunity, *gender* was an influential factor in the performance of preparation actions. Approximately half of the men in both towers (57%) engaged in some sort of preparation, whereas an overwhelming majority of the women (87%) prepared. Also, *seeing others preparing* influenced respondents' preparation actions. If there were other occupants nearby, or if they were explicitly told to prepare, occupants prepared as well.

Specialized personnel were also likely to prepare offices and equipment before evacuating. These occupants were higher-level managers, fire wardens, or staff in specialized occupancies, including

kitchens, banks, or computer-support services. Since only a minority of occupants held these roles, this type of preparation was not included in the predictive model.

Evacuation

After helping and preparation were complete, WTC occupants developed an adaptive plan for evacuation. This plan not only consisted of determining a destination (i.e., outside of the building), but also the means of travel and the route taken to reach that destination. As shown in Figure 4-6, evacuation only occurred initially if the route off the floor was considered accessible. In cases where the route was inaccessible, occupants remained in place until they or someone else could identify an *accessible route*.

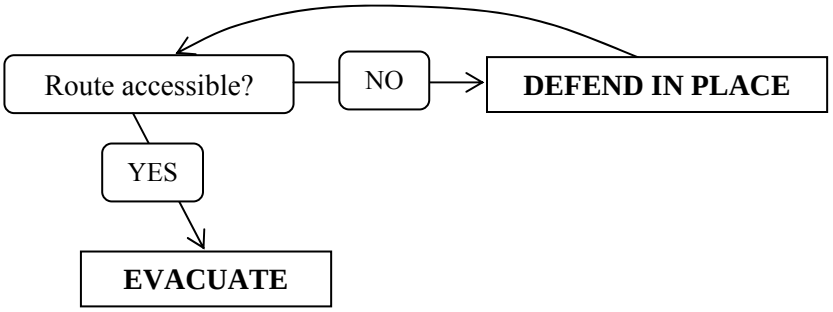


Figure 4-6: Factors that influenced evacuation protective actions

Means of travel – Stairs or elevators?

Although elevators were not available to occupants in WTC 1, they were available to WTC 2 occupants between the time the first plane struck WTC 1 and 9:03 am, when their own tower was attacked. A minority of respondents in WTC 2 (15%) took advantage of elevators for evacuation. Although this is not a large sample from which to draw conclusions, interviews did shed light on the factors that influenced elevator usage in WTC 2. Figure 4-7 identifies these factors. These influences are not included in the larger model owing to space restrictions. However, notation $^{(C)}$ is provided in Figure 4-3 in reference to "evacuation" to show that other figures are provided elsewhere in the chapter to support the larger model. As indicated in the figure, WTC 2 occupants used elevators based on their beliefs about the event, the behavior of others, and their locations in the building.

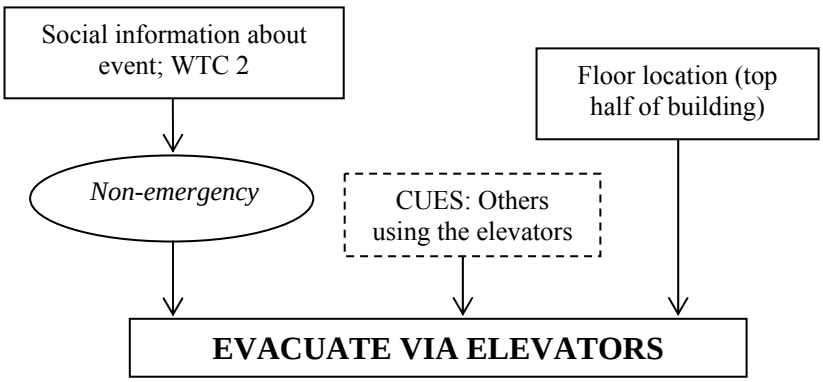


Figure 4-7: Factors that influenced the use of elevators for evacuation

First, people who thought that there was no emergency in the building used elevators. This finding is consistent with information indicating that occupants were routinely told not to use elevators in fires and other emergencies. As noted earlier, occupants in WTC 2 often heard from others during the milling process that the emergency situation was actually taking place in WTC 1, and that their building was secure. An occupant who was in a group with three others on the 101st floor of WTC 2 explained why she chose elevators over stairs for evacuation:

> …guess in that situation you're told never take the elevator, well that was in a concern [but] it wasn't our building. So you take the elevator down…never occurred to me to take the stairs…the three of us headed for the elevator because it's the easiest and fastest way down. There was no way...I didn't even think stairs. (WTC2/101/0001)

Social influence was also a key factor in whether respondents decided to use the elevators for evacuation. Elevators came to be seen as a practical option for evacuation when others started using them, and especially when fire wardens and managers (i.e., credible sources) instructed people to use them. Finally, individuals were likely to use elevators if they were located higher in the building. Although people from all floors used elevators (in this case, from floors 11 to 104), the majority originated from the top half of the building.[28]

The majority of WTC 2 occupants recalled constant reminders to refrain from elevator usage during emergencies, which is no doubt why elevators tended to be chosen by people who did not consider

[28] Due to size of the sample, more research is needed to verify the factors identified as influential of elevator usage.

WTC 2 to be in danger. Even if occupants were uncertain about the situation, they were likely to err on the side of caution and use the stairs for evacuation. Social influence also played a role in persuading WTC 2 occupants not to use elevators. If people, especially credible sources, were instructing occupants to use the stairs and not the elevators, they were likely to follow these instructions. However, the situation changed dramatically when their tower was hit at 9:03 am and there was no doubt that an emergency was now taking place in their building. Elevators were no longer even considered an option.

Routes to the destination

Once the means of egress was established – stairs versus elevators – occupants then had to decide the route to take to get there. For elevators, it was fairly simple, because elevators were located in the same elevator bank in the center of the floor. However, for stair users, deciding on a route of travel was a bit more complicated. With three exit stairs available from each floor,[29] which stair would they choose?

In both towers, people chose a particular stair based upon their familiarity with the stair location or the actions of others. These factors are displayed in Figure 4-8.

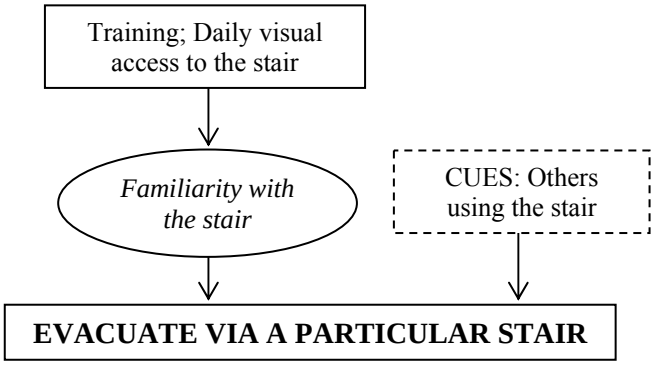


Figure 4-8: Factors that influenced the use of a particular stair

What caused people to be familiar with the stair layout? The first factor was participation in previous building evacuations or fire drills. The procedure of traveling to a designated stair and waiting at the stair for a period of time during fire drills was described by an individual in WTC 1 as being drilled

[29] Some floors contained internal stairs that connected certain floors together. These were not considered exit stairs.

into occupants over and over again (WTC1/069/0001). Although individuals did not necessarily move into the stair and evacuate down, practice drills helped them to recall stair locations in both buildings on 9/11. Individuals were also familiar with stair location because stairs were located in a position along their daily, normal route throughout the floor. Stairs were commonly located very close to their offices or to locations that they passed several times a day, including the bathrooms or the elevators (WTC1/028/0001).

On the other hand, there were respondents who reported that they followed others to the stair or followed others' instructions as to which stair to use. In this case, either someone directed them, e.g., a fire warden or security guard, or the individuals simply followed the crowd. Respondents who followed others may or may not have been familiar with the stair layout. Either way, they chose the evacuation route based on others' actions.

This ends the discussion of the predictive model shown in Figure 4-3. Next, I will summarize the specific factors that influenced each stage of the decision-making process and discuss how these contrast with findings from empirical research on other disasters and building fires, as well as the underlying processes explaining why certain factors were influential while others were not.

Discussion of Results

In Figure 4-9, I compare my findings to factors identified as significant in the PADM. Factors listed in the table but not bolded are those found in the WTC that are consistent with empirical research from disasters and building fires. Factors that are bolded are the factors that are unique to the WTC and that constitute additions to theories of emergency decision-making. Finally, any factors that are crossed out in Figure 4-9 are those that were not determined to be influential in the WTC.

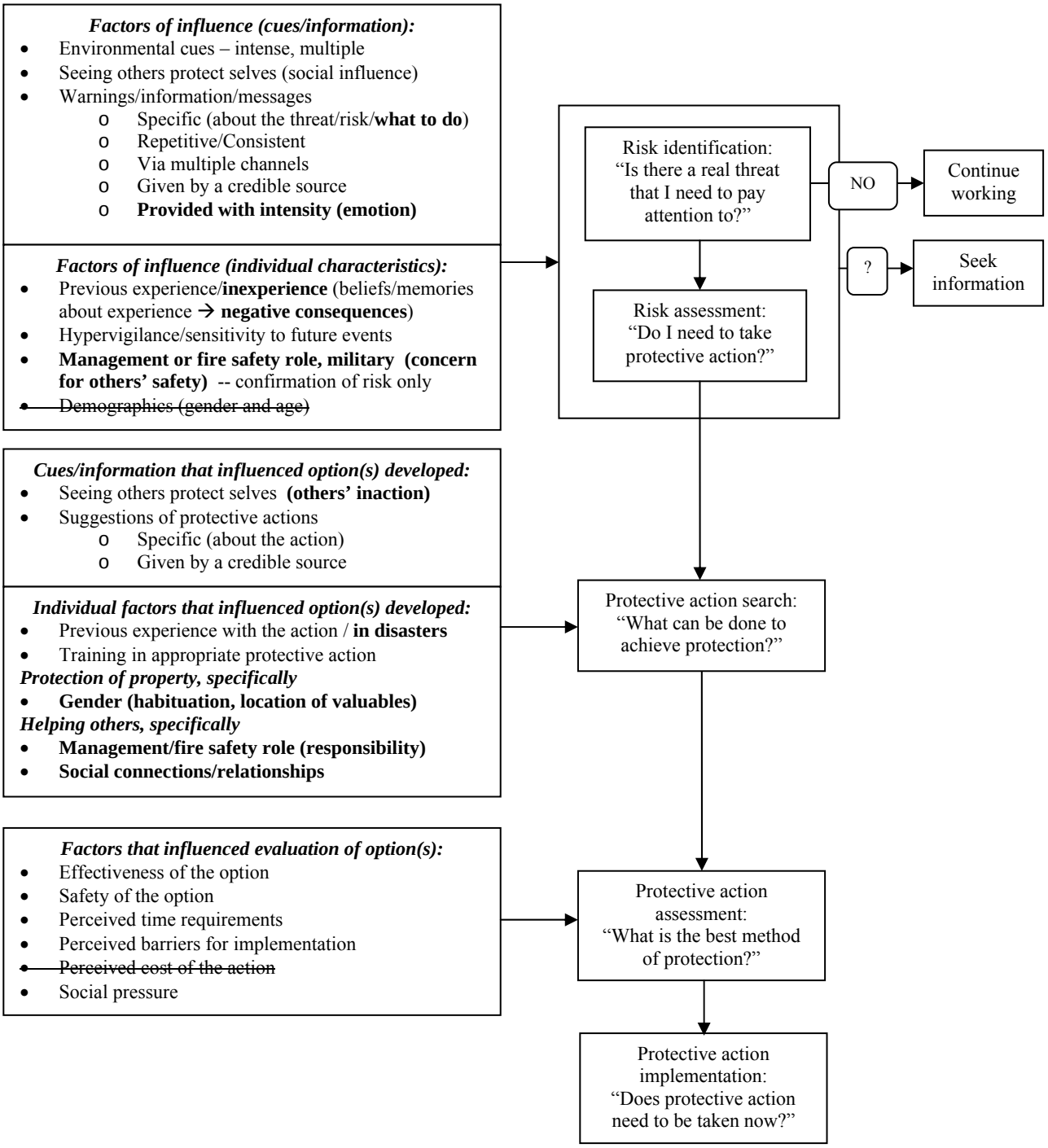


Figure 4-9: WTC model factors versus factors identified in the PADM

Risk identification and assessment

Many of the factors found to influence risk identification and assessment in previous disasters and building fires are consistent with the WTC results. Occupants who witnessed multiple, intense physical and social cues, including seeing others protect themselves, were likely to develop a sense of the threat and personalize the risk associated with the threat. Also, once occupants received specific information about the threat, the risk or what to do (i.e., evacuate), especially if the information was consistent, given via multiple channels, and delivered by a credible source, occupants were able to identify and assess the risk. Occupants were more likely to assess risk if they had a prior sensitivity to future disasters occurring in the WTC. In addition, previous experience with disasters, especially the 1993 WTC bombing, had an influence on risk identification and assessment, primarily due to individuals' memories of the events.

Earlier in this chapter, it was posited that beliefs about previous crisis experiences, rather than simply having had those experiences, are what influences risk identification and assessment. The WTC disaster sheds light on this debate, by first focusing on the influence of beliefs on risk identification. The availability heuristic was used by WTC occupants, in that they were likely to think that an event they easily recalled from their past was happening again in 2001. A good example of this was thinking that the 2001 event was a bombing. Many occupants, even those not present for the 1993 WTC bombing, interpreted the events on 9/11 as indicating a bombing because the 1993 bombing was such a vivid memory. Another example, prevalent for those without memories of WTC emergencies or who experienced less intense cues, was to interpret the situation as a severe thunderstorm. According to their recollections of the 2001 attacks, as the building swayed, individuals immediately remembered that the same swaying occurred in previous thunderstorms in the WTC.

By employing both the availability and anchoring heuristics, WTC occupants even envisioned that other types of events, ones that had previously taken place outside the towers, were taking place in 2001. This approach, for example, was used by occupants who interpreted the 2001 event as a plane crash. During the sensemaking process, memories of smaller planes flying around the towers or the plane

that had accidentally struck a building in New York City,[30] were easily recalled. Occupants then anchored upon these memories, and adjusted them to the current situation in the WTC towers, resulting in an interpretation that a small Cessna or helicopter had accidentally hit WTC 1. This finding is consistent with Lindell and Perry's (2004) assessment that individuals have difficulty envisioning events that are more dangerous than previously experienced. WTC occupants had never experienced a large, commercial airliner striking the building or any other building in the world, and because of this, they were unable to interpret the 2001 event as such (unless they saw it occur). And, obviously, since it would have been very difficult for anyone at that time to think of someone intentionally piloting an airliner into a building, even those who concluded a plane had struck would naturally believe it had done so accidentally.

Analysis of the WTC disaster also sheds light on why beliefs of previous experiences influenced occupants' assessments of risk. If WTC occupants interpreted the situation in a certain way based on memories of previous experiences, the memories were accompanied by positive or negative emotions about the event. Again, using the anchoring heuristic, occupants anchored upon these emotions when assessing the risk on September 11. For example, of the WTC occupants who initially interpreted the 2001 disaster as an earthquake, a few recalled their prior earthquake experiences in a positive light, and in turn, rejected the notion of risky consequences on 9/11. On the other hand, almost all survivors of the 1993 bombing, and even the non-survivors who simply remembered the event, perceived a higher possibility of negative consequences in the September 11th attacks, and in turn, personalized the risk (when multiple, intense cues were perceived) because the bombing was so traumatic for those involved.

The WTC analysis identified a new factor to include in Figure 4-9, and that is the influence of *cue intensity* on risk identification and assessment; however, this finding is consistent with research from the human factors and ergonomics disciplines stating that warnings provided with an urgent tone and a faster speaking rate are more likely to increase perceptions of danger (Jang 2007; Edworthy, Hellier and Rivers 2003; Hellier et al. 1999). The intensity of social cues, specifically if evacuation instructions were provided with intensity, in the form of screaming, yelling, or the use of active-danger words, or if a large

[30] A B-25 bomber crashed into the Empire State Building in 1945 (Goldman 1980).

number of people were evacuating, caused the individual to believe that he was also in danger. WTC occupants saw that risk had been identified by others in the building, which in turn, influenced them to believe that something dangerous was taking place. The affect heuristic, where experienced or recalled feelings are used as information in the decision process, can shed light on the influence of cue intensity on risk (Slovic et al. 2005). Decisions involving a large amount of uncertainty, including whether the event poses a significant risk to the occupant or not, "often lead individuals to resolve choices by focusing on the cues that send the strongest affective signals" (Kunreuther et al. 2002). In the WTC, occupants who were unsure about whether a threat existed or whether the threat posed a risk relied on the feelings evoked by the intensity of the social cues received. Hearing screams to evacuate or seeing seas of people running to the stairs evoked a sense of personal fear regarding the event, which aided in their own understanding that something serious was taking place on 9/11.

Additionally, the influence of *social role,* namely having a management or fire safety role or prior experience in the military, on confirmation of risk is also included in Figure 4-9. What influenced individuals from these three groups to confirm danger associated with the event and decide to evacuate before others was consideration for the safety of others. They had the potential for risk to others in mind when they personalized their own risk. Whereas managers and fire wardens had people for whom they were responsible before the disaster began, former military personnel in the WTC considered themselves well trained to react to things, including reacting to the notion that others were in danger (WTC1/063/0002).

Milling actions – Information seeking and continuing to work

According to the PADM, people continue to seek information if they are unable to answer the questions that emerge throughout the decision-making process (Lindell and Perry 2004). The same factors were found to influence information-seeking during the 9/11 attacks, which is consistent with quantitative studies also performed on the event (Kuligowski and Mileti 2009). Even some who had previously decided that protective action was necessary re-engaged in information-seeking actions to make sense of

and confirm new information. WTC 2 occupants, in particular, returned to the sensemaking and milling processes when they received word that there was no emergency in the building.

Also consistent with the PADM (Lindell and Perry 2004), as well as other studies of the 2001 WTC disaster (McConnell et al. 2010), occupants who continued to work did so because the cues they originally received were not significant enough to interrupt activities. In other words, they did not perceive a threat that was significant enough to even begin assessing the risk. This is also shown in Figure 4-9.

Rate of decision-making

Although not displayed in Figure 4-9, a factor identified by Lindell and Perry (2004) as influential for the rate or speed of information flow was the presence of informal networks. These findings are consistent with this study of the WTC, in that individuals who were surrounded by their coworkers almost immediately began *milling or talking with others* about the event in the 9/11 attacks, increasing the speed of information flow. Also, the more discussions that people had during the milling process, the more their interpretations of the situation converged on the idea that the situation presented a danger, which increased risk perceptions and personalization of the risk. Also, terrorist attacks, building fires and other rapid-onset disasters are different from slow-onset events, like hurricanes. In the case of slow-onset events, individuals are initially unclear about whether the threat will materialize at all. However, in the WTC, respondents were discussing events that had already taken place, and because of this, some people had seen what had happened in WTC 1 and began discussing this with informal networks in the building. Additionally, as occupants decided to evacuate, they frequently shared this decision with others, influencing others to evacuate as well.

Protective actions

A major difference between the WTC decision model and the PADM is that some of the factors that influenced protective actions varied based upon the action type. For example, gender was only found to influence preparatory actions, rather than all protective actions taken in the WTC. Therefore, it was not

appropriate to list all of the factors as influential to the search for protective actions. Any factors that were found to be influential to only one action type were identified as such in Figure 4-9.

Helping

People helped based upon their perceptions of responsibility for and social affiliation with others in the towers. These meanings were created from occupants' social stock of knowledge, including their pre-existing roles in the building and relationships with others, and the actions of others around them. WTC findings were consistent with empirical disaster research on the types of factors that influence the search for protective actions, including experience helping in previous disasters, suggestions from others to help, and training in the protection of others (i.e., fire warden training). However, the new findings identified as influential to emergency decision-making are having a pre-disaster management role and social connections with others in the building.

Based upon Weller and Quarantelli's (1973) extension of ENT, Dynes and Quarantelli (1980) identified the underlying reasons why some individuals are likely to volunteer or help others after a disaster. Dynes and Quarantelli (1977:8) state that "disaster impact does not modify the 'causes' of behavior. What disaster impact does is to create a series of tasks with which the conventional social organization of the community must cope." In other words, the 2001 WTC disaster presented individuals with a normative crisis, and while some roles and relationships emerged, most were expanded upon based on the pre-disaster social order to cope with the emergent situation.

First, fire wardens were likely to help in the WTC. According to Dynes and Quarantelli's matrix of volunteers (1980), fire wardens resembled the "organizational volunteer" because these volunteers' helping behavior was influenced by social norms and relationships established *before* the disaster occurred. Since it was fire wardens' pre-defined jobs to help others during a disaster, it is not surprising that they helped others in 2001.

Company managers, on the other hand, represented individuals who expanded their pre-disaster roles and relationships to help during the disaster, labeled in Dynes and Quarantelli's volunteer matrix as "volunteers in expanded roles." Managers had defined tasks in their firms that involved leading others in

the work place. In the 2001 WTC disaster, managers expanded their company-based authoritative roles to lead and instruct others during the disaster. Managers felt responsible for the safety of their employees, especially those under their immediate supervision.

Individuals who did not have pre-defined responsibilities, or even experience in previous emergency situations, also helped. The actions of these individuals are consistent with theory and research on the emergence of helpers in the face of disasters (Connell 2001; Turner and Killian 1987). Collective behavior theory indicates that keynoters emerge in normative crises to help others by advancing suggestions of what to do in response to the disaster. Emergent helpers frequently assisted people with whom they shared pre-disaster social ties, including occupants who were a part of their colleague or friendship group; and in turn, engaged in helping on a much smaller scale than managers or fire wardens. As soon as emergent helpers saw their friends and colleagues not engaging in protection, they began to help. This finding is consistent with Brennan's (1996) research on the influence of the presence of loved ones on helping behavior in building fires, which found that victims of building fires took time to help family members and friends also involved in the fire before evacuating.

Based on findings from research on disasters, it is also possible that helpers emerged for other reasons. Lowe and Fothergill (2003), who studied helping behavior after the 2001 WTC disaster, found that one group of helpers who emerged from the surrounding community after the incident were actual survivors of the attacks. The authors saw these helpers as fulfilling a compelling altruistic need to serve members of the community as well as themselves. In essence, survivors attempted to redefine negative experiences of their own victimization through volunteering and helping others. Another possibility is that emergent helpers felt better about undertaking evacuation actions if they could encourage others to do so. This is consistent with social influence theory, which argues individuals are often inhibited in performing actions because others are not performing them (Latane and Darley 1970). If they received instructions to evacuate and did not want to be the only ones walking to the stairs, they may have been motivated to bring others along with them.

Even though previous research shows that gender influences protective actions, gender was not found as a factor that predicted helping in this event. Previous disaster research has found that men help others more often than women after a disaster has occurred, for example, by engaging in rescue activities within their community (Bryan 2002; Enarson and Scanlon 1999), while women stay at home and tend to familial needs. That research, however, primarily focuses on helping behavior within a community, positing that men and women follow stereotypical familial gender roles within the home which influence behavior. Gender was not linked to helping in the 9/11 attacks, most likely because of the differences between roles and responsibilities of office workers versus members of a family within the home. In the WTC, both women and men held management and fire-safety roles and also emerged as helpers in their social circles during the event. Their roles and pre-established relationships with others took precedence over the influence of gender in this emergency situation.

There are additional factors that influenced occupants to refrain from helping. First, some people could not help because they were prevented from doing so. Although some people offered help to strangers, for example, telling people not to use the elevators or directing them to stairs or elevators, helpers were more likely to assist their employees, colleagues or friends. If the individuals with whom they had social ties were located on another floor, people were also less likely to help. Additionally, if the action was seen as ineffective to achieve others' safety, people were unlikely to perform the action. For example, unless they were specifically asked to assist, helping was viewed as ineffective by some managers when they saw other managers (of higher status) already engaged in helping on the floor. In these instances, their own helping actions were perceived an unnecessary as well as contrary to the evacuation instructions received from the helper.

Another aspect of protective actions not discussed in the PADM is why people terminate helping behavior. This was pertinent for helping actions in the WTC attacks, because some helpers continued providing assistance for many decision cycles. Risk perception was key in the termination of helping, especially if occupants' tasks were completed. In essence, helpers engaged in a "risk perception check" to confirm that evacuation was still necessary. However, if they no longer felt the situation was risky after

helping was completed, they reverted back to the milling process. In this case, their previous evacuation decision was not confirmed, and evacuation was no longer seen as necessary.

Preparation

WTC occupants prepared based upon their gender and the actions of others. Without additional analysis, both factors are consistent with previous empirical research from disasters and building fires. In community disasters, research posits that women follow household-based gender roles, which influence their preparation behavior. They regain control of the disaster situation by taking control over household items and preparing for their family (Fordham 1998). However, a fire in an office building presents a different situation. Preparation mainly refers to gathering personal or work items, without thinking or considering others. Demographic factors like gender are unlikely to directly influence an action (Lindell and Perry 2004). Instead, it is likely that mediating factors were at play here.

One possible mediating factor is the way in which men and women are accustomed to carrying their valuables. Men typically carry cash and credit cards in wallets on their persons, whereas women often carry their valuables in purses. When men discussed gathering personal items, this normally consisted of grabbing their jackets or briefcases before moving to the stairs. Also, when men discussed not needing to collect personal items, some indicated that they already had valuables, such as cell phones with them, so preparation was unnecessary. Therefore, it is likely that the location of financial or personal property, i.e., on or away from the person, influenced preparation.

Another mediating factor may have been the habitual nature of gathering personal belongings before leaving the building each day. A man on the 66th floor of WTC 1 stated that he prepared because, "Well this is what I do when I leave the building. I take my things with me" (WTC1/066/0001). In an attempt to experience some sense of normalcy in a non-normal situation, he gathered his belongings as he would on any other day before leaving the floor. WTC occupants, especially women since they are more likely to keep their personal property in a purse, were used to gathering personal belongings each day before leaving the building. These same patterns persisted on September 11th.

If occupants considered preparing, they did so unless they encountered barriers. If they were not located near their belongings, they were unable to prepare. Additionally, perceived time constraints were a barrier. If occupants perceived insufficient time to prepare, they did not engage in the action.[31] Last, occupants did not prepare if the action was assessed as unnecessary. For example, occupants who thought that they would return to the building later in the day on September 11, 2001 were unlikely to prepare.

The evacuation plan

Evacuation plans in the WTC involved more than simply deciding to evacuate the building. They also included decisions on the means of evacuation and the route of travel. Both the means and route of travel chosen were influenced by previous training, previous experience using elevators or stairs, and the actions and inactions of others. Each of these factors is consistent with previous research on why specific protective actions are taken.

In non-disaster times, elevators are the familiar and routine option for building occupants to get to and from their workplaces each day. If occupants considered the situation in the building as stable or a non-emergency, they also considered elevators as an effective option for safe evacuation. Similar to the decision to evacuate explained above, occupants' views on the safety of elevators as a means for evacuation also increased when others chose them for evacuation.

Elevators were viewed as an ineffective option in situations viewed as emergencies and when others were not using them. Since WTC occupants were trained to not use elevators during emergencies, many recalled and followed these instructions in the 2001 event. Also, social influence deterred occupants from using elevators, in that if no one else was using them, they were also viewed as less effective.

Stairs were mainly chosen based upon occupants' familiarity with them. Consistent with Sime's affiliation model (Sime 1983), WTC occupants tended to move toward the stairs with which they were familiar from previous experiences in the building. Especially if individuals were not familiar with exits,

[31]Perceived risk was not identified in this study as an influential factor to preparation, although other studies have found this to be the case (McConnell et al. 2010). In some instances, WTC occupants who perceived risk collected belongings because they envisioned serious conditions in the building likely to inhibit their immediate return, whereas others who perceived risk also reported perceiving time constraints, and thus, did not prepare.

they followed others to the stairs, which is also consistent with research on exit route choice (Nilsson and Johansson 2009; Shields and Boyce 2000). In an attempt to follow social norms and perform actions that are expected of them, WTC occupants also followed crowds that were evacuating to an exit or followed instructions by security, fire wardens, or managers to a particular exit. Similar to elevators, a stair route was not considered an option if no one was using it or if people encountered barriers, such as toxic conditions, that inhibited its use.

Theoretical foundation

As mentioned earlier, the SI perspective contends that an individual act is the result of the following behavioral process: perception, interpretation or meaning-making regarding the current environment, and decision-making (Blumer 1969). Expanding that to the realm of normative crises, ENT posits that a disaster or other forms of social disruption can create a normative crisis whereby individuals interact collectively to construct a new definition of the situation and propose new lines of action (Turner and Killian 1987). New norms developed within a collectivity emerge as a result of the new situation, but are also influenced by pre-crisis (conventional) norms and social relationships.

ENT provides a valid foundation for the prediction of pre-evacuation actions in the WTC. My research confirms the longstanding finding that actions are not performed based directly on environmental cues or information received, but rather are influenced by the meanings assigned to those cues and to the situation based upon an individual's social stock of knowledge. Each pre-evacuation action was a direct result of an individual's meaning or interpretation of the evolving event developed through social interaction. Environmental cues were perceived, interpreted through a filter based upon an individual's social stock of knowledge, and then based on this newly developed situational reality, subsequent actions were performed.

Actions undertaken during the milling and sensemaking processes, including information seeking and continuing to work, were primarily based on the interpretations of the situation and the risk, developed through the lens of past experiences in both emergencies and non-emergencies. A group of researchers who performed a quantitative study of the 1993 WTC bombing to test predictions from ENT

also identified the importance of risk interpretations on occupants' subsequent behavior (Aguirre, Wenger, and Vigo 1998). They discovered a negative relationship between risk perception and length of time spent in the pre-evacuation period, and although my research does not attempt to predict pre-evacuation timing, Aguirre, Wenger and Vigo (1998) identify the importance of risk perception on the decision to take protective action during the milling process, which is consistent with the findings in this study of the 2001 WTC disaster.

At first glance, it may seem that protective actions were performed based solely upon pre-existing social roles and past experiences in the towers. For example, a major finding was that high-level managers and fire wardens (who often held management roles as well) were more likely than others to perform large-scale helping. The influence of pre-disaster social roles, training, and experience is consistent with the work of McPhail (1991) who stated that individuals with certain social roles and expertise were more likely to keynote, or suggest protective actions to others. However, consistent with SI, protective actions were performed based upon meanings established for those actions. For example, the perception of responsibility, rather than simply holding a management or fire-safety role, influenced an occupant's performance of large-scale helping. This was made evident by the fact that not all managers in this study's sample helped others. Only the higher-level managers who decided to evacuate without social instructions (labeled in Chapter 3 as early responders) were likely to perform large-scale helping. Other managers, in the process of receiving instructions to evacuate from their higher-level bosses and colleagues, believed that they were not required to take responsibility for the safety of their employees and colleagues, unless they were specifically instructed to help. Others on their floors were already fulfilling this responsibility, and thus, they did not need to.

Instead of being linked directly to actions taken, pre-disaster social roles, training, and experience (or an individual's social stock of knowledge), were linked to the meanings established for actions. Perceptions of responsibility, social affiliation, habituation, and familiarity, all of which directly influenced the performance of protective actions, were developed primarily based upon pre-existing social roles and relationships in the building and previous experience in emergencies. This finding is

consistent with Weller and Quarantelli's (1973) expansion of ENT and the notion that an emergent norm should be viewed more as a revised definition of the situation, developed within the context of pre-existing norms and social relationships, as opposed to a completely novel one. Aguirre, Wenger and Vigo (1998) also found validation for the importance of social relationships in their study of the 1993 WTC bombing. Whereas they found a relationship between social affiliation and the length of time spent performing actions, my research identified the relationship between social affiliation and the performance of specific protective actions.

Conclusions

I developed a conceptual model that identified the factors that predicted WTC pre-evacuation actions. Factors influenced perceptions of the situation and the risk, which then influenced the actions taken during the milling and sensemaking processes. Once the decision to take protective action was made, other types of factors, including pre-disaster roles and relationships, previous experiences, opportunity, and the actions of others, influenced the meanings and definitions that eventually influenced actions taken to achieve protection in the face of the disaster.

My analyses and the resultant model indicate that social behavior in the WTC building emergency was similar to social behavior in a disaster setting and that many of the factors that influence risk perception and protection in disasters were found in the WTC. However, the predictive model makes significant contributions to current evacuation theory by identifying factors not identified in previous evacuation research, factors that influenced *specific* types of protective actions, and factors that influenced occupants to develop evacuation plans from a building, including using the elevators for evacuation. The extensive analyses and model results discussed here describe evacuation decision processes in much greater detail than either research on building fires or studies on community-wide evacuations. Both kinds of studies tend to gloss over the very phenomena that are the focus of this study, such as how people perceive and interpret environmental cues and warnings, how they seek confirmation, and what they do before moving to safety.

Additionally, the analyses presented here provide details on the pre-evacuation period in a building fire and predict actions taken to achieve safety. As mentioned earlier, computer evacuation models simulating building fires underspecify evacuation behavior, especially the actions performed during pre-evacuation. The model presented here can be tested, expanded, and validated to eventually produce a predictive model of pre-evacuation behavior in building fires.

Chapter 5 - 9/11…"We Will Never Forget"

One moment you are checking your email and the next, you feel as if your building is swaying into the Hudson River hundreds of feet below. As soon as it no longer feels appropriate to continue working, but more important to discover what is going on, a normative crisis has developed. This study focused on the occupant decisions and actions that resulted from the normative crises in the World Trade Center towers on September 11, 2001. In the preceding chapters, I explored the process of decision-making and collective behavior under extreme uncertainty, illustrating occupants' development of new norms and strategies for action. Interview data from WTC survivors painted a powerful picture of the difficulties associated with making sense of a seemingly confusing and dynamic situation. I also examined the influence of pre- and post-disaster factors on the decision-making process, specifically focusing on the factors that influenced the performance of various actions before occupants began to evacuate.

Recapitulation of the Normative Crisis in the WTC

The study of the 2001 WTC disaster presented insights on the ways in which people respond to a building emergency. I performed an extensive qualitative analysis of 245 interviews with survivors of the WTC building evacuations, provided by Project HEED (Galea et al. 2006), to study the types of actions performed during the pre-evacuation period and understand why those actions were taken.

I provide two models of social response in this dissertation. The first model, presented in Chapter 3, describes the decision-making processes of WTC occupants during the pre-evacuation period. The second model, presented in Chapter 4, outlines the factors that influenced actions taken during the pre-evacuation period.

The WTC decision-making processes consisted of a series of decisions to act based upon the receipt of environmental cues and the development of cognitions about the events. The pre-evacuation period began as soon as occupants noticed that something was different or even potentially dangerous in

the WTC. For some, this involved actually seeing a large commercial airliner flying toward the towers prior to 8:46 am. Others were jolted into concern by the noises, the shaking, or the sight of fireballs, debris, or thick, black smoke inside or outside of Tower 1. These sights, sounds, and smells prompted individuals to begin sensemaking processes, either alone or with others, to figure out what was going on and whether they were at risk. A minority of occupants in WTC 2 decided quickly that they were not in danger and continued working soon after WTC 1 was hit. The majority of occupants in both towers engaged in a series of information-seeking activities that transported them around their floors – looking out windows, talking to one another, and looking to others for information. There was a whirlwind of activity on all floors, as occupants engaged in milling processes and subsequently received additional information. Eventually, when they felt that they should take protective action – either by deciding on their own or being told to evacuate – they transitioned into a different phase in the decision-making process, which involved the performance of acts designed to protect themselves and others. Some occupants prompted others to evacuate, some prepared themselves to leave the floor, and finally, all occupants in this research sample eventually entered the stairs or elevators to leave the buildings.

A description of the decision-making process set the scene for Chapter 4, in which I identified the factors that influenced actions taken during the pre-evacuation period, including seeking information and continuing to work during the milling and sensemaking processes, as well as helping, preparing to leave, and initiating evacuation actions to achieve protection. WTC occupants continued to engage in milling and sensemaking actions, until they reached one of two thresholds: personalizing the risk or receiving social cues to evacuate. Either threshold influenced their decisions that protective action was necessary. Occupants who decided to evacuate when they personalized the risk, which was achieved by witnessing multiple, consistent, and intense cues, did so because they either considered others' safety (managers, fire wardens and military personnel) or envisioned negative consequences on 9/11 (including survivors of the 1993 WTC bombing and other emergencies, and individuals with emergency-related occupations). All others decided to evacuate when they were told to, regardless of their perceptions of danger. Protective actions were also performed based upon meanings occupants assigned to the situation. Helping actions

were performed by individuals who felt responsible for others on the floor, including managers and fire wardens, or individuals with pre-established social ties to others. Preparing prior to departure, another protective action, was performed based upon the opportunity to perform the action, the actions of others, and gender roles, although a plausible explanation here is that the influence of gender is mediated by the location of valuables or habituation. Finally, occupants evacuated once they completed preparation activities, if taken, and only when they had an accessible route to a stair or elevator.

Comparisons and Context

Certain theories were important for understanding emergency decision-making and action in the 2001 WTC disaster. Social psychological theories of human action in normal times (Symbolic Interactionism [SI] and Social Constructionism), during normative crises (Emergent Norm Theory [ENT]), and in response to hazards and disasters (the Protective Action Decision Model [PADM]), and research on decision-making under uncertainty (including the importance of satisficing rationality), provided substantial foundation for the exploration of human responses to the 9/11 attacks. Based upon these theories, I originally proposed the following four basic premises for this research, re-listed here from Chapter 1:

1) When the event first occurred, WTC occupants engaged in symbolic interaction processes to create meaning. This meaning in the WTC was a new normative structure to guide their future behavior. To create this new normative structure, they engaged in ***information seeking actions*** to define the situation and what it meant to them.

2) Based on the definition of the situation (above), a new line of action was created. If occupants interpreted the situation as one that was risky to them, they began performance of ***protective actions***. If not, they continued their ***previous actions*** or continued ***information seeking***.

3) Each protective action was also ***constructed*** based upon the meanings assigned to objects in the occupants' environment, the definition of the situation, and the assessment of risk.

4) The search for the new normative structure and the performance of protective actions occurred within both pre-existing social relationships and norms (an individual's social stock of knowledge).

The study of the overall decision-making process during the WTC pre-evacuation period (Chapter 3) provides support for premises 1 and 2. Prior to 8:46 am, WTC occupants were initially acting under the influences of conventional norms, based upon their social stock of knowledge. They were working on projects, attending meetings, and performing everyday tasks associated with their roles in the company and the building. However, when the plane hit WTC 1 at 8:46 am, people were faced with what I have termed a normative crisis, a situation described by ENT as one in which conventional norms no longer apply (Turner and Killian 1987; 1972; 1957). While still acting on the basis of shared conceptions of social reality, WTC respondents engaged in symbolic interaction with a new goal in mind: to create new social norms on which to act. This is shown by both the initial sensemaking and milling phases in the WTC decision-making process. In both phases, WTC occupants attempted to develop interpretations or definitions of the situation and to assess the risk to themselves and others. In the initial sensemaking phase, consistent with the "self-indication" process suggested by the SI perspective (Blumer 1969), and also with mental modeling as suggested by decision-making studies (Klein 1999), WTC respondents attempted to interpret the initial cues through a reflexive process. However, this process lasted only a brief period. Soon after, occupants began interacting with their environment, which is consistent with the milling process outlined by ENT. From these internal reflections and social interactions, respondents eventually developed interpretations of the event and the risk. Consistent with the PADM (Lindell and Perry 2004), which is based on human response to disasters, WTC respondents often engaged in information-seeking actions to continually obtain more information about the event to help in the development of event understanding.

Although many of the situational interpretations developed were inaccurate, the meanings that respondents assigned to the environmental cues did lead to the development of new norms. Once respondents perceived risk or were told to evacuate, they accepted a new normative structure for their actions – the need to evacuate the building. Also consistent with the PADM (Lindell and Perry 2004), they engaged in protective actions based upon the new normative structure. Before that point, however,

WTC respondents continued to engage in information-seeking actions, and some even discounted the risk and continued to work.

The literature on decision-making under uncertainty provides support for the protective action decisions made before leaving the floors. Satisficing, or choosing an action based on its perceived adequacy rather than its definitive appropriateness (Simon 1956), was a common method used in the WTC. Extreme time pressure and severe, life-threatening conditions, identified by decision scientists as factors that limit the search for a large number of options (e.g., Gigerenzer and Selten 2001; Klein 1999; Zakay 1993; Janis 1982; Ben-Zur and Breznitz 1981), were present in the WTC emergency, causing individuals to act quickly, without intense thought -- for example, because others were taking some action, rather than because that action was the best, safest, most appropriate action to take under the circumstances. This was certainly the case with preparing to evacuate and choosing an evacuation route. WTC occupants rarely spent time thinking about their other options for protection, but often took certain actions because others were doing so.

The predictive model of pre-evacuation actions (Chapter 4) supports premises 3 and 4 by showing that WTC occupants logically and carefully constructed each action based on the meanings they assigned to the situation. This project's findings are consistent with SI and its proposition that actions are performed based upon the meanings that individuals assign to the objects in their environment, rather than the objects themselves (Blumer 1969). Meanings took various forms for WTC occupants on 9/11, including the perceived credibility or seriousness of cues; the individuals' interpretations of the situation, for example, the condition of the building and the people in the building; and the individuals' perceptions or assessments of risk. Consistent with Weller and Quarantelli's (1973) extension of ENT to incorporate the influence of pre-disaster context on disaster response, WTC meanings were also invariably created within the context that existed prior to the disaster, referred to throughout this dissertation as an individual's social stock of knowledge (Berger and Luckmann 1966), including pre-disaster norms, experiences, roles and social relationships. The 2001 WTC disaster presents a prime example of how an individual's social stock of knowledge influenced meanings created, decisions made and actions

performed during an emergency situation. For example, managers extended their pre-disaster authoritative responsibilities on 9/11 in order to help others evacuate before evacuating themselves, based on their perceived responsibility for others. The types of knowledge influential to the development of meanings, which ultimately lead to the performance of pre-evacuation actions in the WTC were related to statuses and roles within the workplace, experience in emergencies or fire safety training, pre-9/11 perceptions of risk (or sensitivities to risk), and gender.

This research provides a direct link between understanding human responses during stable times, community disasters, building fires, and terrorist attacks, even one as extreme as two commercial airliners flying into 110-story high-rise towers. However, new insights were also developed in the course of this research that add to the existing theory and literature on decision-making and human response during crises.

Adding to current theory

The results of this project present the first inductively-developed conceptual model explaining why specific actions were performed during the pre-evacuation period of a building evacuation. Many of the sociological models of community or building evacuations have focused on quantitative methods and techniques in an attempt to model the factors that influence evacuation behavior -- in other words, whether a family or a building occupant evacuates after cues or an emergency warning are perceived. I investigated the linkages among concepts in a different way than quantitative methods have previously. Since qualitative methods were used to analyze the face-to-face interviews provided by Project HEED, it was possible to focus on decision processes and action sequences in detail. All six actions: seeking information, continuing to work, helping, preparing, defending in place, and evacuating acted as separate dependent variables in this analysis, in which it was important to understand the factors that influenced each one.

An important element in this conceptual model is the identification of the specific nature of pre-evacuation actions. To improve evacuation models so that they can more accurately simulate the pre-

evacuation time period, I was required to study both individual actions and the perceptions and decisions that shaped those actions. Previous empirical research on decision-making under threat conditions often lumps actions into two categories: actions to seek information or actions to achieve protection. Empirical research on building fires has gone one step further and identified the actions that are performed to achieve protection; however, that research neglects attention to the nuances of such actions. This study revealed that *each* pre-evacuation action represents a series of specific physical steps that take time to complete and have consequences that are important to understand in relation to subsequent decision-making. Helping behavior provides a good example of what I mean here. The helping behaviors performed by one set of occupants in the WTC were different from those performed by others, in that those in positions of responsibility and those with relevant training were more likely to engage in multiple helping behaviors in which they moved around the floor instructing people to evacuate, whereas others helped (or instructed) only their colleagues or friends positioned near them. Differences in actions among various types of individuals are rarely discussed in disaster or fire research, possibly because they are difficult to discover without the details provided by in-depth interviews and meticulous qualitative methods.

This research also documents the order in which actions were performed during the pre-evacuation period, another important detail required for computer modeling and one which is often lacking in other research. Because details of occupant evacuations were relayed in sequence during the interviews, as a narrative, it was possible to analyze the actions that occupants were likely to perform earlier in the pre-evacuation period and those that occupants were likely to perform at a later point in time. Bryan (2002) and Proulx (2002), among others (McConnell et al. 2010), have used different methods to document the sequence of actions in various building fires. A popular method has been to ask occupants to number actions in the order in which they were performed. However, the data used in this research and the methods used for analysis made it possible to identify trends in the order of actions, in addition to identifying those actions that directly led to certain decisions or subsequent actions.

Another important aspect of emergency behavior often neglected by previous research is the fluidity of the decision-making process. Previous empirical research has focused on collecting general values for important variables at one point in time during decision-making, often neglecting to capture how those variables changed over time. For example, surveys may ask how many cues a person perceived or how much he or she felt at risk directly before evacuating. The detailed interview data used in this project made it possible for me to monitor cognitions and how they changed over time before each pre-evacuation action was performed. Because of this analysis, the predictive model presented in Chapter 4 captures the volatility of both the environment and occupant cognitions and how changes in either one of these factors directly influenced subsequent actions.

The findings from this research also expand the PADM, which was developed primarily from community-based disaster studies, to account for a shorter time-frame, a structure evacuation, and a terrorist attack, as opposed to a natural or technological disaster. While my research findings validated many of the factors identified as influential to the decision-making process, new factors were identified to expand the model. The *intensity of the social cues received*, or the urgency or fear associated with the information, had not been previously identified in disaster studies as a factor likely to increase perception of threat and risk. Additionally, whereas empirical studies of disasters and fires had identified previous experience in disasters as influential to risk identification and assessment, my research highlights the importance of *occupants' memories and beliefs about previous disasters and other events*. WTC occupants found it difficult to imagine events worse than what they had experienced in the past, thinking that the booming sounds and building shaking after the first plane's impact resulted from a severe thunderstorm, construction accident, bombing, or small Cessna plane hitting the building, among other interpretations. Individuals were unable to fathom that a larger commercial airliner had hit their tower, unless they actually saw it take place, since this was the first time that something like that had happened in the towers or any other building in the world. Then, based upon these memories and the emotions attached to them, the levels of danger that they attributed to the situation on 9/11 were anchored in remembered levels of danger associated with previous events.

I also identified new factors that influenced protective actions. Previous research and theory have shown that seeing individuals take action influences others to follow the crowd and perform the action as well. This was not the case for all actions. The *presence of others* helping in the WTC caused some people in responsible positions to decide against helping, mainly because someone else was already doing it. Finally, specific factors from individuals' social stock of knowledge, including their *gender* and *management* or *fire safety role*, as well as *pre-existing social relationships*, were newly identified as influential in the development of meanings that eventually led to the performance of the following actions: helping and preparing for evacuation.

Refuting other theories and assumptions

Certain theories were not supported by this research. One in particular is the theory of mass panic in response to disasters. As mentioned in Chapter 3, Janis and Mann (1977) developed a conflict model to describe the process of emergency decision-making. If individuals are faced with a situation that they perceive as hopeless, in that there are options available for the implementation of protective action but the conditions keeping these options viable are rapidly deteriorating, they move into panic mode. In this mode, they are in a highly emotional state and are likely to make quick judgments about next steps, which could lead to poor judgment and maladaptive (e.g., risky) behavior. Even though social science experts have disputed panic theories for over fifty years, going so far as to label mass panic and competitive behavior during emergencies as a myth, the media, popular culture, and policy makers continue to perpetuate the myth (Fahy and Proulx 2009; Tierney 2003; Fischer 1998; Proulx and Sime 1991; Wenger et al. 1975; Quarantelli and Dynes 1972). The pictures painted by panic myths are those of fragile social grouping incapable of coping with disasters, so much so that they are likely to hurt others to save themselves or stand by watching social relationships deteriorate around them (Tierney 2003). This could not be further from the lived experiences of 2001 WTC survivors.

Theories of panic did not hold true in this study, as is the case with other terrorist attacks, including the 1995 sarin attack, the 2001 anthrax attacks, and the 2005 London underground bombing (Sheppard et al. 2006). Even under extreme stress and despite the fact that WTC occupants, especially

those closest to the impact zones, may have felt extreme fear that they were in danger, they did not resort to competitive flight behavior, dazed nonmovement, or social misconduct or disorder. Occupants on the floors closest to the impact zone in WTC 1 continually worked together to strategize ways to achieve safety. When their familiar routes seemed inaccessible, they did not give up hope. Instead, they began to search for new ways out or improvise ways to keep safe by creating safety zones within their office suites.

Instead of engaging in panic flight, many WTC occupants remained in potentially dangerous situations for long periods of time, even after perceiving risk to themselves, before deciding to evacuate. Some WTC 2 occupants even went back to work, following what Quarantelli and Dynes (1972:10) refer to as "strong tendencies to continue with on-going lines of behavior in preference to initiating new courses of action," or what I described earlier as the normalcy bias. People's first tendency in any incident is to believe that nothing unusual is happening or that they are safe regardless of the seriousness the situation, and the behavior observed in the 2001 WTC disaster was no different.

WTC occupants were extremely resilient and altruistic in the face of very dangerous conditions. Even though many were waiting for information over the public address system, as they were trained to do, fellow occupants emerged as leaders to cope, innovate, and develop new lines of action for both themselves and their employees and colleagues. As is found in other types of disasters (Tierney 2003), the disaster victims themselves were the real first responders who managed the evacuation and performed rescues, all the while, putting themselves in harm's way to ensure others' safety. Thus, this research presents yet another argument for the fact that individuals do not panic in the face of serious emergencies.

While WTC occupants did not panic, they also did not evacuate immediately in response to the first plane crash, refuting the current default assumption made by many computer evacuation models that evacuees act immediately and efficiently in response to any emergency. As mentioned in Chapter 1, most evacuation models ignore or require users to make gross assumptions regarding occupant behavior in the pre-evacuation period, in essence assuming that occupants do not spend a significant amount of time delaying their evacuation, perhaps to justify not accurately accounting for this time period. However, even in the face of very extreme environmental cues, WTC occupants had a high capacity for collective

sensemaking. Occupants spent time engaged in the milling process, continually seeking additional information. Once they decided to evacuate, they then took additional time preparing others and themselves for the vertical descent to safety. All WTC occupants delayed evacuation for some period of time, sometimes up to 16 minutes or more, especially in the absence of clear and consistent cues to evacuate.

Implications for Evacuation in the Future

Panic is not an inevitable response to terrorist or disaster incidents; however, the belief that people panic in emergencies has been known to influence decisions about disseminating public warnings. Emergency officials have withheld warnings and messages from the public for fear that event information will cause a panic (Fahy and Proulx 2009; Sheppard et al. 2006; Fischer 1998; Dynes and Quarantelli 1972). This research shows that because individuals are more likely to take significant amounts of time to search for information and decide to leave, and then prepare to leave, emergency messages should be disseminated to the public as early as possible.

Instead of receiving emergency messages over the building-wide public address system in the WTC towers, occupants with perceived responsibilities instructed people for whom they felt responsible to evacuate. There were several reasons why these instructions were effective in influencing individuals to stop sensemaking and milling processes and start taking protective actions, and these reasons provide important implications for emergency communication in buildings. First, consistent with other research (e.g., Connell 2001; Aguirre et al. 1991), this study found that evacuation instructions were successful because they were provided in addition to other, sometimes intense, physical and social cues. Many WTC occupants had already received cues from their environment for which they were seeking confirmation, and the receipt of evacuation instructions provided the evidence necessary for them to believe that something was actually wrong and action needed to be taken. This study, as well as other research of community-wide disasters (Mileti and Sorensen 1990), supports the implication that emergency messages and instructions should be provided via multiple means to alleviate the need for excessive information

seeking. For example, and especially in emergencies that produce an insufficient number of environmental cues, building occupants could be presented with a public announcement, followed by a text message and a phone call, each letting them know that an emergency is taking place. Since evacuation behavior of others was also persuasive in the WTC, announcements could be accompanied with information on whether other building occupants are also responding to the event, for example, via social networking sites or streaming video.

Second, WTC instructions provided important information regarding what to do (evacuate the building), eliminating the need for and the time associated with protective action search and assessment (Stages 3 and 4 in the PADM). These findings are consistent with research stating that emergency messages are more effective when they contain the following information: what people should do (e.g., evacuate), when they need to act, who should be taking action and who should not be taking action (i.e., if a group of people should stay in place, they should be told), and why they need to act (i.e., what is the danger and its consequences to them if they do not act) (Mileti and Sorensen 1990). However, in the WTC, even after receiving evacuation instructions, occupants still took time to perform actions in preparation for their evacuation. Since this research showed that WTC occupants also followed other types of instructions, including instructions to retreat from the windows, gather belongings, and use a particular exit stair, emergency officials can reduce the amount of time spent in the pre-evacuation period by providing other types of instructions as well, including the following: Do not delay, leave immediately, do no prepare, and use [a specific exit], preferably the exit closest to them. This is similar to what passengers on commercial airlines are told before every take-off: if an evacuation is necessary, proceed to the nearest exit (either in front or behind you) and leave all possessions behind (Federal Aviation Administration 2009).

Another reason why instructions to evacuate on 9/11 were effective is because they were provided in person, face-to-face, in a manner that was serious, intense, and fear-producing. What is often the case in buildings, and what was supposed to happen in the WTC towers, is that people receive warnings and instructions over public address systems. Sometimes messages are pre-recorded or provided

by a computer-generated voice, rather than an actual person. In the WTC, evacuation instructions on various floors provided by a live person, face-to-face, using a fast-paced and urgent tone, increased observers' perceptions of risk, and ultimately influenced evacuation response. Guidance and studies on emergency communication (Chandler 2010; Jang 2007; Edworthy, Hellier and Rivers 2003), as well as findings presented here, show that evacuation instructions should be delivered in an urgent tone and, when possible, provided in person. The more the individual provides fearful expressions and intense evacuation movements, such as running to an exit, the more effective the emergency message will be.

Finally, like other guidance on crisis risk communication (Chandler 2010; Mileti and Sorensen 1990), this research suggests that instructions should be given by credible or authoritative sources, for example, managers and fire wardens. This study focused only on an office building setting; therefore, there may be additional social roles, aside from management or fire safety, in other building types that hold credibility or authority for the population. One issue found in the WTC, at least in this study's sample, was that most fire wardens also held roles as company managers on 9/11. Assigning fire safety leadership roles to people who are already predisposed to help may decrease the number of people who actively engage in helping behavior during an emergency, and in turn, increase the amount of time helpers delay before evacuating. One way to remedy this issue is to empower other types of occupants, in addition to managers, to enroll in key fire safety roles. Based on this research, people with previous experiences in disasters or individuals with emergency-related occupations may already hold credibility as emergency experts with the larger population, and as an extension of this research, may be more likely to take interest in fire safety roles.

The WTC findings also shed light on potential improvements to pre-event safety measures, including emergency training. Due to the perpetuation of the panic myth, studies have found that disaster victims have been reluctant to engage in self-protective behavior for fear of encountering uncontrollable, panicked groups of people (Fischer 1989). Some have envisioned drivers exhibiting road rage on evacuation routes or building occupants pushing and trampling others inside the stairs. In addition to the training already in place, occupants' willingness to respond during an emergency may increase if

occupants are provided with additional education on how people actually respond to disasters, terrorist attacks, and building fires. Current emergency training in buildings usually involves an initial video or pamphlet discussing the emergency procedure for the building, the fire wardens (if part of the procedure), and the location of the exits. Additionally, people may or may not engage in regular evacuation drills. Even if they do, they are rarely, if ever, provided with information on how people have responded to emergencies in other buildings in the past. Building emergency training courses can be improved by discussing social responses to emergencies, in essence, providing assurances that occupants are unlikely to panic, and instead are more likely to act altruistically in an emergency.

Taking this one step further, additional occupant training can provide information on consequences that are likely if individuals decide to disregard emergency instructions in various types of events. In the WTC, occupants who had memories of negative experiences with previous emergencies, including the 1993 WTC bombing, were able to mentally envision potential negative consequences associated with the 2001 WTC disaster. These individuals recalled vivid memories of long, congested, smoke-filled evacuations after the bomb detonated in 1993, which they considered likely scenarios if they delayed too long in 2001. Training programs could introduce individuals to the types of negative consequences associated with disasters, creating a stockpile of disaster knowledge and memories to which they can refer during the risk identification and assessment stages in future emergencies.

Additional training would also benefit members of the public at large, who are most likely to be the ones who will rescue and otherwise assist others during a disaster. Although small-scale programs involving community emergency response teams (CERTs) and programs such as Citizen Corps have received some support, federal, state and local-level emergency officials often disregard the knowledge and experience of the public when planning for disasters and other emergencies within the community (Tierney 2003). The same is true for building-wide emergency planning. Since certain building occupants are likely to emerge as leaders, for example managers and fire wardens, they could be involved in more intensive emergency planning and training activities in order to foster their role as first responders and ensure that they protect others as well as themselves in the next emergency.

Finally, the WTC predictive model presents implications for computer evacuation modeling techniques and ways in which models simulate the pre-evacuation period. My research shows that occupant behavior performed during this period cannot be ignored. As mentioned earlier, WTC occupants took significant amounts of time, sometimes longer than 16 minutes, to search for information and decide to leave, and then prepare themselves and others to leave. Also, this research highlights an inadequacy of other current computer modeling methods used to simulate behavior – specifically, the method by which model users, rather than the computer model itself, are required to pre-determine simulated agent actions prior to the start of the model simulation. This research has established that behavior is a function of both pre-event and event (or situational)-based factors. Pre-event factors include roles and experiences that the individual brings to any situation, whereas event-based factors originate from the emergency situation itself, including environmental cues and the cognitions developed by occupants based upon these cues and pre-event factors. Because event-based factors, including perceptions of risk, are key in predicting evacuation decisions and resulting behavior, it is impossible for model users to accurately predict behavior ahead of running the actual computer simulation of the emergency.

What is needed instead is a predictive model of the pre-evacuation period that can be incorporated into current evacuation computer models; so that the computer model itself predicts evacuation behavior. Fortunately, this research moves evacuation modeling one step closer to this goal, in that it demonstrates that occupant behavior during the pre-evacuation period of a building emergency, specifically the 2001 WTC disaster, can be conceptually modeled. The WTC pre-evacuation predictive model, consistent with underlying theory of emergency decision-making (Lindell and Perry 2004), shows that emergency behavior follows specific patterns that can be predicted based upon pre-event and event-based factors. Pre-event conditions and environmental cues were successfully linked to perceptions and cognitions of the situation, which then influenced behaviors performed. The model highlights the importance of risk perception, and the personalization of risk, for the performance of milling and sensemaking actions. My research also demonstrates, as an addition to theory on emergency decision-making, that the performance of specific protective actions also follows patterns that can be predicted

based upon pre-event and situational factors. Probabilities of performing these actions were also identified; however, these probabilities may reflect the specifics of the WTC event. More research is needed to validate these findings from the 2001 WTC disaster in order to generalize this conceptual model to other events. Also, additional research on the timing associated with each pre-evacuation action and the factors that influenced these times are necessary before a conceptual model, such as this one, can be included in a computer evacuation model whose purpose is to predict evacuation timing.

In its current state, however, the WTC pre-evacuation predictive model could be translated into a computer model to predict if and when certain behaviors are performed. Certain computer modeling approaches are better than others for simulating occupant emergency decision-making. Agent-based modeling is one such approach. The agent-based modeling approach represents individual entities, their interactions with one another, and interactions with the environment. This way of linking behavior with computation is an especially valuable way to model theories about processes (Gilbert 2008).

A common modeling approach in agent-based modeling (Gilbert 2008) that would aid in the transition of the predictive model to computer evacuation modeling code is the use of behavioral rules. These rules are essentially "condition-action" or "if, then" rules because they include both the condition that must be true for the rule to be used and a subsequent action component (what action is performed). More appropriate to the pre-evacuation predictive model are nested "if-then" rules that would account for indirect conditions (such as environmental cues and an individuals' social stock of knowledge) that influence perceptions (of the situation and the risk), which then influence the action taken. To develop the "if-then" behavior rules for emergencies, the conceptual model would be required to account for two different types of variables for each individual. The first type is the static attributes, which are historical in nature, in that the simulated individual brings these into an emergency scenario. Static attributes could include social roles, training, and previous experience in emergencies. The second type of attribute is dynamic, or attributes that are situational in nature because they are subject to change based upon the simulated individual's experiences during the model scenario, including risk perception and the number

or trends in environmental cues received over time. Both types of attributes can be tracked by the model throughout the simulated scenario for each occupant.

This research provides only one example of a predictive model for the pre-evacuation period of a building terrorist attack. In order to develop an all-inclusive predictive conceptual model of pre-evacuation, additional studies are required to validate and expand the findings presented here. Studies of others types of events, buildings, and populations may identify additional types of protective actions and factors that influence these actions. For example, it is possible that different populations would find other types of individuals credible, especially since a residential building is not likely to house a group of office managers willing to help them to safety. Who are the types of people willing to emerge and help in other incidents and what is it about them that influences evacuees to follow their instructions? For example, work by Samoshin, Boyce and Shields (2005) has shown that members of staff are likely to help customers evacuate during emergencies in retail stores. What types of previous events will affect evacuation behavior in the next emergency? Even though many of the same factors are likely to remain consistent from one event to another, i.e., the influence of risk perception, previous experience in emergencies, and the intensity of cues, it will be important to validate their importance and identify additional factors when implementing these ideas in a computer evacuation model.

Data from future emergencies can be collected in a variety of different ways, using quantitative or qualitative methods. In particular, more qualitative data are needed from actual fire events. Face-to-face interviews should be collected from building fire survivors to understand their decision-making processes and the reasons they performed specific actions in response to the event. This detailed information can only be captured by qualitative methods. If made available, CCTV or security cameras that record actual fire events should also be used to verify memories of events.

This work begins the long process of developing an all-inclusive, predictive model of the pre-evacuation period for use by computer evacuation models. The inclusion of a model that predicts pre-evacuation actions will increase the computer model's level of accuracy as well as decrease the burden placed on the model users, who currently are required to pre-determine occupant behavior. In addition to

the work presented here and the work required to validate these concepts, additional data are necessary to complete its development. Since the purpose of computer evacuation modeling is to calculate the time spent evacuating a building, a predictive model should be able to predict the amount of time that modeled agents will spend performing each pre-evacuation action. The data used for this research did not focus on the timing of evacuation activities, and therefore there are no times assigned to specific pre-evacuation actions in this research.

There are other resources available that estimate the amount of time spent performing pre-evacuation actions in other emergencies. Empirical studies of actual incidents (Proulx, Reid and Cavan 2004; Fahy and Proulx 2001; Brennan 1997) and evacuation drills (Purser and Kuipers 2004, Gwynne et al. 2003; Shields and Boyce 2000; Purser 1998) provide overall timing estimates for activities in the pre-evacuation period. Additionally, some studies attempt to predict how long people delay before evacuating (Kuligowski and Mileti 2009; Averill et al. 2005; Aguirre, Wenger and Vigo 1998; Sorensen 1991). However, very few researchers discuss times associated with specific pre-evacuation actions (Galea et al. 2010). Pre-evacuation action times were reported by some WTC occupants and are presented in Table 5-1 as a range of times (minutes) for each action.

Action	**Range of timing (minutes)**	**WTC occupant reference (interview numbers)**
Preparation	0.5 to 5	WTC 1: WTC1/027/0001; WTC1/035/0002; WTC1/057/0001; WTC1/059/0002; WTC1/061/0002; WTC1/066/0001; WTC1/071/0008; WTC1/081/0002; WTC1/085/0002 WTC 2: WTC2/032/0001; WTC2/051/0001; WTC2/070/0002; WTC2/080/0001
Information seeking (discussion with others)	3	WTC1/066/0002
Information seeking (looking out the window)	1 to 5	WTC 1: WTC1/062/0001; WTC1/063/0001 WTC 2: WTC2/060/0002; WTC2/066/0001; WTC2/072/0001; WTC2/077/0001; WTC2/104/0001
Helping (by authorities)	4 to 10	WTC 1: WTC1/038/0002 WTC 2: WTC2/011/0001; WTC2/038/0001; WTC2/067/0002; WTC2/071/0003; WTC2/105/0002

Table 5-1: Range of times associated with WTC pre-evacuation actions

Assigning times to specific actions will be a difficult task when implementing this type of behavior model because, for some behaviors, times may be scenario or building-specific. For example,

helping actions performed by occupants in positions of responsibility were almost exclusively dependent on the distance they had to walk around the floors to instruct employees to evacuate. Additionally, the act of preparation includes not only gathering personal items but also walking to an office/cubicle. It is unclear if the reported times included in Table 5-1 include both the time required to perform the act and the time required to travel the floor.

Additional data are also necessary on factors that influence the perception phase of the decision-making process. The perception phase was not part of this research since the data analyzed were face-to-face interviews of respondents' experiences, making it impossible to determine which cues went unnoticed and why. Reviews of previous empirical studies of natural and technological disasters as well as building fires have identified factors that influence hearing, seeing, and smelling cues from the environment (Kuligowski 2009; Mileti et al. 2006; Mileti and Sorensen 1990). These reviews can be used to expand the predictive model developed here.

Final Thoughts

I am a fire protection engineer who went back to school to study sociology six years ago. I returned to student life because I wanted to understand the people I am trying to protect at a more fundamental level. Over the course of seeking my graduate degree, I have learned a great deal about human behavior, and I am forever indebted to disaster survivors all over the world who took time to speak about their personal experiences, especially the WTC survivors who participated in the HEED Project. Their experiences, scrutinized by researchers like me, will aid in the development of improved emergency procedures, technology, and computer models for buildings and communities. In this very important way, I hope that all 9/11 survivors, their families, and families of the deceased know that we will truly never forget what they went through.

I am also an evacuation modeler. I have a personal interest in increasing the accuracy of the evacuation models that I use in almost all of my evacuation research projects. Since I began using the models over 10 years ago, it became apparent that many of them lacked significant capabilities owing to a

lack of understanding of emergency response behavior. By bridging the distance between engineering and social science, I have aimed to fill these gaps and eventually improve the quality and results of computer evacuation models, and in turn, building safety.

As I have learned more and more about human response during emergencies, I am impressed with the altruism that emerges and the improvisation that occurs among strangers and colleagues alike. Important trends in decision-making and evacuation behavior in response to disasters can no longer be ignored by model developers and fire protection engineers. We cannot and should not assume that human behavior is too complicated to understand and predict. Although we are not at the point of incorporating an all-inclusive predictive model into our evacuation calculation techniques, we are getting closer. Engineers can help to disseminate these findings, first by understanding, and second by restating that people are unlikely to panic in fire emergencies, on one hand, and unlikely to respond with optimistic efficiency, on the other. We have a job to do, as a field, to accurately account for human behavior in our building codes, evacuation procedures, and calculation techniques. We have the evidence to do so. We just need to take the next step.

Chapter 6 – Works Cited

Aguirre, Benigno E. 1991. "Evacuation in Cancun During Hurricane Gilbert." *International Journal of Mass Emergencies and Disasters* 9(1): 31-45.

Aguirre, Benigno E., Dennis Wenger, and Gabriela Vigo. 1998. "A Test of the Emergent Norm Theory of Collective Behavior." *Sociological Forum* 13(2): 301-320.

Aguirre, Benigno E., Walter A. Anderson, Sam Balandran, Brian E. Peters, and H. Max White. 1991. *Saragosa, Texas, Tornado, May 22, 1987: An evaluation of the warning system*. Washington, DC: National Academy Press.

Altheide, David L. and John M. Johnson. 1994. "Criteria for Assessing Interpretive Validity in Qualitative Research." Pp. 485-499 in *Handbook of Qualitative Research*, edited by N.K. Denzin and S. Guba. Newbury Park, CA: Sage.

ASME. 2010. *A17.1 – 2010/CSA B44-10 Safety Code for Elevators and Escalators*. New York: American Society of Mechanical Engineers.

Averill, Jason D., Dennis S. Mileti, Richard D. Peacock, Erica D. Kuligowski, Norman Groner, Guylene Proulx, Paul A. Reneke and Harold E. Nelson. 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Occupant behavior, egress, and emergency communications*. Report NCSTAR 1-7. Gaithersburg, MD: National Institute of Standards and Technology. (Also available at http://wtc.nist.gov/NISTNCSTAR1-7.pdf).

Ben Zur, Hasida and Shlomo J. Breznitz. 1981. "The Effect of Time Pressure on Risky Choice Behavior." *Acta Psychologica* 47(2): 89-104.

Berger, Peter L. and Thomas Luckmann. 1966. *The Social Construction of Reality: A treatise in the sociology of knowledge*. Garden City, New York: Anchor Books.

Best, R. L. 1977. *Reconstruction of a Tragedy: The Beverly Hills Supper Club Fire*. Quincy, MA: National Fire Protection Association.

Blumer, Herbert. 1969. *Symbolic Interactionism: Perspective and method*. Berkley, CA: University of California Press.

Bourque, Linda and Lisa A. Russell. 1994. *Experiences During and Responses to the Loma Prieta Earthquake*. Sacramento, CA: Governor's Office of Emergency Services.

Bourque, Linda B., Kimberley I. Shoaf, and Loc H. Nguyen. 1997. "Survey Research." *International Journal of Mass Emergencies and Disasters* 15(1): 71-101.

Brennan, Patricia. 1997. "Timing Response in Real Fires." Pp. 807-818 in *Fire Safety Science – Proceedings of the Fifth International Symposium*, edited by Y Hasemi. London, England: Interscience Communications Ltd.

Brennan, Patricia. 1996. “Impact of Social Interaction on Time to Begin Evacuation in Office Building Fires: Implications for modelling behaviour.” Pp. 701-710 in *Interflam '96. International Interflam Conference, 7th Proceedings*, edited by C. A. Franks and S. Grayson. London, UK: Interscience Communications Ltd.

Brennan, Patricia. 1995. “Smoke Gets in Your Eyes: The effect of cue perception on behaviour in smoke.” Pp. 187-197 in *ASIAFLAM ’95. International Conference on Fire Science and Engineering 1st Proceedings*, edited by W. K. Chow. London, UK: Interscience Communications Ltd.

Brown, Roger and James Kulik. 1977. “Flashbulb Memories.” *Cognition* 5(1): 73-99.

Brown, Thomas M. and Charles E. Miller. 2000. “Communication Networks in Task-Performing Groups: Effects of task complexity, time pressure, and interpersonal dominance.” *Small Group Research* 31(2): 131-157.

Bryan, John L. 2002. “Behavioral Response to Fire and Smoke.” Pp. 3-315 – 3-341 in *The SFPE Handbook of Fire Protection Engineering Third Edition*, edited by P.J. DiNenno. Quincy, MA: National Fire Protection Association.

Bryan, John L. 1983. *An Examination and Analysis of the Dynamics of the Human Behavior in the MGM Grand Hotel Fire*. Quincy, MA: National Fire Protection Association.

Bryan, John L. 1977. *Smoke as a Determinant of Human Behavior in Fire Situations*. College Park, MD: University of Maryland, College Park.

Bulmer, Martin. 1979. “Concepts in the Analysis of Qualitative Data.” *Sociological Review* 27(4): 651-677.

Burkhart, Ford N. 1991. *Media, Emergency Warnings, and Citizen Response*. Boulder, CO: Westview Press.

Burns, Kevin. 2005. “Mental Models and Normal Errors.” Pp. 15-28 in *How Professionals Make Decisions*, edited by H. Montgomery, R. Lipshitz and B. Brehmer. Mahwah, NJ: Erlbaum Associates.

Canter, David. 1980. *Fires and Human Behaviour*. New York, NY: John Wiley & Sons.

Canter, David, John Breaux and Jonathan Sime. 1980. “Domestic, Multiple Occupancy and Hospital Fires.” Pp. 117-136 in *Fires and Human Behaviour*, edited by David Canter. New York, NY: John Wiley & Sons.

Canter, David, Ian Donald, and Judith Chalk. 1992. “Pedestrian Behaviour during Emergencies Underground: The psychology of crowd control under life threatening circumstances.” Pp. 135-150 in *Safety in Road and Rail Tunnels*, edited by A. Vardy. Bedford: Independent Technical Conferences Ltd.

Chaiken, Shelly. 1987. “The Heuristic Model of Persuasion.” Pp. 3-39 in *Social Influence: Ontario Symposium*, edited by M. P. Zanna, J. M. Olson and C. P. Herman. Hillsdale, NJ: Lawrence Erlbaum Associates.

Chalk, Peter, Bruce Hoffman, Robert Reville, and Anna-Britt Kasupski. 2005. *Trends in Terrorism: Threats to the United States and the Future of the Terrorism Risk Insurance Act*. Santa Monica, CA: RAND Corporation.

Chandler, Robert. 2010. *Emergency Notification*. Santa Barbara, CA: Praeger.

Cohen, Hillel W., Robert M. Gould, and Victor W. Sidel. 2004. "The Pitfalls of Bioterrorism Preparedness: The anthrax and smallpox experiences." *American Journal of Public Health* 94(10): 1667-1671.

Connell, Rory. 2001. *Collective Behavior in the September 11, 2001 Evacuation of the World Trade Center*. Preliminary Paper #313. Newark, DE: University of Delaware Disaster Research Center.

Cutter, Susan and Kent Barnes. 1982. "Evacuation Behavior and Three Mile Island." *Disasters* 6(2): 116-124.

Dash, Nicole and Hugh Gladwin. 2007. "Evacuation Decision Making and Behavioral Responses: Individual and household." *Natural Hazards Review* 8(3): 69-77.

DeJoy, David M. 1999. "Attitudes and Beliefs." Pp. 189-219 in *Warnings and Risk Communication*, edited by M.S. Wogalter and D.M. DeJoy. London: Taylor and Francis.

Denzin, Norman K. 1970. *The Research Act.* Chicago, IL: Aldine.

Denzin, Norman K. and Yvonna S. Lincoln. 2005. "Introduction: The discipline and practice of qualitative research." Pp. 1-32 in *Handbook of qualitative research* (2nd), edited by N.K. Denzin and Y.S. Lincoln. Thousand Oaks: Sage.

Diggory, James C. 1956. "Some Consequences of Proximity to a Disease Threat." *Sociometry* 19(1): 47-53.

Dishman, Chris. 1999. "Trends in Modern Terrorism: Review article." *Studies in Conflict and Terrorism* 22(4): 357-362.

Drabek, Thomas E. 1997. "Following Some Dreams: Recognizing opportunities, posing interesting questions, and implementing alternative methods." *International Journal for Mass Emergencies and Disaster* 15(1): 21-46.

Drabek, Thomas E. 1994. "Risk Perceptions of Tourist Business Managers." *Environmental Professional* 16: 327-341.

Drabek, Thomas E. 1986. *Human System Responses to Disaster: An inventory of sociological findings.* New York, NY: Springer-Verlag.

Drabek, Thomas E. 1969. "Social Processes in Disaster: Family evacuation." *Social Problems* 16(3): 336-349.

Drabek, Thomas E. 1968. *Disaster in Aisle 13*. Columbus, OH: Ohio State University, College of Administrative Science.

Drabek, Thomas E. and Keith Boggs. 1968. "Families in Disaster: Reactions and relatives." *Journal of Marriage and the Family* 30: 443-451.

Drabek, Thomas and John S. Stephenson, III. 1971. "When Disaster Strikes." *Journal of Applied Social Psychology* 1(2): 187-203.

Dynes, Russell R. 1968. *The Functioning of Expanding Organizations in Community Disasters*. Report Series #2. Newark, DE: Disaster Research Center.

Dynes, Russell R. and Enrico L. Quarantelli. 1980. "Helping Behavior in Large-Scale Disasters." Pp. 339-54 in *Participation in Social and Political Activities*, edited by D.H. Smith, J. Macaulay, and Associates. San Francisco, CA: Jossey-Bass Publishers.

Dynes, Russell R. and Enrico L. Quarantelli. 1977. *Helping Behavior in Large Scale Disasters: A social organizational approach*. Preliminary Paper #48. Newark, DE: Disaster Research Center.

Dynes, Russell R. and Enrico L. Quarantelli. 1975. *The Role of Local Civil Defense in Disaster Planning*. Report Series #16. Newark, DE: Disaster Research Center.

Edelman, Perry, Elicia Herz, and Leonard Bickman. 1980. "A Model of Behaviour in Fires Applied to a Nursing Home Fire." Pp. 181-203 in *Fires and Human Behaviour*, edited by D. Canter. New York, NY: John Wiley & Sons.

Edworthy, Judy, Elizabeth Hellier, and J. Rivers. 2003. "The Use of Male or Female Voices in Warnings Systems: A question of acoustics." *Noise Health* 6(21): 39-50.

Elder, Keith, Sudha Xirasagar, Nancy Miller, Shelly Ann Bowen, Saundra Glover, and Crystal Piper. 2007. "African Americans' Decisions Not to Evacuate New Orleans before Hurricane Katrina: A qualitative study." *American Journal of Public Health* 97(1): S124–S129.

Enarson, Elaine, and Betty Hearn Morrow. 1997. "A Gendered Perspective: The voices of women." Pp. 116-140 in *Hurricane Andrew: Ethnicity, gender, and the sociology of disasters*, edited by W. G. Peacock, B. H. Morrow, and H. Gladwin. New York, NY: Routledge.

Enarson, Elaine and Joseph Scanlon. 1999. "Gender Patterns in Flood Evacuation: A case study of couples in Canada's Red River Valley." *Applied Behavioral Science Review* 7(2): 103-124.

Epley, Nicholas and Thomas Gilovich. 2006. "The Anchoring-and-Adjustment Heuristic: Why the adjustments are insufficient" *Psychological Science* 17(4): 311-318.

Fahy, Rita F. and Guylene Proulx. 2009. "Panic and Human Behaviour in Fire." Pp. 387-398 in *Proceedings of the 4th International Symposium on Human Behaviour in Fire*. London, UK: Interscience Communications Ltd.

Fahy, Rita F. and Guylene Proulx. 2001. "Toward Creating a Database on Delay Times to Start Evacuation and Walking Speeds for Use in Evacuation Modeling." Pp. 175-183 in *2nd International Symposium on Human Behaviour in Fire*. London, UK: Interscience Communications Ltd.

Fahy, Rita F. and Guylene Proulx. 1997. “Human Behavior in the World Trade Center Evacuation.” Pp. 713-724 in *Fire Safety Science -- Proceedings of the Fifth International Symposium*, edited by Y. Hasemi. London, UK: Interscience Communications Ltd.

Federal Aviation Administration. 2009. “Safety Information.” Retrieved February 1, 2011 (http://www.faa.gov/passengers/fly_safe/information/).

Fischer, Henry W., III. 1998. *Response to Disaster: Fact versus fiction and its perpetuation: The sociology of disaster* (2nd ed.). New York, NY: University Press of America.

Fischer, Henry W., III. 1989. *Hurricane Gilbert: The Media's Creation of the Storm of the Century During September 1988*. Boulder, Colorado: The Natural Research and Applications Center, The University of Colorado.

Fischer, Henry W., III, George F. Stine, Brenda L. Stoker, Marna L. Trowbridge, and Eric M. Drain. 1995. “Evacuation Behavior: Why do some evacuate while others do not? A Case Study of the Ephrata, Pennsylvania (USA) Evacuation.” *Disaster Prevention and Management* 4(4): 30-36.

Fitzpatrick, Colleen, and Dennis S. Mileti. 1991. “Motivating Public Evacuation.” *International Journal of Mass Emergencies and Disasters* 9(2): 137-152.

Fitzpatrick, Colleen and Dennis S. Mileti. 1990. “Perception and Response to Aftershock Warnings During the Emergency Period.” Pp. 75-83 in *The Loma Prieta Earthquake: Studies of Short-Term Impacts*, Monograph No. 50, edited by R. Bolin. Boulder, CO: University of Colorado, Institute of Behavioral Science, Natural Hazards Research and Applications Information Center.

Flynn, Cynthia B. 1979. *Three Mile Island Telephone Survey*. Report No. NUREG/CR-1093. Washington, DC: Nuclear Regulatory Commission.

Flynn, James, Paul Slovic, and C.K. Mertz. 1993. “The Nevada Initiative: A risk communication fiasco.” *Risk Analysis* 13(5): 497-508.

Fordham, Maureen H. 1998. “Making Women Visible in Disasters: Problematising the private domain.” *The Journal of Disaster Studies, Policy and Management* 22(2): 126-143.

Fothergill, Alice. 1998. “The Neglect of Gender in Disaster Work: An overview of the literature.” Pp.11-25 in *The Gendered Terrain of Disaster Through Women’s Eyes*, edited by E. Enarson and B.H. Morrow. Westport, CT: Praeger Publishers.

Friedsam, H. J. 1961. “Reactions of Older Persons to Disaster-Caused Losses: A hypothesis of relative deprivation.” *Gerontologist* 1: 34-37.

Fritz, Charles E. 1961. “Disasters.” Pp. 651-694 in *Contemporary Social Problems*, edited by R. K. Merton and R. A. Nisbet. New York, NY: Harcourt.

Fritz, Charles E. and Eli Marks. 1954. “The NORC Studies of Human Behavior in Disaster.” *Journal of Social Issues* 10(3): 26-41.

Galea, Edwin R., Steven Deere, Gary Sharp, Lazaros Filippidis, and Lynn Hulse. 2010. "Investigating the Impact of Culture on Evacuation Behaviour." Pp. 879-892 in *The Proceedings of the 12th International Fire Science and Engineering Conference, Interflam 2010*. London, UK: Interscience Communications Ltd.

Galea, Edwin R., Lynn Hulse, Rachel Day, Asim Siddiqui, and Gary Sharp. 2009. "The UK WTC 9/11 Evacuation Study: An overview of the methodologies employed and some analysis relating to fatigue, stair travel speeds and occupant response times." Pp. 27-40 in *The Proceedings of the 4th International Symposium on Human Behaviour in Fire*. London, UK: Interscience Communications Ltd.

Galea, E.R., J. Shields, D. Canter, K. Boyce, R. Day, L. Hulse, A. Siddiqui, L. Summerfield, M. Marselle, P. Greenall. 2006. "Methodologies Employed in the Collection, Retrieval and Storage of Human Factors Information Derived from First Hand Accounts of Survivors of the WTC Disaster of 11 September 2001." *Journal of Applied Fire Science* 15(4): 253-276 (published in Nov 2008).

Galea, E.R., J. Shields, D. Canter, K. Boyce, R. Day, L. Hulse, A. Siddiqui, L. Summerfield, M. Marselle, P.V. Greenall. 2007. "The UK WTC 9/11 Evacuation Study: Methodologies used in the elicitation and storage of human factors data." Pp. 169-181 in *Proceedings of the 11th International Fire Science and Engineering Conference, Interflam 2007*. London, UK: Interscience Communications Ltd.

Gearson, John. 2002. "The Nature of Modern Terrorism" Pp. 7-24 in *Superterrorism: Policy Responses*, edited by Lawrence Freedman. Malden, MA: Blackwell Publishing.

Gershon, Robyn R.M., Marcie S. Rubin, Kristine A. Qureshi, Allison N. Canton, Frederick J. Matzner. 2008. "Participatory Action Research Methodology in Disaster Research: Results from the World Trade Center evacuation study." *Disaster Medicine and Public Health Preparedness* 2(3): 142-149.

Gershon, Robyn R.M., Kristine A. Qureshi, Marcie S. Rubin, and Victoria H. Raveis. 2007. "Factors Associated with High-Rise Evacuation: Qualitative results from the World Trade Center evacuation study." *Prehospital and Disaster Medicine* 22(3): 165-173.

Gigerenzer, Gerd and Reinhard Selten. 2001. *Bounded Rationality: The adaptive toolbox*. Cambridge, MA: The MIT Press.

Gilbert, Nigel. 2008. *Agent-Based Models*. Thousand Oaks, CA: Sage Publications.

Gioia, Dennis A. and Peter P. Poole. 1984. "Scripts in Organizational Behavior." *Academy of Management Review* 9(3): 449-459.

Gladwin, Christina H. 1989. *Ethnographic Decision Tree Modeling*. Newbury Park, CA: Sage.

Glaser, Barney G. and Anselm L. Strauss. 1967. *The Discovery of Grounded Theory: Strategies for qualitative research*. Hawthorne, NY: Aldine De Gruyter.

Goffman, Erving. 1963. *Stigma: Notes on the management of a spoiled identity*. New York, NY: Simon and Schuster.

Goldman, Jonathan. 1980. *The Empire State Building Book*. New York, NY: St. Martin's Press.

Goodall, H. Lloyd 2000. *Writing the New Ethnography*. Lanham, MD: AltaMira Press.

Greene, Marjorie R., Ronald W. Perry, and Michael K. Lindell. 1981. "The March 1980 eruptions of Mt. St. Helens: Citizen perceptions of volcano hazard." *Disasters* 5(1): 49-66.

Groner, Norman. 2009. "A Situation Awareness Analysis for the Use of Elevators During Fire Emergencies." Pp. 61-72 in *4th International Symposium on Human Behavior in Fire: Conference Proceedings*. London, UK: Interscience Communications.

Grosshandler, William, Nelson Bryner, Daniel Madrzykowski, and Kenneth Kuntz. 2005. *Report of the Technical Investigation of The Station Nightclub Fire*. Report NCSTAR 2: Vol. 1. Gaithersburg, MD: National Institute of Standards and Technology.

Gwynne, S., E.R. Galea, J. Parke, and J. Hickson. 2003. "The Collection and Analysis of Pre-evacuation Times from Evacuation Trials and their Application to Evacuation Modeling." *Fire Technology* 39(2): 173-195.

Hall, John R. 2004. "How Many People Can Be Saved from Home Fires if Given More Time to Escape?" *Fire Technology* 40(2): 117-126.

Hammersely, Martyn and Paul Atkinson. 1995 *Ethnography: Principles in Practice*, 2nd edition, London: Routledge.

HEED. 2009. "WTC Evacuation Study." Retrieved July 26, 2009 (*http://fseg2.gre.ac.uk/HEED/index.html*).

Hellier, Elizabeth, Ben Weedon, Austin Adams, Judy Edworthy, and Kathryn Walters. 1999. "Hazard Perceptions of Spoken Signal Words." Pp. 158-162 in *Contemporary Ergonomics 1999*, edited by M. Hanson, E. J. Lovesey, S. A. Robertson. London, UK: Taylor & Francis.

Helweg-Larsen, Marie and James A. Shepperd. 2001. "Do Moderators of the Optimistic Bias Affect Personal or Target Risk Estimates? A Review of the Literature." *Personality and Social Psychology Review* 5(1): 74-95.

Hermann, Charles F. 1963. "Some Consequences of Crisis which Limit the Viability of Organizations." *Administrative Science Quarterly* 8(1): 61-82.

Heyes, Emma and Michael Spearpoint. 2009. "Lifts for Evacuation – Human Behaviour Considerations." Pp. 73-84 in *Proceedings from the 4th International Symposium on Human Behaviour in Fire*. London, UK: Interscience Communications Ltd.

Hoffman, Susanna M. 1993. "Up from the Embers: The Aftermath of the Oakland Berkeley Firestorm: A survivor's anthropologist's perspective." Paper presented at the Society for Applied Anthropology Annual Meeting, San Antonio.

Horiuchi, S., Y. Murozaki, and A. Hokugo. 1986. "A Case Study of Fire and Evacuation in a Multi-Purpose Office Building, Osaka, Japan." Pp. 523-532 in *Fire Safety Science -- Proceedings of the First International Symposium*, edited by C. Grant and P. Pagni. Washington, DC: Hemisphere Publishing Corp.

Hovland, Carl I., Irving L. Janis, and Harold H. Kelley. 1953. *Communication and Persuasion: Psychological studies in opinion change*. New Haven, CT: Yale University Press.

Hulse, Lynn and Rachel Day. 2010. Email message to author, September 17.

Isner, Michael S. and Thomas J. Klem. 1993. *World Trade Center Explosion and Fire, New York, New York, February 26, 1993. Fire Investigation Report.* Quincy, MA: National Fire Protection Association.

Jang, Phil-Sik. 2007. "Designing Acoustic and Non-acoustic Parameters of Synthesized Speech Warnings to Control Perceived Urgency." *International Journal of Industrial Ergonomics* 37(3): 213-223.

Janis, Irving L. 1982. "Decision Making Under Stress." Pp. 69-87 in *Handbook of Stress: Theoretical and clinical aspects*, edited by L. Goldberger and S. Breznitz. New York, NY: The Free Press.

Janis, Irving L. and Leon Mann. 1977. *Decision Making: A psychological analysis of conflict, choice, and commitment*. New York, NY: Free Press.

Johnson, Norris R., William E. Feinberg, Drue M. Johnston. 1994. "Microstructure and Panic: The impact of social bonds on individual action in collective flight from The Beverly Hills Supper Club Fire." Pp. 168-189 in *Disaster, Collective Behavior And Social Organization*, edited by R. Dynes and K. Tierney. Newark, NJ: University of Delaware Press.

Kahneman, Daniel, Paul Slovic, and Amos Tversky. 1982. *Judgment Under Uncertainty: Heuristics and biases*. New York, NY: Cambridge University Press.

Karau, Steven J. and Janice R. Kelly. 1992. "The Effects of Time Scarcity and Time Abundance on Group Performance Quality and Interaction Process." *Journal of Experimental Social Psychology* 28(6): 542-571.

Karter, Michael J., Jr. 2010. *Fire Loss in the United States During 2009*. National Fire Protection Association Report. Quincy, MA: National Fire Protection Association.

Katz, Jack. 1983. "A Theory of Qualitative Methodology: The social system of analytic fieldwork." Pp. 127-148 in *Contemporary Field Research: A collection of readings*, edited by R. M. Emerson. Prospect Heights, IL: Waveland Press, Inc.

Keating, John P. and Elizabeth Loftus. 1984. *Post Fire Interviews: Development and field validation of the Behavioral Sequence Interview Technique*. NBSIR 84-477. Gaithersburg, MD: National Bureau of Standards.

Keel, Robert O. 1999. "Ethnomethodological Perspective (on Crime and Deviance)" Pp. 148-152 in *Encyclopedia of Criminology and Deviance*, edited by C. Bryant. New York, NY: Taylor and Francis.

Ketteridge, Anne-Michelle and Maureen Fordham. 1998. "Flood Evacuation in Two Communities in Scotland: Lessons from European research." *International Journal of Mass Emergencies and Disasters* 16(2): 119-144.

Klein, Gary. 1999. *Sources of Power: How people make decisions*. Cambridge, MA: The MIT Press.

Kuligowski, Erica. 2009. "The Process of Human Behavior in Fires." Pp. 627-632 in *Proceedings from the 4th International Symposium on Human Behaviour in Fire*. London, UK: Interscience Communications Ltd.

Kuligowski, Erica D. and Dennis S. Mileti. 2009. "Modeling Pre-evacuation Delay by Occupants in World Trade Center Towers 1 and 2 on September 11, 2001." *Fire Safety Journal* 44(4): 487-496.

Kuligowski, Erica D., Richard D. Peacock, and Bryan L. Hoskins. 2010. *A Review of Building Evacuation Models, 2nd Edition*. NIST Technical Note 1680. Gaithersburg, MD: National Institute of Standards and Technology.

Kunreuther, Howard. 2002. "Risk Analysis and Risk Management in an Uncertain World." *Risk Analysis* 22(4): 655-664.

Kunreuther, Howard. 1991. *A Conceptual Framework for Managing Low Probability Events*. Philadelphia, PA: Center for Risk and Decision Processes, University of Pennsylvania.

Kunreuther, Howard, Robert Meyer, Richard Zeckhauser, Paul Slovic, Barry Schwartz, Christian Schade, Mary Frances Luce, Steven Lippman, David Krantz, Barbara Kahn, Robin Hogarth. 2002. "High Stakes Decision Making: Normative, descriptive and prescriptive considerations." *Marketing Letters* 13(3): 259-268.

Kupperman, Robert H. and Darrell M. Trent. 1979. *Terrorism: Threat, reality, response*. Stanford, CT: Hoover Institution Publication.

Latane, Bibb and John M. Darley. 1970. *The Unresponsive Bystander: Why doesn't he help?* New York, NY: Appleton-Century Crofts.

Laqueur, Walter. 1996. "Postmodern Terrorism." *Foreign Affairs* 75(5): 24–36.

Levin, B. M. 1984. *Human Behavior in Fire: What we know now*. Report No. SFPE TR 84-03. Gaithersburg, MD: National Bureau of Standards.

Levin, B. M. and Norman Groner. 1994. *Human Factors Considerations for the Potential Use of Elevators for Fire Evacuation of FAA Air Traffic Control Towers*. NIST-GCR-94-656, Gaithersburg, MD: National Institute of Standards and Technology.

Lichtenstein, Sarah, Paul Slovic, Baruch Fischoff, Mark Layman, and Barbara Combs. 1978. "Judged Frequency of Lethal Events." *Journal of Experiment Psychology: Human Learning and Memory* 4(6): 551-578.

Lindell, Michael K., and Ronald W. Perry. 2004. *Communicating Environmental Risk in Multiethnic Communities*. Thousand Oaks, CA: Sage Publications.

Lindell, Michael K. and Ronald W. Perry. 1992. *Behavioral Foundations of Community Emergency Planning*. Washington, DC: Hemisphere.

Lindell, Michael K., Jing-Chein Lu, and Carla S. Prater. 2005. "Household Decision Making and Evacuation in Response to Hurricane Lili." *Natural Hazards Review* 6(4): 171-179.

Lindell, Michael K., Ronald W. Perry, and Marjorie R. Greene. 1983. "Individual Response to Emergency Preparedness Planning near Mt. St. Helens." *Disaster Management* 3(Jan/March): 5-11.

Loftus, Elizabeth F. 2003. "Make-Believe Memories." *American Psychologist* November: 867-873.

Loftus, Elizabeth F. 2002. *Memory Faults and Fixes*. Issues in Science & Technology. National Academies of Science publication. Washington, DC: National Academies.

Loftus, Elizabeth F. 1997. "Creating False Memories." *Scientific American* 277: 70-75.

Loftus, Elizabeth F. and Hunter G. Hoffman. 1989. "Misinformation and Memory: The creation of new memories." *Journal of Experimental Psychology: General*, 118(1): 100-104.

Lowe, Seana and Alice Fothergill. 2003. "A Need to Help: Emergent volunteer behavior after September 11th" Pp. 293-314 in *Beyond September 11th: An Account of Post-Disaster Research*. Boulder, CO: Natural Hazards Research and Applications Information Center, University of Colorado.

Mack, Raymond W. and George W. Baker. 1961. *The Occasion Instant: The structure of social responses to repeated air raid warnings*. National Research Council, Washington, DC: National Academy of Sciences.

Marks, Eli S. and Charles E. Fritz. 1954. *Human Reactions in Disaster Situations*. Unpublished Manuscript, Volume 3. Chicago, IL: National Opinion Research Center, University of Chicago.

Maxwell, Joseph A. 2005. *Qualitative Research Design: An interactive approach*. Thousand Oaks, CA: Sage Publications.

Maxwell, Joseph A. 2004. "Causal Explanation, Qualitative Research, and Scientific Inquiry in Education." *Educational Researcher* 33(2): 3-11.

Maxwell, Joseph A. and Diane M. Loomis. 2002. "Mixed Methods Design: An alternative approach." Pp. 241-271 in *Handbook of Mixed Methods in Social and Behavioral Research*, edited by A. Tashakkori and C. Teddlie. Thousand Oaks, CA: Sage.

McConnell, N.C., K.E. Boyce, J. Shields, E.R. Galea, R.C. Day, and L.M. Hulse. 2010. "The UK 9/11 Evacuation Study: Analysis of survivors' recognition and response phase in WTC1." *Fire Safety Journal* 45(1): 21-34.

McGuire, William J. 1985. "The Nature of Attitudes and Attitude Change." Pp. 233-256 in *Handbook of Social Psychology*, edited by G. Lindzey and F. Arsonson. New York, NY: Random House.

McPhail, Clark. 1991. *The Myth of the Madding Crowd*. New York, NY: Walter de Gruyter, Inc.

Mead, George Herbert. 1938. *The Philosophy of the Act*. Edited by C.W. Morris with J.M. Brewster, A.M. Dunham, & D. Miller. Chicago, IL: University of Chicago.

Mead, George Herbert. [1934] 1967. *Mind, Self, & Society from the Standpoint of a Social Behaviorist.* Edited by C.W. Morris. Chicago, IL: The University of Chicago Press.

Merton, Robert K. 1968. *Social Theory and Social Structure*. New York, NY: The Free Press.

Michel, Lacie M. 2007. "Personal Responsibility and Volunteering after a Natural Disaster: The case of Hurricane Katrina." *Sociological Spectrum* 27(6): 633-652.

Miles, Matthew B. and A. Michael Huberman. 1984. *Qualitative Data Analysis: A sourcebook of new methods*. Beverly Hills, CA: Sage.

Mileti, Dennis S. 1993. "Communicating Public Earthquake Risk Information." In *Prediction and Perception of Natural Hazards*, edited by J. Nemec, J. M. Nigg and F. Siccardi. The Netherlands: Kluwer Academic Publishers.

Mileti, Dennis S. 1975. *Natural Hazard Warning Systems in the United States: A research assessment*. Program on Technology, Environment and Man. Boulder, CO: Institute of Behavioral Sciences, University of Colorado.

Mileti, Dennis S. 1974. *A Normative Causal Model Analysis of Disaster Warning Response*. Boulder, CO: University of Colorado Department of Sociology.

Mileti, Dennis S. and E. M. Beck. 1975. "Communication in Crisis: Explaining evacuation symbolically." *Communication Research* 2(1): 24-49.

Mileti, Dennis S. and Joanne DeRouen Darlington. 1997. "The Role of Searching in Shaping Reactions to Earthquake Risk Information." *Social Problems* 44(1): 89-103.

Mileti, Dennis S. and Colleen Fitzpatrick. 1993. *Great Earthquake Experiment: Risk communication and public action.* Boulder, CO: Westview Press.

Mileti, Dennis S. and Colleen Fitzpatrick. 1992. "Causal Sequence of Risk Communication in the Parkfield Earthquake Prediction Experiment." *Risk Analysis* 12(3): 393-400.

Mileti, Dennis S. and Paul W. O'Brien. 1993. "Public Response to Aftershock Warnings." Washington, DC: Geological Survey, U.S. Department of the Interior.

Mileti, Dennis S. and Paul W. O'Brien. 1992. "Warnings during Disasters: Normalizing communicated risk." *Social Problems* 39(1): 40-57.

Mileti, Dennis S. and Lori Peek. 2001. "Hazards and Sustainable Development in the United States." *Risk Management: An International Journal* 3(1): 61-70.

Mileti, Dennis S. and John H. Sorensen. 1990. *Communication of Emergency Public Warnings: A social science perspective and state-of-the-art assessment*. ORNL-6609. Oak Ridge, TN: Oak Ridge National Laboratory, U.S. Department of Energy.

Mileti, Dennis S. and John H. Sorensen. 1988. "Planning and Implementing Warning Systems." Pp. 321-345 in *Mental Health Response to Mass Emergencies*, edited by M. Lystad. New York, NY: Bunner/Mazel.

Mileti, Dennis S., Thomas E. Drabek, and J. Eugene Haas. 1975. *Human Systems in Extreme Environments: A sociological perspective.* Boulder, CO: Institute of Behavioral Science, University of Colorado.

Mileti, Dennis S., Rachel Bandy, Linda B. Bourque, Aaron Johnson, Megumi Kano, Lori Peek, Jeannette Sutton, and Michele Wood. 2006. "Annotated Bibliography for Public Risk Communication on Warnings for Public Protective Actions Response and Public Education," http://www.colorado.edu/hazards/publications/informer/infrmr2/pubhazbibann.pdf.

Morrow, Betty H. and Elaine Enarson. 1996. "Hurricane Andrew through Women's Eyes: Issues and recommendations." *International Journal of Mass Emergencies and Disasters* 14(1): 1-22.

Nelson, L. D. 1973. "Proximity to Emergency and Helping Behavior: Data from the Lubbock Tornado Disaster." *Nonprofit and Voluntary Sector Quarterly* 2(4): 194-199.

Nigg, Joanne M. 1987. "Communication and Behavior: Organizational and individual response to warnings." Pp. 103-117 in *Sociology of Disasters*, edited by R. R. Dynes, B. DeMarchi, and C. Pelanda. Milan, Italy: Franco Angeli Libri.

Nilsson, Daniel and Anders Johnansson. 2009. "Social Influence during the Initial Phase of a Fire Evacuation – Analysis of Evacuation Experiments in a Cinema Theatre." *Fire Safety Journal* 44(1): 71-79.

O'Brien, Paul W. and Patricia Atchison. 1998. "Gender Differentiation and Aftershock Warning Response." Pp. 173-180 in *The Gendered Terrain of Disaster: Through Women's Eyes*, edited by E. Enarson and B. H. Morrow. Westport, CT: Greenwood Publishing Group.

Okabe, Keizo, and Shunji Mikami. 1982. "A Study on the Socio-Psychological Effect of a False Warning of the Tokai Earthquake in Japan." A Paper presented at the Tenth World Congress of Sociology, Mexico City, Mexico.

Omer, Haim and Nahman Alon. 1994. "The Continuity Principle: A unified approach to disaster and trauma." *American Journal of Community Psychology* 22(2): 273-287.

Parsons, Talcott. 1951. *The Social System*. New York, NY: The Free Press.

Peacock, Walter G., Betty H. Morrow, and Hugh Gladwin. 1997. *Hurricane Andrew: Ethnicity, gender, and the sociology of disasters*. London: Routledge.

Peguero, Anthony A. 2006. "Latino Disaster Vulnerability: The dissemination of hurricane mitigation information among Florida's homeowners." *Hispanic Journal of Behavioral Sciences* 28(1): 5-22.

Perry, Ronald W. 1979. "Evacuation Decision-Making in Natural Disasters." *Mass Emergencies* 4(March): 25-38.

Perry, Ronald W. and Marjorie R. Greene. 1982. "The Role of Ethnicity in the Emergency Decision-Making Process." *Sociological Inquiry* 52(4): 306-334.

Perry, Ronald W. and Michael K. Lindell. 1986. *Twentieth-Century Volcanicity at Mt. St. Helens: The routinization of life near an active volcano*. Tempe, AZ: School of Public Affairs, Arizona State University.

Perry, Ronald W. and Lisa S. Nelson. 1991. "Ethnicity and Hazard Information Dissemination." *Environmental Management* 15(4): 581-587.

Perry, Ronald W., Michael K. Lindell, and Marjorie R. Greene. 1981. *Evacuation Planning in Emergency Management*. Lexington, MA: Lexington Books.

Peterson, Camerson R. and Lee R. Beach. 1967. "Man as an Intuitive Statistician." *Psychological Bulletin* 68(1): 29-46.

Phillips, Brenda D. 1997. "Qualitative Methods and Disaster Research." *International Journal for Mass Emergencies and Disaster* 15(1): 179-195.

Ponting, J. Rick and Enrico L. Quarantelli. 1973. *Some Observations on Organized Response to the Snowstorm in Columbia, South Carolina, February 9, 1973*. Working Paper #49. Columbus, OH: Disaster Research Center, The Ohio State University.

Prince, Samuel H. 1920. *Catastrophe and Social Change*. New York, NY: Columbia University.

Proulx, Guylene. 2002. "Movement of People: The evacuation timing." Pp. 3-342 – 3-365 in *The SFPE Handbook of Fire Protection Engineering Third Edition*, edited by P.J. DiNenno. Quincy, MA: National Fire Protection Association.

Proulx, Guylene. 1997. "Misconceptions about Human Behavior in Fire Emergencies." *Canadian Consulting Engineer* March: 36-38.

Proulx, Guylene and Chantal Laroche. 2003. "Recollection, Identification and Perceived Urgency of the Temporal-Three Evacuation Signal." *Journal of Fire Protection Engineering* 13(1): 67-82.

Proulx, Guylene and Joelle Pineau. 1996. "The Impact of Age on Occupants' Behaviour during a Residential Fire." In *Proceedings of the Human Factors and Ergonomics Society 40th Annual Meeting*. Santa Monica, CA: Human Factors and Ergonomics Society.

Proulx, Guylene and Jonathan D. Sime. 1991. "To Prevent Panic in an Underground Emergency: Why not tell people the truth?" Pp. 843-852 in *Fire Safety Science -- Proceedings of the Third International Symposium*, edited by G. Cox and B. Langford. London, UK: Interscience Communications Ltd.

Proulx, Guylene, Irene M. A. Reid and Neil R. Cavan. 2004. *Human Behavior Study, Cook County Administration Building Fire, October 17, 2003 – Chicago, IL*. Ottawa, Canada: National Research Council of Canada.

Purser, David A. 1998. "Quantification of Behavior for Engineering Design Standards and Escape Time Calculations." Pp. 497-506 in *Human Behaviour in Fire: Proceedings of The First International Symposium*. London, UK: Interscience Communications Ltd.

Purser, David A. and Marion E. Kuipers. 2004. "Interactions Between Buildings, Fires and Occupant Behavior Using a Relational Database Created From Incident Investigations and Interviews." Pp. 443-456 in *Human Behaviour in Fire: Proceedings of the Third International Symposium*. London, UK: Interscience Communications Ltd.

Quarantelli, Enrico L. 1980. *Evacuation Behavior and Problems: Findings and implications from the research literature*. Columbus, OH: Disaster Research Center, Ohio State University.

Quarantelli, Enrico L. 1960. “A Note on the Protective Function of the Family in Disasters.” *Marriage and Family Living* 22(3): 263-264.

Quarantelli, Enrico L. and Russell R. Dynes. 1972. “When Disaster Strikes (It Isn't Much Like What You've Heard and Read About)” *Psychology Today* 5(February): 67-70.

Quarantelli, Enrico L., Russell R. Dynes, and J. Eugene Haas. 1966. *Organizational Functioning in Disaster: A preliminary report*. Working Paper #7. Newark, DE: Disaster Research Center.

Quarantelli, Enrico L., J.R. Ponting, and J. Fitzpatrick. 1974. *Police Department Perceptions of the Occurences of Civil Disturbances*. Working Paper #59. Columbus, OH: Disaster Research Center, The Ohio State University.

Quarantelli, Enrico L., Clark Lawrence, Kathleen Tierney, Ted Johnson. 1979. “Initial Findings from a Study of Socio-Behavioral Preparations and Planning for Acute Chemical Hazard Disasters.” *Journal of Hazardous Materials* 3(1): 77-90.

Richards, Lyn and Tom Richards. 1994. “From Filing Cabinet to Computer.” Pp. 146-172 in *Analyzing Qualitative Data*, edited by A. Bryman and R.G. Burgess. London: Routledge.

Riessman, Catherine Kohler. 2002. “Analysis of Personal Narratives.” Pp. 695-710 In *Handbook of Interview Research: Context and method*, edited by J. F. Gubrium and J. A. Holstein. Thousand Oaks, CA: Sage.

Ritchie, Liesel A., Kathleen J. Tierney, Duke Austin, Matthew Beres**,** Christine A. Bevc, Brandi Gilbert, and Jeannette N. Sutton. 2008. *Disaster Preparedness among Community-Based Organizations in the City and County of San Francisco*. Boulder, CO: The University of Colorado, Institute of Behavioral Sciences, Natural Hazards Center.

Ritchie, Jane and Liz Spencer. 1994. “Qualitative Data Analysis for Applied Policy Research.” Pp. 173-194 in *Analyzing qualitative data*, edited by A. Bryman and R. G. Burgess. New York, NY: Taylor & Francis.

Ritchie, Jane, Liz Spencer, and William O’Connor. 2003. “Carrying out Qualitative Analysis.” Pp. 219-262 in *Qualitative Research Practice, A Guide for Social Science Students and Resarchers*, edited by J. Ritchie and J. Lewis. Thousand Oaks, CA: Sage.

Rodriguez, Havidan, Joseph Trainor and Enrico L. Quarantelli. 2006. “Rising to the Challenges of a Catastrophe: The emergent and pro-social behavior following Hurricane Katrina.” *The ANNALS of the American Academy of Political and Social Science* 604(1): 82-101.

Rudolph, Jenny W. and Daniel B. Raemer. 2004. “Diagnostic Problem Solving during Simulated Crises in the OR.” *Anesthesia and Analgesia* 98(5S): S34.

Ryan, Gery W. and H. Russell Bernard. 2000. “Data Management and Analysis Methods.” Pp. 769-802 in *Handbook of Qualitative Research*, edited by N.K. Denzin and Y.S. Lincoln. Thousand Oaks, CA: Sage.

Samoshin, D. A., K. E. Boyce, and T. J. Shields. 2005. "Investigation into Staff Behaviour in Unannounced Evacuations of Retail Stores: Implications for training and fire safety engineering." Pp. 519-530 in *Proceedings 8th International Symposium. International Association for Fire Safety Science*, edited by D Gottuk, B Lattimer. London, UK: Interscience Communications Ltd.

Santos, Gabriel and Aguirre, Benigno E. 2004. "Critical Review of Emergency Evacuation Simulation Models." Pp. 27-52 in *Workshop on Building Occupant Movement During Fire Emergencies*, edited by R. D. Peacock and E. D. Kuligowski. Gaithersburg, MD: National Institute of Standards and Technology.

Sekizawa, Ai. 2004. "Human Factors in Fire Safety Measures." *Fire Science and Technology* 23(4): 296-302.

Sharot, Tali, Elizabeth A. Martorella, Mauricio R. Delgado, and Elizabeth A. Phelps. 2007. "How Personal Experience Modulates the Neural Circuitry of Memories of September 11." *Proceedings of the National Academy of Sciences of the United States of America* 104(1): 389-394.

Sheppard, Ben, G. James Rubin, Jamie K Wardman and Simon Wessely. 2006. "Viewpoint: Terrorism and Dispelling the Myth of a Panic Prone Public." *Journal of Public Health Policy* 27(3): 219–245.

Shields, T.J. and K.E. Boyce. 2000. "A Study of Evacuation from Large Retail Stores." *Fire Safety Journal* 35(1): 25-49.

Sime, Jonathan D. 1998. "Visual Access Configurations: Spatial analysis and occupant response inputs to architectural design and fire engineering." Pp. 140-151 in *Shifting Balances - Changing Roles in Policy, Research and Design (Proceedings of the 15th International Association for People-Environment Studies Conference)*, edited by J. Teklenburg, J. Van Andel, J. Smeets, and A. Seidel. UK: International Association for People-Environment Studies.

Sime, Jonathan. 1984. "Escape Behaviour In Fire: 'Panic' or affiliation?" Ph.D. dissertation, Department of Psychology, University of Surrey.

Sime, Jonathan D. 1983. "Affiliative Behaviour During Escape to Building Exits." *Journal of Environmental Psychology* 3(1): 21-41.

Simon, Herbert A. 1956. "Rational Choice and the Structure of Environment." *Psychological Review* 63(2): 129-138.

Slovic, Paul, Baruch Fischhoff and Sarah Lichtenstein. 1977. "Behavioral Decision Theory." *Annual Review of Psychology* 28: 1-39.

Slovic, Paul, Howard Kunreuther and Gilbert F. White. 1974. "Decision Processes, Rationality, and Adjustments to Natural Hazards." Pp. 187-205 in *Natural Hazards*, edited by Gilbert F. White. New York, NY: Oxford University Press.

Slovic, Paul, Ellen Peters, Melissa L. Finucane, Donald G. MacGregor. 2005. "Affect, Risk and Decision Making." *Health Psychology* 24(4): S35-S40.

Slovic, Paul, Ellen Peters, Melissa L. Finucane, Ellen Peters, Donald G. MacGregor. 2004. "Risk as Analysis and Risk as Feelings: Some thoughts about affect, reason, risk and rationality." *Risk Analysis* 24(2): 311-322.

Sorensen, John H. 1991. "When Shall We Leave? Factors Affecting the Timing of Evacuation Departures." *International Journal of Mass Emergencies and Disasters* 9(2): 153-165.

Sorensen, John H. and Barbara Vogt-Sorenson. 2006. "Community Processes: Warning and evacuation." Pp. 183–199 in *Handbook of Disaster Research*, edited by H. Rodriguez, E. L. Quarantelli, and R. R. Dynes. New York, NY: Springer.

Sorensen, John H. and Gilbert White. 1980. "Natural Hazards: A cross cultural perspective." Pp. 89-95 in *Human Behavior and the Environment: Advances in theory and research*, edited by I. Altman, A. Rapoport and J.F. Wohlwill. New York, NY: Plenum.

Stern, Jessica. 1999. *The Ultimate Terrorist*. Cambridge, MA: Harvard University Press.

Strauss, Anselm L. and Juliet M. Corbin. 1998. *Basics of Qualitative Research: Techniques and procedures for developing grounded theory*. Thousand Oaks, CA: Sage Publications, Inc.

Szalay, Lorand B., Andres Inn, Shelley K. Vilov, and Jean B. Strohl. 1986. *Regional and Demographic Variations in Public Perceptions Related to Emergency Preparedness*. Report for Federal Emergency Management Agency. Bethesda, MD: Institute of Comparative Social and Cultural Studies, Inc.

Thomas, William I. 1923. *The Unadjusted Girl*. Boston, MA: Little, Brown, and Co.

Thompson, Catherine M., John A. Forester, Susan E. Cooper, Dennis C. Bley, and John Wreathall. 1997. "The Application of ATHEANA: A technique for human error analysis." Pp. 9-13-9-17 in *Proceedings of the 1997 IEEE Sixth Conference on Human Factors and Power Plants.* Los Alamitos, CA: IEEE.

Tierney, Kathleen J. 2003. "Disaster Beliefs and Institutional Interests: Recycling disaster myths in the aftermath of 9-11." Pp. 33-51 in *Terrorism and Disaster: New Threats, New Ideas (Research in Social Problems and Public Policy, Volume 11)*, edited by Ted I. K. Youn. Bingley, UK: Emerald Group Publishing Limited.

Tierney, Kathleen J. 1993. *Disaster Preparedness and Response: Research findings and guidance from the social science literature*. Preliminary Paper #193. Newark, DE: Disaster Research Center.

Tierney, Kathleen J. 1980. "Emergent Norm Theory as Theory: An analysis and critique of Turner's formulation." Pp. 42-53 in *Collective Behavior: A Source Book*, edited by M. D. Pugh. St. Paul, MN: West Publishing Company.

Tierney, Kathleen J., Michael K. Lindell, and Ronald W. Perry. 2001. *Facing the Unexpected: Disaster preparedness and response in the United States.* Washington, DC: Joseph Henry Press.

Tong, David and David Canter. 1985. "The Decision to Evacuate: A study of the motivations which contribute to evacuation in the event of fire." *Fire Safety Journal* 9(3): 257-265.

Trumbo, Craig W. and Katherine A. McComas. 2003. "The Function of Credibility in Information Processing for Risk Perception." *Risk Analysis* 23(2): 343-353.

Turner, John C. 1991. *Social Influence*. Pacific Grove, CA: Brooks/Cole.

Turner, Ralph H. and Lewis M. Killian. 1987. *Collective Behavior*. Englewood Cliffs, NJ: Prentice Hall, Inc.

Turner, Ralph H. and Lewis M. Killian. 1972. *Collective Behavior*. Englewood Cliffs, NJ: Prentice Hall, Inc.

Turner, Ralph H. and Lewis M. Killian. 1957. *Collective Behavior*. Englewood Cliffs, NJ: Prentice Hall, Inc.

Turner, Ralph H., Joanne M. Nigg, Denise H. Paz, and Barbara S. Young. 1981. *Community Response to Earthquake Threat in Southern California, Part 10, Summary and Recommendations*. Los Angeles, CA: Institute for Social Science Research, University of California, Los Angeles.

Tversky, Amos and Daniel Kahneman. 1974. "Judgment Under Uncertainty: Heuristics and biases." *Science* 185: 1124-1131.

Vaughan, Diane. 1999. "The Dark Side of Organizations: Mistake, misconduct, and disaster." *Annual Review of Sociology* 25: 271-305.

Vogt, Barbara M. 1991. "Issues in Nursing Home Evacuations." *International Journal of Mass Emergencies and Disasters* 9(2): 247-265.

Wachtendorf, Tricia, James M. Kendra, and Brandi Lea. 2010. "Community Behavior and Response to Disaster." Pp. 29-40 in *International Disaster Nursing*, edited by E. Daily and R. Powers. World Association of Disaster and Emergency Medicine and Cambridge Press.

Warheit, G. and R.R. Dynes. 1968. *The Functioning of Established Organizations in Community Disasters*. Report Series #1. Newark, DE: Disaster Research Center.

Watson, John B. 1913. "Psychology as the Behaviorist Views It." *Psychological Review*.

Weick, Karl E. 1995. *Sensemaking in Organizations*. Thousand Oaks, CA: Sage Publications.

Weick, Karl E. 1993. "The Collapse of Sensemaking in Organizations: The Mann Gulch Disaster." *Administrative Science Quarterly* 38: 628-652.

Weller, Jack M. and Enrico L. Quarantelli. 1973. "Neglected Characteristics of Collective Behavior." *The American Journal of Sociology* 79(3): 665-685.

Wenger, Dennis E., James K. Dykes, Thomas D. Sebok, and Joan Neff. 1975. "It's a Matter of Myths: An empirical examination of individual insights into disaster response." *Mass Emergencies* 1: 33-46.

Zakay, Dan. 1993. "The Impact of Time Perception Processes on Decision Making Under Time Stress." Pp. 59-72 in *Time Pressure and Stress in Human Judgment and Decision Making*, edited by O. Svenson and A. John Maule. New York, NY: Plenum Press.

Appendices

FIGURES

Appendix A

HEED DATABASE ACCESS CONDITIONS

Please provide the following information in type format (not hand written):

Access Conditions
This Agreement is made with an effective date of ___/___/___ between Prof Ed Galea Director of the WTC research team [HEED Director], whose registered address is, Fire Safety Engineering Group, School of Computing and Mathematical Sciences, University of Greenwich, Old Royal Naval College, Park Row, London, SE10 9LS and the applicant _____ [applicants name] whose registered address is:

_____
_____
_____
_____[work address of applicant]

By signing this application, the applicant, if granted access to the HEED database, agrees to abide by the following conditions of use:

a) The developers of the HEED database have taken precautions to protect the true identity of the interviewees. The applicant agrees that they will not attempt to uncover or reveal the identity of any of the interviewees, the organisations the interviewees worked for, or the identity of any other person that may be mentioned by the interviewees.

b) The applicant agrees that they will not reproduce in part or in full, contents of the HEED database in any form without the written permission of the HEED Director.

c) The applicant will not pass on to anyone else their userid and/or password.

d) Any report, publication, presentation or web based material that the applicant may produce or contribute to, resulting from or containing information obtained from the HEED database shall contain the following acknowledgement:

> The author(s) gratefully acknowledge the UK WTC project HEED, funded by the UK EPSRC (grant EP/D507790/1) for providing access to the HEED database.

e) Any report, publication, presentation or web based material that the applicant may produce or contribute to, resulting from or containing information obtained from the HEED database shall contain the following reference within the bibliography of the document:

> E.R. Galea, J. Shields, D. Canter, K. Boyce, R. Day, L. Hulse, A. Siddiqui, L. Summerfield, M. Marselle, P. Greenall, Methodologies employed in the collection, retrieval and storage of human factors information derived from first hand accounts of survivors of the WTC disaster of 11 September 2001, *Journal of Applied Fire Science*, Vol 15, Number 4, 253-276, 2006 (published in Nov 2008).

f) A paper/electronic copy of any report, publication or presentation produced by the applicant which is considered to be in the public domain will be sent to the HEED Director within 8 weeks of appearing in published form.

g) A link to any web based material produced by the applicant which is considered to be in the public domain will be sent to the HEED Director within 8 weeks of appearing in published form.

h) Access to the HEED database can be removed from the applicant at any time.

Signed: _____ [applicants signature]

Print Name: _____[applicants name]

Dated: _____[day/month/year]

Appendix B – The Predictive Model of the 2001 WTC Disaster

The purpose of this appendix to display a larger version of the predictive model, provided earlier as Figure 4-3. Here, in the chapter appendix, the model is displayed in three parts to allow for ease of viewing. Figure B-1 shows the WTC milling and sensemaking processes of the original model. Figure B-2 displays the WTC actions and decisions made as a result of the milling and sensemaking processes. Last, Figure B-3 shows the WTC protective action sequences of the original model.

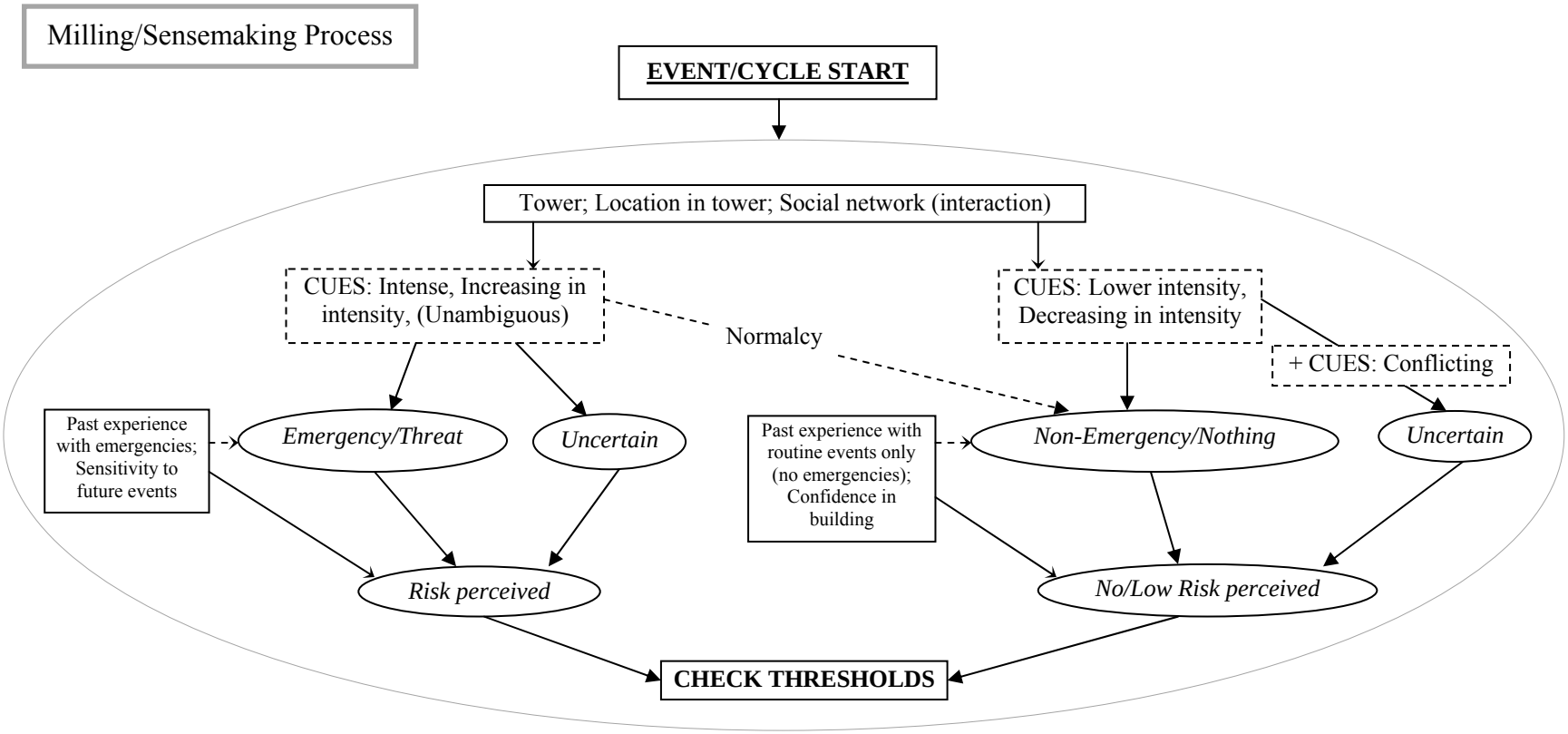


Figure B-1: Influences to the WTC milling and sensemaking processes (originally displayed in Figure 4-3)

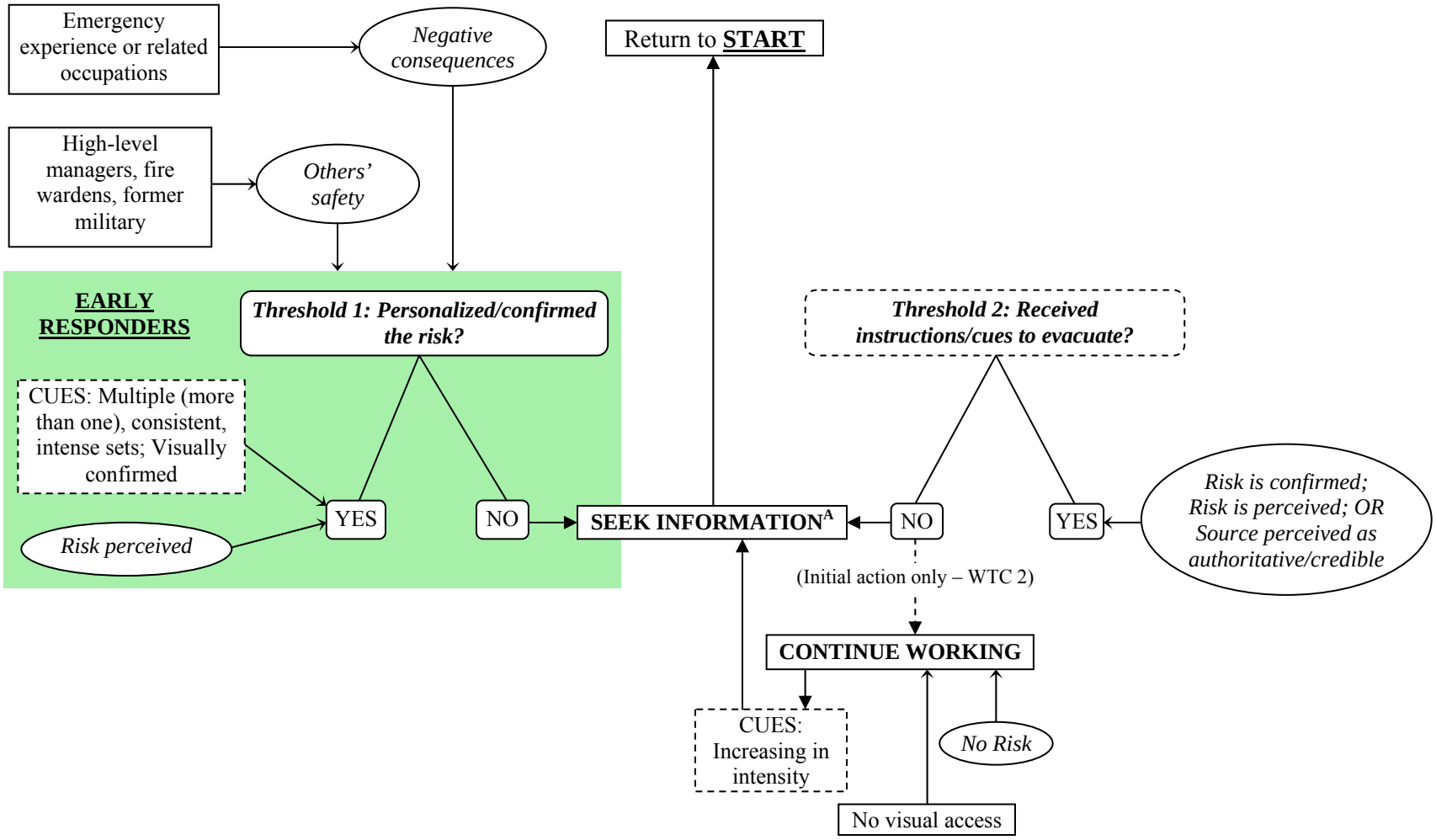


Figure B-2: Influences to the WTC actions taken and decisions made as a result of the milling and sensemaking processes (originally displayed in Figure 4-3)

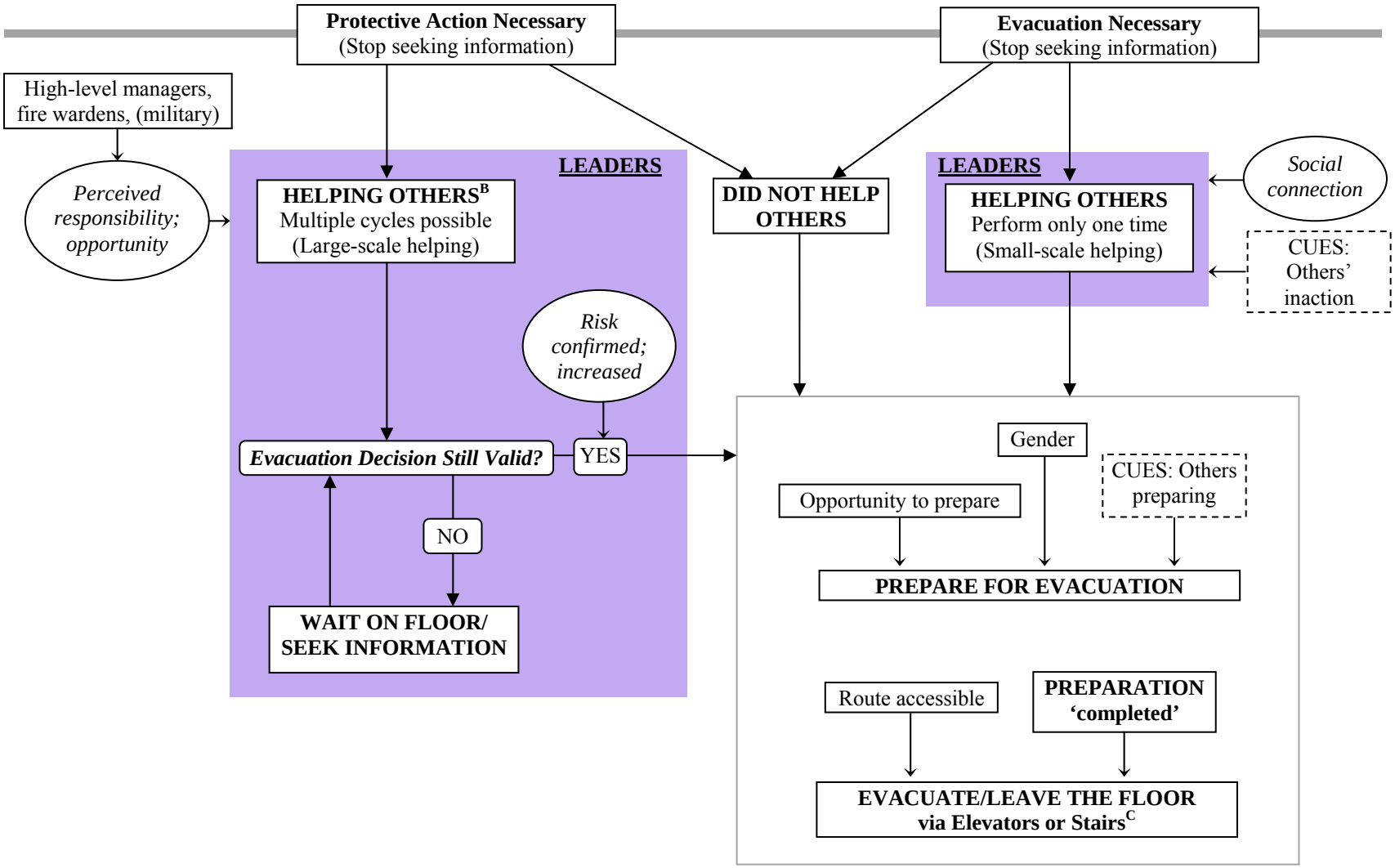


Figure B-3: Influences to the protective actions taken in the WTC (originally displayed in Figure 4-3)