BURNING DOWN THE SILOS: INTEGRATING NEW PERSPECTIVES FROM SOCIAL SCIENCE RESEARCH

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ABSTRACT

The field of human behavior in fire is founded by and has deep roots within the field of fire protection engineering. Extensive research and modeling efforts have been performed on the aspects of human behavior in fire that we can directly observe, including evacuation or movement dynamics, evacuation behaviors/actions and the observable factors that influence these actions. A smaller proportion of research has been performed to identify the individual and group-level underlying processes that produce these observations.

In this paper, I urge human behavior in fire researchers to expand our thinking to include expertise from the social sciences. I present two examples of theories from the field of social psychology that would enable our field to expand our thinking and research into the "unobservable" aspects of human behavior in fire. Next, I discuss the implications of these theories on human behavior in fire research, and in turn, the added benefits to fire protection engineering, in particular our life safety analyses. Finally, I end this paper with a brief discussion on the benefits of collaborating with other social science-based disciplines.

INTRODUCTION

The field of human behavior in fire is founded by and has deep roots within the field of fire protection engineering. In 2002, John L. Bryan, founder of the fire protection engineering department at the University of Maryland, College Park, published an article outlining the history of human behavior in fire[1]. Some of the earliest work in the field involved capacity counts of pedestrian velocity for the design of New York City's Hudson Terminal Building in 1909[2], as well as work on the capacity of footways conducted and published by the London Transit Board[3]. The first academic study on human behavior in fire, however, was conducted by Bryan himself on the 1956 Arundel Park fire[4]. His rationale for this type of study was the following:

> "…fire protection engineers developed building features to enhance fire safety of the occupants, to control the ignition of fires, and to effectively suppress the fires that did occur…However, it was recognized by some that a difference between a minor fire incident and a major fire incident often involved the human behavior of the personnel immediately prior to the fire incident or during the fire incident."

The 1970s and 80s, labeled by Bryan as "The Productive Years", brought about the redefinition of panic[5], the importance of emergency communication[6], individual studies of fires in various types of occupancies (i.e., residential, healthcare, hotels, etc.)[7], a concern for occupants with mobility impairments[8], the observation of evacuation drills from high-rise buildings[9], and the initiation of computer evacuation modeling[10,11,12], among many other efforts. What this research prompted, besides new knowledge, was an increased demand for fire protection engineers with experience with and understanding of techniques used to incorporate human behavior in engineering calculations. This continuing demand is apparent as options for “in-house” human-behavior-related classes, research, and projects became more prevalent in fire protection engineering or safety departments in universities around the world, including the University of Ulster, University of Maryland, Worcester Polytechnic Institute, Lund University, University of Greenwich, and Victoria University, among many others. Professional societies, such as the Society of Fire Protection Engineers, also produce guidance to help engineers better understand human behavior in fire[13].

The common thread to all of these efforts is their foundation within the fire protection engineering discipline. Some might even go so far as to say that we have “silo-ed” ourselves within the engineering field. The issue here is that human behavior in fire, similar to many other situations involving human performance, is a multi-disciplinary problem. Human behavior in fire involves the intersection of the built environment (i.e., buildings and infrastructure), the fire environment, and people. This problem requires input from a variety of disciplines outside of engineering – particularly the social sciences.

The social sciences (i.e., “the study of society and the manner in which people behave and influence the world around us”)[14], can provide rich insight to the field of human behavior in fire. While we have already received significant input from non-engineering disciplines, such as environmental and cognitive psychology, human factors and ergonomics, mathematics, architecture, law, chemistry, emergency management and planning, physics, computer science, and toxicology; we can grow our field even further, and it is critical that we do. We would significantly benefit from the added input from a variety of the social sciences, including sociology, social psychology, human geography (i.e., a sense of place), anthropology (i.e., the study of humans – ideas about race, culture, and peoplehood), economics, and political science, to name a few. The introduction of these subjects would provide different perspectives on the way that individuals and groups cope with emergency scenarios.

In this paper, I urge human behavior in fire researchers to expand our thinking to include expertise from the range of social science pursuits. I start by acknowledging the seminal work that has already been completed in our field, however, pointing out that a focus of our research has been on collecting and analyzing data on the “observable” aspects of human behavior in fire, as opposed to identifying the underlying processes that produce these observations. I then present two examples of theories from social psychology that would enable our field to expand our thinking and research into the “unobservable” aspects of human behavior in fire. Next, I discuss the implications of these theories on human behavior in fire research, and in turn, the added benefits to fire protection engineering, in particular our life safety analyses. Finally, I end this paper with a brief discussion on the benefits of collaborating with other social science-based disciplines.

SEMINAL WORK IN HUMAN BEHAVIOR IN FIRE

Researchers in the field of human behavior in fire have provided significant empirical knowledge and understanding to the fire protection engineering community. Boyce[15] recently published a compendium of all papers presented in the human behavior and modelling sessions at Interflam since 1999, and the papers presented at all five of the Human Behaviour in Fire symposia. The compendium lists over 380 conference publications from 22 different topic areas within the field.

Going back through the conference proceedings, the majority of the research focuses on the aspects of human behavior in fire that we can directly observe[a]. This includes research on evacuation or movement dynamics, including observable data such as movement speeds, density, flows, and to some extent, merging behavior. This information is extremely important because it provides much needed data for engineers performing life safety analyses, especially those using evacuation models, to calculate the time required for people to move to a safe location. Additional publications have reported timing for certain aspects of the building evacuation, such as pre-evacuation delay times and

[a] Individual references are not included for each type or category for the purposes of brevity. All publications can be found by searching Boyce (2015).

overall evacuation times for the building or for a specific population within the building. More recently, this research has been expanded to include data collection and analysis of the movement characteristics of vulnerable populations, for example, children, older adults, and people with disabilities – including those who require the use of an evacuation device to evacuate the building. Additional research, although less frequently studied, has collected movement characteristics of evacuees under the influence of alcohol.

Boyce[15] shows that there has also been a number of conference publications on the modeling of evacuation movement; specifically, the importance of tracking individuals, their physical movements, and their evacuation timing in the event of a building fire. In addition, several evacuation modeling reviews have been performed – both in publication[16,17] and online[18,19] – analyzing over 60 computer-based evacuation models that are available for use in conducting life safety analyses. Although these models began with a focus on evacuation from buildings, some have been expanded to calculate evacuation timing for rail, air, and maritime transportation systems. These models and their underlying calculation techniques are crucial to the engineering community and performance-based analyses.

Beyond movement times, a significant amount of research has been devoted to other *observable* aspects of human behavior in fire. These aspects include recording and analyzing the types of evacuation behaviors/actions that are performed during building evacuation; route choice based upon observable characteristics of the building, person, surrounding population, or physical environment; and occupant responses to fire stimuli, including the waking effectiveness of smoke alarms. Data analyzed and reported on human behavior in fire have primarily included evacuation-related actions performed by specific building occupants; cues that prompted first-awareness of the fire event and the order of these cues; and the effect of culture, gender, age or other observable characteristics on the performance of actions.

On the other hand, a smaller proportion of the conference-related research has focused on the underlying or "unobservable" processes of human behavior in fire[20,21,22,23,24,25]. Even though influential researchers from non-engineering disciplines, like Tong and Canter[26]; Sime[27]; Johnson, Feinberg and Johnston[28]; Latane and Darley[29]; and Jones and Hewitt[30], set the scene for such study over 30 years ago, research into evacuation processes and decision-making seems to have gained minimal traction over the years.

One exception to this is the research performed on one of the largest evacuations in U.S. history, the 2001 World Trade Center (WTC) Disaster. Possibly due to the significance of the event, studies and investigations ensued that bridged gaps between engineering and social science disciplines[31,32,33,34]. Just from my experience with Project 7 of the U.S. Federal Investigation of the 2001 World Trade Center Disaster[31], three experts from cognitive human factors, architectural planning/environmental psychology, and social psychology/sociology were engaged to work with the NIST team to determine why the injuries and fatalities were so high or low depending on location, including all technical aspects of fire protection, occupant behavior, evacuation, and emergency response. With a different purpose in mind, i.e., to both inform the development of future building regulations and evacuation computer models and to make data available to bona fide building safety researchers in countries around the world, the HEED project[b] asked similar questions of WTC survivors[32]. Both projects featured here explored the *underlying processes that influence actions taken in a building evacuation* and in turn, collected information on the *process* by which individuals decided upon specific actions and eventually evacuated their tower. In efforts to study the 2001 WTC Disaster, researchers obtained rich, detailed and important information about the "unobservable" aspects of human behavior in fire – i.e., the underlying processes of evacuation decision-making.

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[b] The HEED project was a collaborative effort between three universities – the Universities of Greenwich, Liverpool, and Ulster with expertise in fire safety engineering, (investigative) psychology, computing science, mathematics and computing, and anthropology. http://fseg2.gre.ac.uk/HEED/HEED_project_team.html

As a field, we cannot wait for another high-profile, large event to gain additional insight from the social sciences. Instead, we can (and should) continue to study the “unobservable” aspects of human behavior in fire. Social science theories, perspectives, and research methods are “ripe for the picking” in order to gain new and innovative ideas for future research. In the following section, I present two theories from social psychology, i.e., the Emergent Norm Theory and the Protective Action Decision Model, that focus on decision-making at the level of the individual, independent of whether the individual is on his/her own, a member of a group, or a member of a larger crowd during an emergency. These theories serve as examples of ways to explain underlying processes of decision-making and actions in fire emergencies.

SOCIAL PSYCHOLOGICAL THEORIES FOR HUMAN BEHAVIOR IN FIRE

In a fire situation, individuals are required to make a concerted effort to create meaning out of new and unfamiliar situations, often under perceived or actual time pressure. From this meaning, a different set of actions is likely to be created. There are theories and research that discuss the processes under which human behavior under uncertainty or in unfamiliar situations occurs. One such theoretical approach is the Emergent Norm Theory, which explains the process of meaning-making under uncertain conditions. Another, which is based on the Emergent Norm Theory and labeled as the Protective Action Decision Model, is aimed specifically at explaining decision-making during disasters. Both will be described in the following sections.

Emergent Norm Theory

Emergent Norm Theory (ENT) explains the process of meaning-making in the face of uncertain conditions[35,36,37]. 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[35], 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[35]. However, occasionally, situations occur that are novel and outside the parameters of routine experiences. Turner and Killian[35] 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”. Other conditions include a change in the social structure or the flow of information within the collective. 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.

The central process that takes place in collective behavior episodes is the construction of a novel definition of the situation[35]. 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 collectively attempt to define the situation, propose and adopt new appropriate norms for behavior, and seek coordinated action to find a solution to the shared problem at hand[38]. 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)[36,39]. Leaders emerge as keynoters, or those who advance suggested interpretations of the event or suggestions on what do to next[34,35]. 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[37]. 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[34,37,38].

The new situation and next steps developed do not emerge in a social vacuum, however[39,40,41]. Rather, individuals within a group bring with them certain aspects of the "normal" or non-emergency situation that influence decisions made in the new situation. First, individuals bring their "social stock of knowledge" to the situation. The social stock of knowledge consists of an individual's internal set of knowledge about the disaster (or disasters in general), experiences from previous disasters or building evacuations, and his/her relationship and roles within the building, especially those related to building fires and other types of disasters[42]. Second, individuals bring conventional norms, i.e., previous ways of acting within the building and/or society as a whole, which are likely to influence the newly developed "next steps for action" during the current disaster situation[41].

Protective Action Decision Model

Up until now, the theory presented explains 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.

The Protective Action Decision Model (PADM), shown in Figure 1, extends ENT's explanation of the meaning-making process in crises to disaster situations[43]. This model, which is based on over 50 years of empirical studies of hazards and disasters[44,45,46,47,48,49], provides a framework that describes the information flow and decision-making that influences protective actions taken in response to natural and technological disasters. Overall, this framework 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), certain types of actions will be performed.

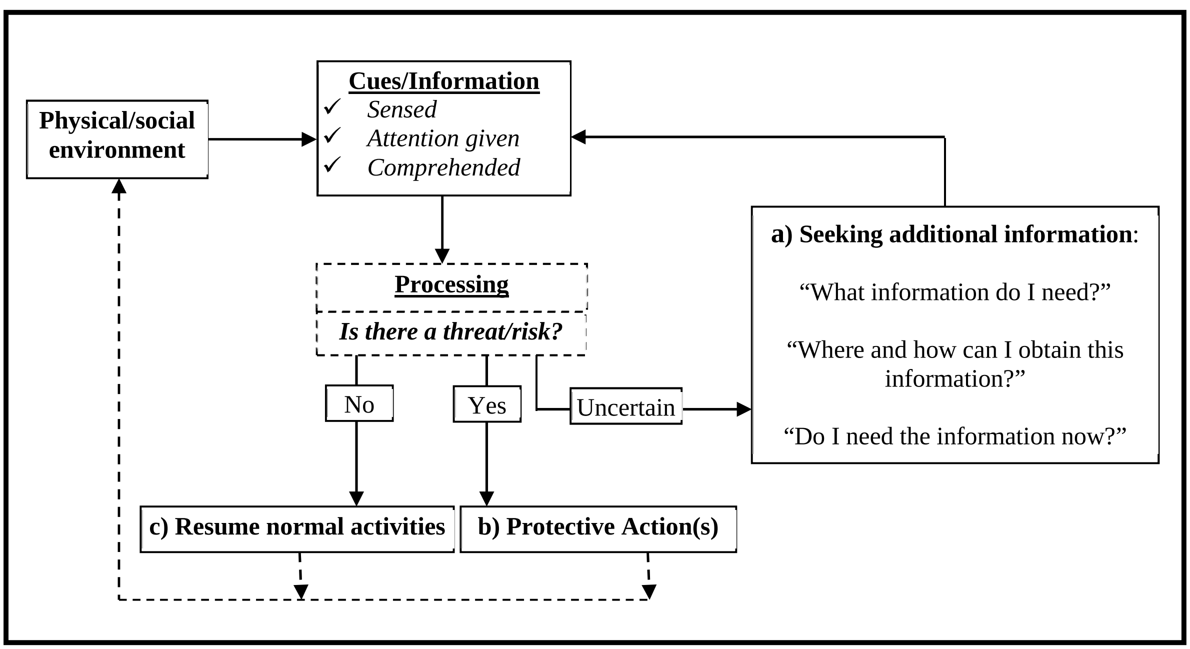

Figure 1: The Protective Action Decision Model, redrawn from Lindell and Perry[43]

The PADM asserts that the process of decision-making begins when people witness cues from the disaster event. The introduction of these cues initiates a series of pre-decisional processes that must occur in order for the individuals (alone or within a group) to perform protective actions. First, the individual must perceive or receive the cue(s). Then, s/he must pay attention to the cue(s). Finally, the individual must comprehend the cue(s).

After the three pre-decisional processes are completed, individuals engage in the *risk identification and assessment phases*. The concept of risk is important since, in most emergency situations, people's first assumption is that nothing unusual is happening, regardless of the intensity of the information perceived; a concept referred to as normalcy bias[48,50,51,52]. It is not until the individual (alone or within a group setting) perceives that there is a real threat to pay attention to and personalizes the risk that they make the decision to take protective action, e.g., evacuate.

In the risk identification phase, the individual decides if there is actually something occurring that may require action, sometimes referred to as warning belief[53] or threat belief[43]. 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[35].

If the individual believes the threat, the next question in the process is whether protective action is necessary; otherwise known as risk assessment. Research has shown that perception of personal risk, or personalizing risk, is highly correlated with disaster response[43,47]. In this stage, the individual determines the likelihood of personal consequences that could result from the threat, asking whether or not protective action is necessary. Essentially, at this point, which is also discussed in human factors research as "situation awareness"[22], the individual attempts to gain insight on the potential outcomes of the disaster and what those potential outcomes mean for safety. The more certain, severe, and immediate the risk is perceived to be, the more likely the individual (alone or within a group setting) is to perform protective actions[54].

Once risk is identified and assessed, the PADM outlines subsequent stages in the decision-making process, including identifying a) what can be done to achieve protection; and b) the best available methods of achieving this protection. After a protective action is chosen and an adaptive plan for action is developed, the final step in the decision-making process involves implementation of the protective action plan or strategy.

Main Points

Based on the discussion of these two theories, three main points can be highlighted. The first is that ***people make decisions and take action in disasters using a decision-making process***. From over 50 years of empirical studies of natural and technological disasters, and based upon ENT, the PADM explains that individuals (alone or within a group) engage in a decision-making process (i.e., a series of steps) before they respond. Inputs to this decision-making model include the cues presented from their environment (including information), the social context, personal characteristics, past experiences, and hazard knowledge. This decision-making process in which people engage is similar to the cue validation process[13], or the PIA (perception-interpretation-action) process[55], in that individuals or groups of individuals must actually receive the cue, recognize the cue and then interpret it correctly before making a decision to act.

The second main point is that ***the risk identification and assessment phases are key to the decision-making process***. Based on the PADM, occupants must perceive a credible threat and personalize the risk before taking protective action. Social science research has been measuring risk perception for years[56]. Although most of these studies focus on pre-event risk perception and its influence on preparedness activities, we can tailor this expertise to meet our needs to study risk perception during the fire event. As examples, NIST[31] and the HEED project[32] retrospectively collected data on risk perception of 2001 WTC survivors at various points along their evacuation timeline in order to understand how and why they decided to evacuate the Towers.

With the exception of isolated individuals, the third main point is that these ***decision-making processes and subsequent actions are most likely performed in groups, or at the very least, in relation to other occupants in the building***. ENT proposes that people come together when taken-for-granted norms and social structure no longer provide adequate guidance for behavior. One example of a situation where previous norms or social structures no longer apply is a building fire emergency.

With ENT in mind, we can envision existing or emergent groups coming together to define the situation, establish whether a threat and risk exist (based on the PADM), and then propose new (or even novel) actions, different from the pre-existing norms, that may lead to safety.

One important note from ENT is that groups can be pre-established, for example, a workplace team or family unit, or they can be impromptu collectivities that come together for the purpose of milling in the emergency[34]. Additionally, revisions of ENT acknowledge the influence of previously-held social roles and relationships on the process of creating new norms and social structures for the disaster situation. For example, research on the 2001 WTC Disaster showed that individuals holding management positions, i.e., a previously held social role, were considered credible sources within milling groups and emerged as keynoters during the protective action decision-making process[57].

In situations where individuals may not engage in decision-making processes within a formal group setting, PADM proposes that the social context, including the actions of others, can still influence their decision-making process. In this case, the decision-making process and subsequent actions are performed in relation to other occupants in the building.

IMPLICATIONS FOR HUMAN BEHAVIOR IN FIRE RESEARCH

The social psychological theories presented in this paper demonstrate the importance of studying decision-making processes, especially the risk perception phases, in order to further study the "unobservable" aspects of human behavior in fire. Although these are not entirely new concepts to our field, they do highlight some important improvements or changes that we could make to our research in human behavior in fire.

First, the social psychological theories display the importance of accounting for and modeling the phases of the decision-making process, which can ultimately predict protective action. Of particular importance will be identifying the factors that influence each stage of the process, including the risk identification and assessment phases. For example, disaster and fire research has shown that individuals are more likely to identify and personalize the risk if, for example, they perceive a larger number of cues[34,58,59] that are intense or extreme in nature[26]. Specific to building fires, 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[60]. Studies like these can provide further insight on the factors that influence risk identification and perception, and ultimately, what influences the decision to take protective action.

The social psychological theories also display the importance of accounting for and modeling the influence of the group on individual decision-making and action in a disaster event. A note should be made; however, that the use of the term "group" here in this paper is different from its use by the calculation techniques that view the entire population as one homogenous group or unit (e.g., the hydraulic calculation techniques). Here, in this paper, the term "group" refers to the formation of social groups, with various characteristics (i.e., demographics, density, location, social relationships, etc.)[61], that interact and act together within the larger building population.

In order to account for the influence of a group (or the social context), it will be important to study the group-level characteristics that influence individual-based decision-making processes. For example, one group-level factor is *social cohesion or relationships*; i.e., how well group members know one another and their acknowledgement of social roles, division of labor, leadership, etc. Another factor is *group heterogeneity*, i.e., a measure of the variety of individual characteristics among group members. In my study of the 2001 WTC Disaster, I explored the impact of group relationships/heterogeneity on individual response in the pre-evacuation period of the disaster[57]. I found that managers, fire wardens and occupants with former military training were more likely to take the role of "keynoters" in the 2011 WTC Disaster, in that they urged others within their group to evacuate. The reason for this result is that the keynoters held roles of responsibility and, in turn, 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. One additional note is that 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 mental processes, in that they envisioned negative consequences of the present emergency and considered others' safety, when deciding to evacuate (or not). Evacuation prompts from these keynoters proved to be effective when the members of their group considered them to be a credible source and/or the members' risk perception increased as a result of the prompt. This one example shows the importance of understanding how roles and relationships among group members influence individuals' decision-making processes, as well as understanding the types of individuals who are more likely than others to keynote.

Additional research could also be performed to tailor the theories presented in this paper to building fire events. The theories presented in this paper establish the theoretical process through which individuals make decisions in response to emergencies. However, the theories are more general in nature and 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 building fire emergencies. Since our field has a strong understanding of the types of actions performed in a building fire, additional research could be performed that link these actions to the decision-making process as well as additional underlying motivations.

New and existing research accounting for the individual-based decision-making process has implications for the ways that alerts and warning information are created and disseminated before and during a building fire emergency[62]. Further understanding of the types of cues and information (and the methods of disseminating that information) that are more likely to increase receipt, attention, comprehension, and risk perception, and in turn, increase the likelihood of a safer response, will aid message providers in crafting a more effective fire alert and warning system for their building population.

Additionally, research on the individual-based decision-making process has implications for the engineering calculations and methods used in life safety analyses. Currently, our calculation methods, including computer evacuation models, forecast little in the way of individual behavior without significant user intervention, and typically do not simulate underlying decision-making processes. Instead of simply assigning pre-evacuation time delays to simulated evacuees, as most do now, models could more accurately predict the types of actions performed in specific locations throughout the building and the accompanying time delays for individuals, both alone and within groups, throughout the entire evacuation process. Additionally, models could account for the dynamic nature of evacuation decision-making and behavior during a building fire; i.e., situations where individuals may change decisions (e.g., to evacuate the building) as cues and information change during the event.

One way forward is to develop a probabilistic conceptual model that can predict evacuee behaviors, based on a series of decisions and the factors that influence those decisions, for the entire evacuation timeline. Among other benefits, this conceptual model would lessen the current burden on model users interested in simulating human behavior in fire. Work has already been published on the need for a conceptual model that would account for both the "unobservable" and observable aspects of human behavior in a building fire emergency, including the benefits this model would bring to our field[57,63].

CONCLUSIONS

In this paper, I have focused primarily on the social psychological aspects of social science as they relate to human response during fire emergencies. Specifically, I introduced examples of two theories/perspectives from social psychology, Emergent Norm Theory and the Protective Action

Decision Model. These two theories provided the foundation for my dissertation research, in which I asked the following two research questions[57]:

- 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?

These questions specifically inquire about individual decisions and resulting behavior, based upon the cues presented from their environment, the social context, personal characteristics, past experience, and knowledge. The purpose of my dissertation was to improve the calculation techniques that engineers use when assessing the life safety of a building design, and since most of the current evacuation models simulate individual (or agent-based behavior), analysis at the level of the individual was deemed appropriate. Social psychological theories, for example, can provide the foundation necessary to answer these types of research questions.

However, there are many other research questions we could envision asking to fully uncover the "unobservable" aspects of human behavior in fire. For example, as a field, we may wish to delve further into the cognitive processes of individual decision-making that fall outside of the social context. Additionally, we may wish to further inquire about the influence of the physical environment (i.e., place) on decision-making and response. Or, instead of focusing exclusively on individual decision-making, we may wish to explore decisions made and actions taken, including delay time, at the level of the group (e.g., family units, friendship groups, companies, etc.). Each of these types of research topics would require exploration into various disciplines within the social sciences, including cognitive psychology, geography, and sociology, to name a few.

So, let's go exploring – both in terms of our research questions as well as the disciplines from the social sciences that can shed light on these questions. The social sciences are filled with theories, perspectives, and research methods, just as the ones I have provided in this paper, that will aid us in expanding our knowledge base further into the realm of the "unobservable". We can (and should) continue to explore the relevant scholarship in particular areas, even if those areas are completely new or foreign to us. We can also partner with researchers in relevant social science disciplines on particular projects where their expertise is required. As is shown by Sime's Affiliative Model[27] or Latane and Darley's social influence experiments[29], the field of human behavior in fire benefits each time new theories like these and many others (e.g., the theory of affordances[64]) are introduced.

Together, we can continue to burn down the silos between the physical and social sciences. I will admit that the silos certainly began to smolder with the development of the field of human behavior in fire. We can completely burn down the silos by continuing to expand our thinking and perspectives and even our project teams to include the range and depth of knowledge provided by social science perspectives. These perspectives will improve upon our current research and outputs, and in turn, provide higher levels of safety for building occupants as well as improve the efficiency and cost-effectiveness of building design and construction.

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