# Fireground Decision-making: A Qualitative Study

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## Certification Statement

I hereby certify that this paper constitutes my own product, that where the language of others is set forth, quotation marks so indicate, and that appropriate credit is given where I have used the language, ideas, expressions, or writings of another.

Signed:_____

## Abstract

The New Hampshire Fire Academy is interested in developing training programs related to incident size-up and decision making. The problem was that no research existed to identify how senior fire officers in New Hampshire conduct a situation assessment, given a typical fire scenario. The purpose of this research was to identify the plausible goals, relevant cues, expectancies, and course of action given by senior fire officers in New Hampshire, given typical fire scenarios. This study employed a descriptive research method in order to determine if the Recognition Primed Decision (RPD) model is relevant to the fire service and fire service training, and to identify the plausible goals, relevant cues, expectancies, and course of action selected by experienced fireground commanders when given typical fire scenarios. Results showed that there is support for the RPD model in the fire service and fire service training, and several key elements of the situation assessment were identified. Additionally, there was a high level of consistency amongst the participants. Recommendations included future research and the development of a pilot training program tailored toward improving fireground recognition skills.

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## Introduction

The New Hampshire Fire Academy oversees the training and certification of firefighters within the state, with programs offered at a central training facility as well as at satellite locations throughout the state. Students participating in courses include members of volunteer or career fire departments, as well as those that are not be affiliated with an organization. Training and certification programs include both basic and advanced topics, with subject areas specific to entry level firefighters, apparatus operators, company officers, chief officers, and related professional disciplines. Program development and review is a continuous process, and an area identified as a critical future need involves the training of new or potential company level fire officers with respect to initial tactical decision-making.

The New Hampshire Fire Academy would like to develop a training program based on Klein's (1993) Recognition Primed Decision (RPD) model. This model asserts that experienced fireground commanders and others that are required to make rapid decisions in complex environments rely on intuitive or naturalistic decision-making rather than classical analysis. According to Klein (1993), when faced with emergency situations, fireground commanders use two processes, situation assessment and mental simulation, to develop a course of action and evaluate the likelihood of success. The situation assessment consists of four components:

1. Plausible goals
2. Relevant cues
3. Expectancies
4. Obvious course of action

The problem is that no research exists to identify how senior fire officers in New Hampshire conduct a situation assessment, given a typical fire scenario. Without this

information it is not possible to develop a training program. The purpose of this research is to identify the plausible goals, relevant cues, expectancies, and course of action given by senior fire officers in New Hampshire, given typical fire scenarios. This study employs a descriptive research method, and the research will address the following research questions:

1. What is the relevance of the RPD model to the fire service and fire service training?
2. Given typical fireground situations, what are the plausible goals identified by experienced fireground commanders?
3. Given typical fireground situations, what are the relevant cues identified by experienced fireground commanders?
4. Given typical fireground situations, what are the expectancies identified by experienced fireground commanders?
5. Given typical fireground situations, what are the courses of action identified by experienced fireground commanders?

## Background and Significance

The New Hampshire Fire Academy is responsible for developing, sponsoring, and administering training programs for fire service personnel throughout the state of New Hampshire. Programs are currently offered for all ranks and disciplines, including those currently serving as or aspiring to be company officers. The fire officer curriculum follows the professional qualifications model established by the National Fire Protection Association (NFPA) through its standard, NFPA 1021: Standard for Fire Officer Professional Qualifications (NFPA 1021). This applied research project will focus on elements of the certification course for Fire Officer 1, as defined in NFPA 1021, and content area of Emergency Scene Delivery, which

involves supervising emergency operations and includes the following job performance requirements, requisite knowledge, and requisite skills (NFPA 1021):

1.6.1 Develop an initial action plan, given size-up information for an incident and assigned emergency response resources, so that resources are deployed to control the emergency.

A. Requisite Knowledge: elements of a size-up, standard operating procedures for emergency operations, and fire behavior.

B. Requisite Skills: the ability to analyze emergency scene conditions, to activate the local emergency plan, including localized evacuation procedures, to allocate resources, and to communicate orally.

1.6.2 Implement an action plan at an emergency operation, given assigned resources, type of incident, and a preliminary plan, so that resources are deployed to mitigate the situation.

A. Requisite Knowledge: standard operating procedures, resources available for the mitigation of fire and other emergency incidents, an incident management system, scene safety, and a personnel accountability system.

B. Requisite Skills: the ability to implement an incident management system, to communicate orally, to manage scene safety, and to supervise and account for assigned personnel under emergency conditions.

A number of course elements are used to address the job performance requirements, requisite knowledge, and requisite skills defined above, including reading and written assignments, in-class activities, and a simulation lab. The simulation lab consists of a tabletop

mockup of a typical city, which includes small scale buildings, streets, hydrants, vehicles, and other aspects of city infrastructure. In addition, a computer simulator program is used to create realistic fire scenarios that are projected onto a wall of the classroom. Students are individually brought into the simulation lab and given information about a developing emergency situation, which they can see on the wall and in the tabletop prop. The students must then size-up the incident and develop an action plan, with other students assuming the role of later arriving units. Efforts are made to make the incidents as realistic and interactive as possible, with students using portable radios for communications and evaluators injecting prompts and distractors. In a typical course each student will assume the role of the initial arriving officer 2 to 3 times.

The simulation lab has been well received by the students and is often highlighted on evaluations as the favorite aspect of the course. However, anecdotal evidence from evaluators suggests that many students have difficulty with the initial phases of the incidents and there are questions as to whether participating in the simulation lab improves student performance, given that they only experience it on a limited basis. To an extent, students are expected to have difficulty with the scenarios. The fire officer course is a training program, and as such the simulation lab component is a learning activity, with the goal of providing an experience that moves students along a continuum toward professional competence. Unfortunately, due to time and budget constraints, the course time devoted to the simulator lab must be limited. Therefore, providing additional simulator experience as a potential solution is not a viable option.

As an alternative to the full-scale simulator it has been suggested that a training program be developed to address the aspects of scene size-up, situational awareness, and initial decision making, with the goal of better preparing students for the interactive simulator experience and improving fireground performance. This training program could also have an effect on

firefighter safety, as size-up and/or situational awareness have been identified as either contributing factors or key recommendations for five out of the last six Fire Fighter Fatality Investigation Reports for structure fires released by the National Institute for Occupational Safety and Health (NIOSH). For more information on these incidents visit www.cdc.gov/niosh/fire and see reports F2013-19, F2013-13, F2013-7, 2013-4, and 2013-2.

Literature related to initial fireground decision making suggests that fire officers rely upon past experiences to make critical decisions (Smith, 2012). When faced with a situation, the past experiences of the individual are analyzed for pattern matches and an action plan is identified and implemented. This relates to the current problem because it has been shown that structural fires have been on the decline for the past several years. According to statistics available from the United States Fire Administration website, there has been a 19.5% decrease in fires in the United States from 2002 to 2011. This means that new or prospective fire officers will be assuming command roles with a smaller inventory of experiences upon which to draw. This problem will become worse if the current trend continues into the future. From a training standpoint, these issues will have an increased effect on the organizational effectiveness of the New Hampshire Fire Academy and for fire departments within the state.

As there has been a demonstrated need for the development of a training program related to scene size-up, situational awareness, and initial decision making, and it has been shown that fire officers may rely on recognition skills gained through experience when making command decisions, this study seeks to determine what senior fire officers see when exposed to typical fireground scenarios. It is hoped that the information gained through this study can be used to develop a low fidelity recognition training program as part of a future effort.

This applied research project is being completed for the Executive Fire Officer Program at the National Fire Academy as part of the course requirements for Executive Analysis of Fire Service Operations in Emergency Management. The focus of this course is on the operational component of fire departments and emergency services organizations, and as such the central research problem of this study is directly related to the goals of the course. This research is also related to the following goals of the United States Fire Administration:

- reduce risk at the local level through prevention and mitigation;
- improve local planning and preparedness;
- improve the fire and emergency services' capability for response to and recovery from all hazards; and
- improve the fire and emergency services' professional status.

## Literature Review

A literature review was conducted as part of this study that included periodicals, scholarly journal articles, and textbooks from the fire service and the field of social science. The primary focus was to identify existing information and research that related to decision making and recognition training. Research was conducted through the Learning Resource Center at the National Fire Academy, the library at the University of Wyoming, and through Google Scholar. A primary focus of the literature review was to address research question 1, which is to identify the relevance of the RPD model to the fire service and fire service training.

Over the past several decades there has been significant research conducted in an effort to better understand the process of decision making in rapidly changing, complex, and dangerous contexts. Much of this work has either involved the fire service or has direct relevance to fire service applications. For instance, early work by Klein (1993) found that experienced fireground

commanders relied principally on intuition when making critical decisions at emergency scenes. This is contrary to what Klein anticipated at the outset of the study, and his work led to the development of a naturalistic decision making model known as the Recognition Primed Decision (RPD) model. In this model, incident commanders rely heavily on their past experiences to guide their decisions, rather than weighing the pros and cons of each course of action or by comparing one option to another. In the RPD process, individuals use situation assessment and mental simulation to classify situations and identify appropriate courses of action (Klein, 1993), as seen in figure 1.

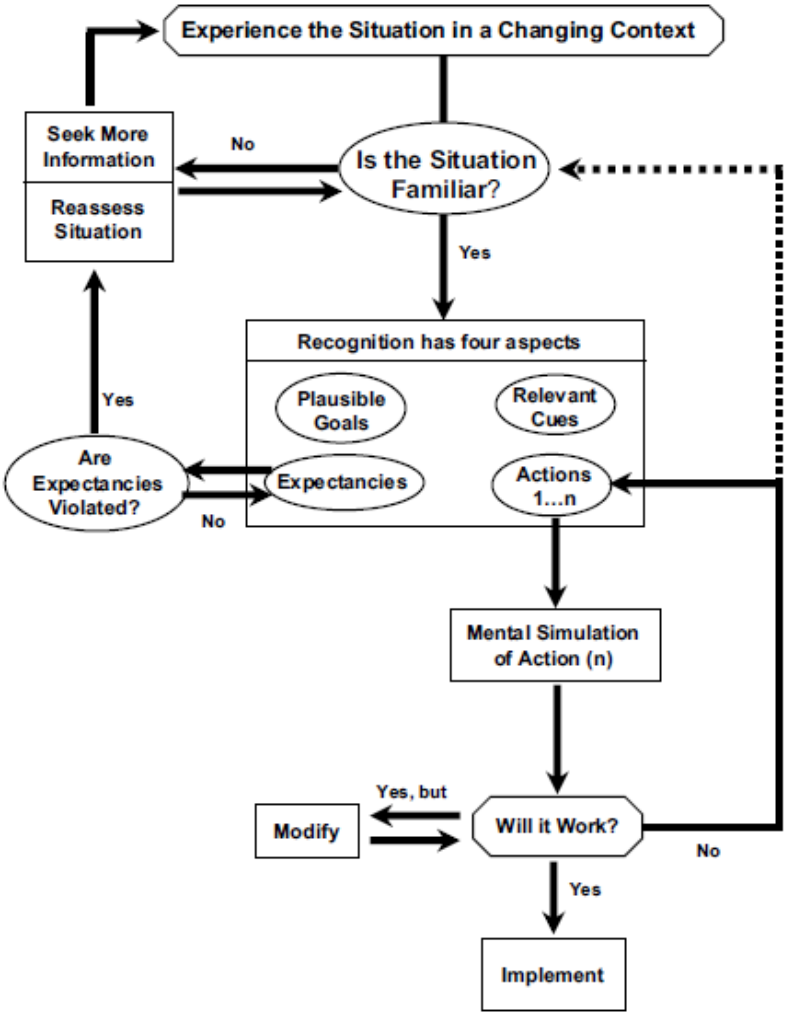

Figure 1. Model of recognition-primed decision making

From: Klein, G. (2008) Naturalistic Decision Making

The situation assessment aspect of RPD is akin to the process of size-up in the fire service. Size-up, according to Smith (2012), is "an evaluation process that reviews all critical factors that could have a positive or negative impact on an incident" (p. 91). Smith differentiates between the size-up conducted by company officers and chief officers. As company officers are often the first to arrive and assume command at an incident, they are responsible for initiating immediate action to address the situation at hand. The company officer "has to make an immediate decision about the volume and intensity of the fire and determine the initial strategies and tactics to be deployed" (Smith, 2012, p. 93). During this critical initial stage of the emergency, the company officer must base their decisions on the information they have gathered during their initial size-up of conditions. This study focuses on the initial arrival size-up that would be conducted by the first arriving company officer.

Many fire service textbooks and trade journals provide guidance on the elements of a thorough and proper size-up. One mnemonic that is widely referenced is WALLACE WAS HOT, where every letter represents a different element of size-up (Smith, 2012, Shouldis, 2012, International Association of Fire Chiefs, 2010). The elements of WALLACE WAS HOT are:

- Water
- Area
- Life hazard
- Location, extent
- Apparatus/personnel
- Construction/collapse
- Exposures
- Weather

- Auxiliary appliances
- Special matters
- Height
- Occupancy
- Time

Each of the 13 elements of the WALLACE WAS HOT size-up mnemonic may have a varied degree of importance at a given fire incident. For instance, while it well known that water is essential for fire suppression, a fire building may have a hydrant supplied by a large water main directly in front of the building, thereby making water of limited concern. In contrast, a building may not have any water within a mile, which would increase the importance of this size-up factor.

According to the RPD model, when presented with a situation, experienced fireground commanders employ a four part recognition strategy consisting of plausible goals, relevant cues, expectancies, and typical actions (Klein, 1999). If the situation is recognized as typical, the fireground commanders "understand what types of goals make sense, which cues are important, what to expect next, and the typical ways of responding in a given situation" (Klein, 1999, p. 24). Further, as the situation has been classified as typical, the incident commanders can determine the likelihood of success for a given course of action.

Klein (1993) cautions that "the danger of misapplying recognitional decision strategies is that personnel will lack the experience needed to identify effective courses of action as the first ones considered, or will lack the ability to mentally simulate the option to find the pitfalls, or will fail to optimize when necessary" (p. 146). However, Klein (1999) also acknowledges the potential for improving the decision making abilities of novices by training them to better

recognize situations, stating that “if the purpose is to train people in time-pressured decision making…if we can present many situations an hour, several hours a day, for days or weeks, we should be able to improve the trainee’s ability to detect familiar patterns” (p. 30).

The training opportunity, according to Klein (1999) is in recognition skills, rather than the total decision making process. This approach has been applied successfully in numerous studies. Research conducted by Fadde (2006) involving novice and expert college baseball players showed that batting performance could be improved by involving players in a low fidelity pitch recognition training program. By exposing a selected group of players to video of varying pitch deliveries, it was demonstrated that the batting averages of the players could be improved beyond a comparison group who were given extra batting practice. The remarkable aspect of the study is that the batting averages improved even though the players involved never swung a bat. The focus was on improving their ability to recognize, process, and predict the type of pitch and delivery in the strike zone, all within a very short time frame. While pitch recognition training may not seem relevant to the fire service, Fadde (2006) highlights the potential for recognition training programs, stating that “technically modest interactive video training may be not only adequate but optimal for developing perceptual decision-making ability in sports and potentially other skill areas”, including “use of force, emergency response, security, and vehicle operation” (p. 253).

In a similar study of the decision-making of professional defensive soccer players, Kermarrec and Bossard (2014) note that “competitive soccer settings should be interesting for research on decision making because defensive plays are uncertain and complex” (p. 190). The aim of their research was to identify the patterns of a typical decision, known as salient features, and show that such features could be classified and used for training purposes. They conclude by

noting that “teachers should use a variety of tasks for decision-making training, including both intuitive and deliberate judgments, and both explicit and implicit learning” (Kermerrac & Bossard, 2014, p. 198). Likewise, Patterson, Pierce, Boydstun, Ramsey, Shannan, Tripp, and Bell (2013) found that intuitive decision making can be developed via implicit learning.

While much of the literature on RPD or emergency decision making in general focuses on the work of Klein, several other researcher have validated or supported the work of Klein and colleagues. For instance, in a study of decision making option generation, Johnson and Raab (2003) found that with ill-defined problems the first option generated as a potential solution was often correct, provided that the nature of the problem was familiar to the participants.

Brennan (2011) suggests a process of mental rehearsals, whereby firefighters and officers consider a potential situation and think about what they might do if confronted with it. Brennan (2011) calls the process “the evolutionary step that takes us beyond our self-contained breathing apparatus emergency procedures and prepares us to respond to a situation that has a huge potential to be mentally overwhelming” (p. 1).

As noted in the background and significance section, it is believed that training related to incident decision making could improve firefighter safety. This is supported by the literature. Kastros (2011), identified the top five causal factors of firefighter deaths on the fireground, according to data from the National Institute of Occupational Safety and Health (NIOSH), which are:

1. Improper risk assessment (poor size-up).
2. Lack of incident command.
3. Lack of accountability.

4. Inadequate communications.
5. Lack of SOGs or failure to follow established SOGs.

These findings show that there is a demonstrated consequence arising from poor size-up skills and suggest that there is a need to focus efforts on improving them.

Gasaway (2014) concurs with these findings and also supports the need for developing situation assessment and decision making skills, noting that "aspiring fireground commanders can preload their memory with images of fire incidents from participating in realistic training scenarios and simulation exercises; reading near-miss reports, case studies, and line-of-duty death reports; watching videos of fire incidents; and talking with experienced firefighters to learn the lessons from past fires" (p. 6).

Findings from the literature review support the use of the RPD model in analysis of fireground decision making and for the potential of the development of recognition based training programs. As noted, the lack of information concerning specific aspects of the RPD situation assessment justify further research.

## Procedures

This project employs a descriptive research method in order to better understand the decision making processes of experienced fire officers. The research is qualitative in nature, rather than quantitative.

> As defined by Creswell (2013): qualitative research begins with assumptions and the use of interpretive/ theoretical frameworks that inform the study of research problems addressing the meaning individuals or groups ascribe to a social or human problem. To study this problem, qualitative researchers use an emerging qualitative approach to inquiry, the collection of data in a natural setting sensitive to the people and places under

study, and data analysis that is both inductive and deductive and establishes patterns or themes (p. 44).

Qualitative research is used "to develop theories when partial or inadequate theories exist for certain populations and samples or existing theories do not adequately capture the complexity of the problem we are examining" (Creswell, 2013, p. 48).

The current study is based on Klein's (1993) Recognition Primed Decision (RPD) model, as discussed in the literature review. This model asserts that experienced fireground commanders and others that are required to make rapid decisions in complex environments rely on intuitive or naturalistic decision-making rather than classical analysis. According to Klein (1993), when faced with emergency situations, fireground commanders use two processes, situation assessment and mental simulation, to develop a course of action and evaluate the likelihood of success. The situation assessment consists of four components:

1. Plausible goals
2. Relevant cues
3. Expectancies
4. Obvious course of action

While the RPD model has a high degree of validity and is widely cited in fire service literature, the theory does not identify specific elements of the situation assessment. This is partly due to the nature of the original research and the applicability of the local findings to other contexts. The purpose of this research is to identify the plausible goals, relevant cues, expectancies, and course of action given by senior fire officers in New Hampshire, given typical fire scenarios. It is believed that within a single fire department there may be some consensus

among the participants that may be transferable within the organization and similar fire departments.

In this study the participants were shown several videos of actual fireground scenarios and were interviewed to evaluate the extent of their situation assessment and to identify possible elements that correlate to the RPD model. Specifically, the data analysis focused on open coding the responses of the participants within the following categories, as found in Klein (1993):

- Plausible goals: what types of goals can be reasonably accomplished in the situation given.
- Relevant cues: what cues are important within the context of the situation.
- Expectancies: what items serve as a check on the accuracy of the situation assessment.
- Actions: identifying the typical actions to take.

The sample for this study was all four shift commanders in a medium sized fire department in New Hampshire. For this study it was determined that tactical decisions could be influenced by local policies, procedures, standard operating guidelines, staffing and resource availability, operational culture, and other factors. For this reason, it was determined that a single fire department should be selected as a test site. Senior staff at the New Hampshire Fire Academy were consulted to identify possible choices for the study. The consensus was that the fire department involved should employ designated full-time incident commanders in order to capitalize on the experience of incident command and prior experience as company officers. This limited the initial study sample to less than 10 fire departments. From this list, a determination was made to solicit the assistance of the Salem, NH fire department. Salem, a city of approximately 28,000 people, has a fire department consisting of three fire stations and a full-

time complement of 15 firefighters and officers per shift. Of these, there is one shift commander per shift, serving at the rank of Captain. There are four work shifts, making the initial sample pool of four individuals. As shift commanders, it is their job function to respond to and command emergency scenes involving numerous fire companies. These individuals have had previous experience as unit commanders and will generally have more than 20 years of experience in the fire service. The fire department involved was selected as a typical example of a New Hampshire fire department.

The Assistant Fire Chief of the Salem Fire Department was contacted regarding this potential study, and approval was granted to proceed. Further, all four captains were contacted individually and consent was gained initially through electronic communications. Individual interviews were scheduled and the study proceeded.

Interviews were conducted in person at one of two locations. The researcher met with each participant privately and discussed the background and purpose of the research before proceeding. Each captain viewed a series of 10 actual fireground videos that were accessed through media sharing sites on the internet. They were selected based on the belief that they represented situations that could be experienced by the fire department in Salem, New Hampshire. During the interview the videos used were displayed through a video projector or large television. The videos primarily displayed the early stages of fires in a number of building types and occupancies before or very shortly after the arrival of the fire department. Each participant was asked a series of questions about each video. The fireground scenarios utilized in this study consisted of the following, and appear in the order that they were shown:

Scenario 1: Split level house

This video presents a fire in a two story split level single family residence. The structure

has a garage underneath, and there is a significant volume of fire showing from the garage. The video was recorded prior to the arrival of the fire department.

Scenario 2: Porch fire

For this scenario the participants view video of a 2 ½ story wood-frame Victorian

structure with a fully involved front porch area. The limited view of the video does not indicate whether the fire has originated from the interior of the structure or if the fire has extended to the interior from the outside.

Scenario 3: Garden style apartment #1

This video shows a fire in a first floor apartment in an occupied 3 story garden style

apartment building. Initially, only smoke can be seen issuing from the exterior sliding patio door, which is open. As the video progresses, fire can be seen extending to the exterior combustible decks of the

second and third floor apartments above.

Scenario 4: Garden style apartment #2

This fire takes place in a similar structure as the previous scenario, but the fire location and visual cues are different. The fire is visible on the exterior combustible deck of a third floor unit, with heavy fire impinging upon the underside of the roof and eaves. People can be seen exiting the structure, indicating that the building is occupied. Smoke can be seen from a nearby gable roof vent.

Scenario 5: Church fire

The fire for this scenario involves a large, stone, gothic style church with an advanced fire condition. Flames can be seen coming through the roof and the fire appears to be widespread throughout the structure. The first arriving engine company is shown to be operating a hoseline. No other apparatus or personnel appear to be on scene.

Scenario 6: Garage fire

In this scenario the fire department is arriving at a well involved fire in the garage of a 1 story ranch style home with an attached garage. Fire conditions are heavy, with

indications that the fire may be through the roof.

Scenario 7: Multiple buildings

This video shows the first companies arriving at a nighttime fire involving several 2 ½

story wood frame structures. Two buildings appear to be well involved, with a third structure severely threatened. The fire appears to be in the rear, but the extent of the fire is not clear from the video as there is no view of the rear.

Scenario 8: Two story single family dwelling

In this scenario the video camera is initially in the cab of the apparatus while it is

responding. A view is shown of the neighborhood during the response, and smoke conditions form a distance. On arrival, the video captures a very brief image of a fire on the second floor of a 2 story wood frame residence. After stopping the apparatus, the video pans to the fire building for a frontal view of conditions.

Scenario 9: Garden style apartment #3

This video has two parts. The first scene shows the arrival conditions for the first due

companies at a fire involving a garden style apartment. The fire is at night, and several people can be seen outside the exit. A light

smoke condition exists on the third floor, and it is not clear exactly what is going on in terms of fire location or extent. After about 20 seconds the video shifts to a rear view, which shows heavy fire conditions on the rear balconies of the second and third floor apartments, with fire exposure to the roof eaves.

Scenario 10: Townhouse fire

In this video fire companies are arriving at a fire in a 3 story attached townhouse style

building, with fire showing from the second floor of a middle unit. As fire crews deploy an initial handline fire conditions accelerate and expose to the outside of the building and roof eaves.

The videos described above were shown to all four captains individually. Each interview lasted approximately one hour. As they viewed the videos they were asked to describe what they were seeing in terms of relevant conditions and to indicate what actions the first arriving officer should take at the emergency. Where practical, follow up questions were asked to further probe the participants for information or to provide additional contextual information that might change their action plan. Interview questions related to the thoughts or feelings of the participants while they viewed each video scenario and primarily concerned their situation assessment and action plan. The following questions were used in some or all of the interviews conducted and scenarios presented:

1. What is happening in this scenario?
2. What initial action(s) should the first arriving officer take at this incident?
3. What are the main problems in this scenario?

4. What is likely to occur next?
5. What follow up actions should the first arriving officer take at this incident?
6. What concerns should the initial incident commander have regarding life safety?
7. How do you feel about this scenario?
8. At this incident, if a confirmed rescue scenario exists, what actions should the first arriving officer take?
9. What are you seeing in the video that is driving your decision making?
10. What should the initial arriving officer be thinking about with this scenario?

Interviews were selected as the primary means of data collection for several reasons. Most significantly, the nature of the research, including the problem and research questions, warrant an open ended, naturalistic response in order to capture authentic decision analysis in the moment. As noted by Klein (2008), decision makers in difficult and developing situations do not compare a set of options when evaluating a situation or selecting an action plan. Instead, experienced incident commanders typically find that the first option they consider is usually satisfactory. For this reason it is essential in this study to determine what the research participants are thinking as they perform the situation assessment. This cannot be achieved through the administration of a survey or other traditional data collection tool. Furthermore, the original RPD research consisted of in depth interviews with experienced incident commanders for similar reasons. The current study follows that model.

Interviews were recorded and transcribed. Passages and text from each scenario interview were analyzed and coded within the following categories, as found in Klein (1993):

- Plausible goals: what types of goals can be reasonably accomplished in the situation given.

- Relevant cues: what cues are important within the context of the situation.
- Expectancies: what items serve as a check on the accuracy of the situation assessment.
- Actions: identifying the typical actions to take.

Analysis of the data was conducted in accordance with the procedures set forth by Creswell (2013) in reference to grounded theory research. As such, interview transcriptions were reviewed and excerpts of the text were categorized through a process of open coding, which "involves taking data ( e. g., interview transcriptions) and segmenting them into categories of information" (Creswell, 2013, p. 286). Open coding was conducted for all four of the components of the situation assessment for each video simulation and resulted in a number of initial categories. Open coding was followed by axial coding, in which the open code categories for each element of the situation assessment were reviewed to identify a central phenomenon that existed across incidents and participants. To achieve this, the videos were grouped into three divisions based on their typology. Scenarios 1, 2, 6, and 8 involved single family dwellings. Though the situations depicted in each video varied, they could collectively be typified as having similarities involving construction, occupancy, size, and other characteristics. Similarly, scenarios 3, 4, 9, and 10 involved multi-family dwellings and were grouped together. The remaining videos consisted of scenarios 5 and 7, which were typified as advanced situations that would be beyond the capabilities of a single alarm assignment. Video 5 involved a church fire, whereas video 7 presented a night time fire involving several structures. These videos were utilized to determine if there were differences in the situation assessment. Grouping scenarios by typology allowed for a comparison of the participant responses to each group of situations, as well as a comparison to the responses of other participants. At the completion of axial coding a

process of selective coding was conducted, whereby the central phenomenon was related to other categories in order to validate the relationships (Creswell, 2013).

## Results

The results for this study were derived from the literature review and through qualitative interviews conducted with all personnel serving at the rank of Captain with the fire department in Salem, New Hampshire.

Research question 1, which sought to determine the relevance of the RPD model to the fire service and fire service training, was addressed through the literature review. It was determined that the RPD model was developed through research conducted with experienced fireground commanders (Klein, 1993), and therefore a direct link exists between the model and the fire service. The RPD model and the work of Klein are extensively cited in fire service publications related to decision making (Gasaway, 2014). In regards to the applicability to fire service training, several studies in other disciplines have shown that decision making skills can be improved through targeted training focused on the recognition aspect of the RPD model, with some citing the potential for such research to impact public safety training. It is clear from the literature review that the RPD model does have relevance to the fire service and fire service training.

The remainder of the research questions were addressed through a qualitative study involving senior fire officers in a mid-sized fire department in New Hampshire. All four shift commanders, serving at the rank of captain in the Salem Fire Department, were individually interviewed as they watched a series of fireground videos. Open dialogue and responses to questions were coded into categories based on the RPD model (Klein, 1993). Research question

2 sought to determine the plausible goals identified by experienced fireground commanders, given typical fireground situations.

**Plausible Goals**

As noted in the methods section, data was coded within the RPD model categories of *plausible goals, relevant cues*, *expectancies,* and *actions*. Several themes emerged from the data. Most prevalent was that in nearly all examples it was clear that the participants expected that fire officers in the scenarios presented should take quick and decisive action with the goal of limiting the progress of the incident. While this may seem obvious, it should be noted that fire officers do have options regarding *goals* and *actions*. In fire service literature *goals* are often categorized as relating to life safety, incident stabilization, or property conservation (Smith, 2012). With the scenarios used in the present study there was a predominant tendency for the participants to identify *goals* related to incident stabilization, which most frequently led to the *action* of applying water to the seat of the fire in the quickest and most direct manner. Interestingly, when the single family video scenarios were augmented with information indicating a high likelihood of trapped civilians needing rescue, the participants still identified *goals* and *actions* related to incident stabilization. This was often rationalized by noting that if the fire situation remained unchecked it would become worse and hamper the ability of the crew to initiate rescue efforts and would likely endanger their safety. Participants could anticipate where the scenario was going, what was likely to happen next, and incident stabilization served as a means of improving life safety by limiting the hazard. As one participant stated, “my credo has always been that if you can put the fire out or at least stop forward progression you have solved most of the problem”. The scenarios involving multi-family structures did prompt more references to life safety, but the goal remained the same. Participants recognized that due to the nature of the

structure in terms of occupancy and size that the potential for life safety problems was greater, and therefore the need to implement a corrective action was supported by a recognition that the problem would intensify and further endanger life safety if efforts were focused on search and rescue rather than fire control.

As anticipated, the goals identified in scenarios 5 and 7 were markedly different than the single and multi-family dwellings. For the church fire there was consensus amongst the participants that the primary goal should be the safety of responding personnel. All of the participants noted the hazards involved in such incidents, including the anticipated collapse of the structure. Several reported knowledge of recent firefighter fatality incidents involving similar structures. The primary goal identified by the participants was most related to life safety, with a secondary goal of property conservation achieved through attending to any nearby exposures. Scenario 7, which consisted of several structures involved in a night time fire, resulted in a goal of property conservation by way of focusing on the third exposure. Participants realized that the first due company would have to triage the structures involved and that if they focused their initial efforts on either of the first two buildings they would likely have fire extension to the third building and lose additional savable property in the exposures to the right of the buildings involved.

Overall the data related to *plausible goals* indicates that experienced incident commanders have a high tendency to identify goals that relate to incident stabilization rather than life safety or property conservation. This would seem counter intuitive from the prevailing fire service literature on tactics and strategy, where the highest emphasis is placed on life safety (Smith, 2014). However, as noted above, the participants often associated quick action with improving the overall life safety of responders and citizens through incident stabilization. The

data from scenarios 5 and 7 serve as a control to show that the goals for an incident can vary depending on the situation.

**Relevant Cues**

According to the RPD model, in order to determine a course of action incident commanders identify and consider *relevant cues* that relate to their *plausible goals*. An aim of this study was to identify the cues that affected the decision making of the participants in the typical fire scenarios studied. For analysis, interview responses were coded using the WALLACE WAS HOT mnemonic discussed in the literature review, resulting in the following categories:

- Water
- Area
- Life hazard
- Location, extent
- Apparatus/personnel
- Construction/collapse
- Exposures
- Weather
- Auxiliary appliances
- Special matters
- Height
- Occupancy
- Time

A theme that arose from the coding of responses was the importance of visual cues that related to assessing the extent of the emergency, the life hazard, and the probability of the situation worsening. This included several specific factors, such as the location and extent of the fire, building construction, time of day, occupancy, and building size. Experienced fireground commanders utilize this information to rapidly assess the magnitude of the problem, the urgency

of action, and the likelihood of success. In contrast to what was seen in the previous section on plausible goals, there was little difference in the responses of participants for the single family, multi-family, and advanced scenarios. In all cases the most often referenced visual cue was the location and extent of the fire. Participants used this information to assess the extent of the problem and if the situation could be impacted by the immediate action of the first arriving company, typically by application of water. In nearly all cases this became the primary focus of the situation assessment. Life safety was a concern, though it was often considered as a conditional item requiring some evidence beyond what was shown in the videos. For example, several videos included people standing outside the structure. The participants often stated that they would question these people to determine if there were any people trapped or unaccounted for. Visual cues that related to life safety included time of day and occupancy, which were stated to increase the potential for a life safety problem but did not necessarily indicate that there was one. Several other factors had a high presence and were interrelated under the theme of forecasting the potential for the problem to intensify. In addition to location and extent of the fire, building construction, area, and in some instances height, were considered to assess the potential for the situation to worsen.

**Expectancies**

For *expectancies* the theme that emerged was the importance of gathering additional information in order to verify that the situation assessment is accurate. After identifying *plausible goals* and *relevant cues*, it was often suggested that officers should conduct a walk around of the building in order to view all sides, particularly those that are not within view on arrival, such as the rear. However, it should be noted that this most often occurred after an initial action was identified. The walk around was considered to be essential, but the participants had

already assessed the situation and determined what should be done. This was another surprising finding. Many tactical manuals suggest that the first arriving command officer should immediately conduct a 360 degree walk around of the structure, unless conditions such as building size prevent it. Participants in this study indicated that the urgency of quick action in many of the scenarios used required that officers implement a strategy toward incident stabilization without delay, and then proceed to a walk around when time allowed. In addition to the need for more information, certain *relevant cues* prompted an *expectancy*. An example of this was when participants were shown a video of a house fire with people standing outside. The people outside were identified as a cue related to life safety and occupancy, with the expectancy being that they could provide information concerning whether all persons were out of the building or if someone was unaccounted for. This information would either verify that the situation assessment was accurate or provide new information that could alter the action plan. Similarly, there were many instances where certain incident conditions that allowed the participants to forecast where the incident was going. For instance, in scenarios 2, 9 and 10 the participants noted that there was fire exposing the underside of the roof soffit and that fire extension into the attic space was imminent. This expectancy that the problem could magnify prompted them to select actions that mitigated the threat, such as immediate water application to the eaves.

As noted by Klein (1993), expectancies serve as a check on the accuracy of the situation assessment. Since the videos used in the research allowed for only a short term presentation of the current incident status, there was no means to determine if the selected action plan was having the desired effect. For example, in the original RDP study conducted by Klein, Calderwood, and Clinton-Cirocco (2010) an example of an expectancy that would be given in

relation to a fire attack action would be the presence of white smoke, indicating that water had reached the seat of the fire. The white smoke, in the form of steam, would serve as a check on the accuracy of the situation assessment. If the expectancy was not met the situation assessment might begin over with an alternate action plan. This aspect of the RPD model was not studied in depth in the current research. However, as noted above there were several important findings.

**Actions**

As stated previously, the participants in this study expected that fire officers in the scenarios presented should take quick and decisive *action* with the goal of limiting the progress of the incident. As all scenarios involved fires in buildings, the general theme identified was that the officers should take action to limit or extinguish the fire as soon as practical. How that action might be implemented was related to the *relevant cues* identified. For instance, the location and extent of the fire would often be tied to what size hose should be deployed and where that hose should be positioned. For the single family and multi-family scenarios there was a high tendency for the participants to almost immediately call for the need to apply water to the seat of the fire. Often this was in the form of a larger attack line, such as a 2 ½" hose. It should be noted that while participants identified the need for quick and plentiful water, there was also a high tendency to recognize the limitations of a single company. For instance, in scenario 4, which involved a fire on the third floor balcony of a garden apartment, several participants realized that getting a hoseline advanced through the interior would be difficult, time consuming, and prone to complications. Seeing this, alternatives such as hitting the fire quickly from the outside or committing two companies to advance the initial interior attack line were suggested. A surprising finding was that there was a high tendency amongst all participants to consider direct application of water from the outside of the building, as opposed to advancing lines through the

interior. It became obvious through the interviews that all of the participants were familiar with recent fire attack research that has been conducted by Underwriters Laboratories (UL) and the National Institute for Science and Technology (NIST). These findings show that the aspects of the RPD model for a particular organization can be influenced by internal and external factors. It is possible that in a different fire department there might not be a tendency to consider exterior fire attack, particularly where organizational culture is in conflict with such tactics.

## Discussion

The findings presented show that the experiences of fireground commanders in this study do contribute to the development of the RPD model. As was noted in the introduction, there is little information in the literature on what the typical goals, cues, expectancies, or actions might be for various situations that fireground commanders might face. In fact, no single study was identified that contained this information. For this reason it is difficult to discuss the relationship of the study results and the findings of others, as there is no comparison. However, certain aspects of the current study do warrant discussion.

First would be whether the results of the current study support or validate the RPD model. According to Klein (2008), experienced fireground commanders rely on a four part situation assessment to match their current situation to patterns they have developed through experience. If a match is generated they are able to identify a typical action plan without having to compare options. In the current study there were very few examples of any alternative strategies being considered. In almost all cases the participants quickly conducted a size-up and identified an action plan. If any alternatives were considered, which only happened in a couple of cases, the participants quickly ruled them out and continued with their first choice. These findings are consistent with the work of Klein (1993, 1998), who found that there was a very

high tendency for the first action identified by experienced incident commanders to be correct for the situation. Results from the current study also validate the four part situation assessment in the RPD model. Participants did clearly identify plausible goals. An important aspect of this component is the term plausible, as in what could reasonably be achieved. Participants surely identified goals, but the emphasis was on what could reasonably be achieved given the situation and local resources and conditions. It should be noted that it is possible that the plausible goals for the scenarios used in this study might be different in other fire departments that have fewer or more resources, differing operating guidelines or policies, or organizational culture. There is clearly an opportunity of future research to validate or expand the findings of this study. For relevant cues it was shown that there is a high level of reliance on certain visual cues, particularly those related to establishing the extent of the current problem. The most often referenced size-up factor in all scenarios was the location and extent of the fire. According to the literature review this finding has not been previously studied, but is in line with the prevailing fire service literature on size-up. As Smith (2012) notes, "the company officer has a need for action. He or she has to make an immediate decision about the volume and intensity of the fire and determine the initial strategies and tactics to be deployed" (p. 93). While the 13 component size-up mnemonic, WALLACE WAS HOT, addresses the commonly considered tactical cues it is apparent from the data that certain factors have a higher degree of importance and are considered more frequently. In this study the participants identified important relevant cues as they discussed what they saw in each video. There was a clear connection between these cues, the goals identified, and their subsequent action plan. As discussed in the results section, the findings for expectancies were not as significant as the other aspects of the RPD situation assessment, primarily due to the nature of the video simulations. However, the findings do

support the RPD model. It was clear that the participants had expectations that would verify the proper implementation of their action plan. There was also a tendency for participants to identify conditions that indicated the future course of the incident. As discussed in the results section there was a very high tendency for participants to call for quick and decisive actions. This final aspect of the RPD situation assessment was well supported by the data and resulted in several key findings that may prove useful in the development of a recognition based training program. The selection of fire control strategies, even when presented with rescue or high life safety scenarios, is a significant finding. Similarly, the high tendency for participants to place an emphasis on tactics that provided for the quickest application of water, primarily through exterior attack, was unexpected. Traditional fire service tactics manuals have placed a preference on placing the first hose line between the fire and any potential occupants (Norman, 2005). Where no life hazard is present the priority has been to place the hose to confine the fire. However, the findings of this study are not inconsistent with current fire service literature. While there has been a historical preference to attack fires from the unburned side and place the initial hose lines on the interior, recent research conducted by UL and NIST have led to numerous publications that call for new tactics. As noted by Kerber and Sendelbach (2013), “applying water to the fire as quickly as possible—regardless of where it is emitting from—can make conditions in the entire structure better” and “during size-up, firefighter crews should assess the fastest and safest way to apply water to the fire” (p.1). While these recommendations are considered new and in some instances have caused controversy in the fire service the emphasis for quick water can be found in earlier texts. For instance, Norman (2005) advises to begin suppression as soon as possible and writes that “the sooner you get down to putting the fire out, the sooner things will

get better" and that "the engine company must always take the earliest opportunity to put out the fire" (p. 39).

In addition to the overall support of the RPD model it should be noted that in the current study there was significant consistency in the codes and themes developed amongst the participants. In numerous scenarios the *plausible goals*, *relevant cues*, *expectancies*, and *courses of action* were similar if not identical.

The organizational implications of this research are that it has been shown that expert incident commanders do conduct situation assessments in a fairly consistent manner, and that these findings support the feasibility of developing a recognition based training program to hasten the development of RPD skills. This training program would focus on the four aspects of the RPD situation assessment, plausible goals, relevant cues, expectancies, and actions, and include an emphasis on recognizing the key features of each scenario. It is hoped that such a program could better prepare students for full scale incident simulations in the fire officer simulator lab, as well as improving actual fireground performance.

## Recommendations

The purpose of this study was to attempt to gain insight into the fireground decision making of experienced incident commanders. Prior research has shown that such decisions are intuitive and rely upon the prior experience of the individual. Using actual fireground video, this study aimed to understand what these experienced fire officers see when exposed to typical and advanced fire scenarios. It is hoped that the findings of this study might be used to develop training programs for new or prospective fire officers that lack the experience based recognition skills.

The current study has shed light on the components making up the situation assessment in the RPD model. It is possible that the results of this research might be used to develop training programs for new or prospective fire officers that lack the experience needed to make intuitive fireground decisions. The high level of consistency amongst participants is particularly promising, in that it shows that there may be *goals*, *cues*, *expectancies*, and *actions* that are correct for the situation given and the context of the fire department involved. Future research could include an additional study with novices within the same fire department in order to do a novice versus expert performance comparison. Results from a study of this nature may show that there is a clear performance gap between novices and experts, thereby validating and supporting the need for a recognition training program for incident size-up.

An additional opportunity would involve expanding the study to other fire departments to see if expert incident commanders in other organizations view the scenarios similarly, with consistent findings, or if local conditions alter the results. Even if the results vary they may prove useful by suggesting how a training program could be designed or modified to meet local expectations.

In addition to future research it is recommended that the results of this study be used to develop a pilot training program to be delivered in the Salem Fire Department. The training should involve members with varied levels of experience and focus on developing recognition skills.

Limitations of the current study include the limited participant sample. Also, the videos selected for this study had strong visual indicators, such as a large volume of fire showing, which may have contributed to the consistency among *goals*, *cues*, *expectancies*, and *actions*.

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