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THESIS

**FORMAL CRITIQUES AND AFTER ACTION REPORTS
FROM CONVENTIONAL EMERGENCIES: TOOLS FOR
HOMELAND SECURITY TRAINING AND EDUCATION**

by

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September 2010

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**FORMAL CRITIQUES AND AFTER ACTION REPORTS FROM
CONVENTIONAL EMERGENCIES: TOOLS FOR HOMELAND SECURITY
TRAINING AND EDUCATION**

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ABSTRACT

The activities and tasks performed by firefighters when responding to emergencies caused by asymmetric threats to homeland security mirror the activities and tasks that firefighters regularly employ when responding to conventional emergencies. However, the learning opportunities created by conventional incidents are not routinely exploited for the purposes of preparing firefighters to respond to incidents of asymmetric origin. Instead, homeland security training and education is often conducted in a manner that is stand-alone and requires a dedicated budget.

The policy analysis conducted assesses the similarities and differences between mitigation procedures and technical skills used when responding to incidents of similar nature but different origin and whether or not formal critiques and after action reports from conventional incidents can be used to effectively support the long-term sustainment of specialized training and education. Efficiency, process values, and robustness and improvability are the criterion used to conduct a modified cost-benefit analysis. The findings suggest that expanding the scope of formal critiques and after action reports from conventional incidents to include “what if” questions about potential incidents of asymmetric origin does facilitate the long-term sustainment of specialized training and education programs in a manner that capitalizes on adult and organizational learning theory principles.

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TABLE OF CONTENTS

I.	INTRODUCTION.....	1
A.	PROBLEM STATEMENT	1
B.	RESEARCH QUESTIONS.....	2
C.	RESEARCH ARGUMENT.....	3
II.	LITERATURE REVIEW	9
A.	ADULT LEARNING THEORY.....	9
B.	ORGANIZATIONAL LEARNING THEORY	12
C.	SURPRISE.....	14
D.	INCIDENT CRITIQUES AND AFTER ACTION REPORTS.....	18
E.	SUMMARY	21
III.	METHODOLOGY	23
A.	SAMPLE SELECTION.....	24
B.	DATA COLLECTION	27
1.	Case Data	27
C.	DATA COMPILATION PROCESS	28
1.	Exercise Evaluation Guides	28
IV.	CHICAGO FIRE DEPARTMENT INFORMATION SOURCES	31
A.	DATA CAPTURE PROCESSES.....	31
B.	BRIEF CASE DESCRIPTIONS.....	33
1.	Hazardous Materials Incident	33
a.	<i>Case 1—Level II Hazardous Materials Incident With an EMS Plan I.....</i>	<i>33</i>
b.	<i>Case 2—Level II Hazardous Materials Incident.....</i>	<i>34</i>
c.	<i>Case 3—Confined Space—Trench Rescue.....</i>	<i>34</i>
d.	<i>Case 4—Confined Space—Trench Rescue.....</i>	<i>35</i>
V.	ANALYSIS AND FINDINGS	37
A.	ANALYSIS OF SIMILARITIES AND DIFFERENCES.....	37
1.	Weapons of Mass Destruction/Hazmat Response and Decontamination Target Capability.....	38
a.	<i>Case 1—Level II Hazardous Materials Incident With an EMS Plan I.....</i>	<i>38</i>
b.	<i>Case 2—Level II Hazardous Materials Incident.....</i>	<i>40</i>
2.	Search and Rescue (Land-Based) Target Capability	42
a.	<i>Case 3—Confined Space—Trench Rescue.....</i>	<i>42</i>
b.	<i>Case 4—Confined Space—Trench Rescue.....</i>	<i>44</i>
3.	Comparison of Capabilities.....	46
B.	MODIFIED COST-BENEFIT ANALYSIS.....	47
1.	Efficiency Analysis.....	47
a.	<i>Case 1—Level II Hazardous Materials Incident With an EMS Plan I.....</i>	<i>48</i>

	<i>b.</i>	<i>Case 2—Level II Hazardous Materials Incident</i>	49
	<i>c.</i>	<i>Case 3—Confined Space—Trench Rescue</i>	51
	<i>d.</i>	<i>Case 4—Confined Space—Trench Rescue</i>	51
	<i>e.</i>	<i>DHS-Approved Awareness Level Training Course</i>	52
	<i>f.</i>	<i>HSEEP-Compliant Exercise</i>	52
2.		Process Values Analysis	55
	<i>a.</i>	<i>Individual Learning</i>	55
	<i>b.</i>	<i>Organizational Learning</i>	58
	<i>c.</i>	<i>Surprise Avoidance</i>	60
	<i>d.</i>	<i>Summary</i>	63
3.		Robustness and Improvability Analysis	63
	<i>a.</i>	<i>Budget</i>	63
	<i>b.</i>	<i>Time Requirements for Implementation</i>	64
	<i>c.</i>	<i>Administrative Complexities</i>	65
	<i>d.</i>	<i>Flexibility</i>	67
	<i>e.</i>	<i>Summary</i>	68
	C.	CHAPTER SUMMARY AND CONCLUSIONS	68
VI.		RECOMMENDATIONS	71
	A.	VALUE CURVE REDEFINITION	73
		1. Eliminate	74
		2. Reduce	74
		3. Raise	75
		4. Create	76
	B.	ACTION STEPS	77
VII.		CONCLUSION	81
	A.	LIMITATIONS	82
	B.	AREAS FOR FURTHER RESEARCH	82
		APPENDIX: SAMPLE AFTER ACTION REPORT	85
		LIST OF REFERENCES	91
		INITIAL DISTRIBUTION LIST	95

LIST OF FIGURES

Figure 1.	Homeland Security Training and Education Strategy Canvas.....	73
Figure 2.	Eliminate-Reduce-Raise-Create Grid	74

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LIST OF TABLES

Table 1.	Summary of Target Capability Task Performance	40
Table 2.	Resource Requirements for Exercises of the Same Scope and Duration as an Incident.....	50
Table 3.	Resource Requirements for Formal Critiques.....	51

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LIST OF ACRONYMS AND ABBREVIATIONS

AAR	After Action Report
CAD	Computer Aided Dispatch
CFD	Chicago Fire Department
CPD	Cardio Pulmonary Resuscitation
DHS	Department of Homeland Security
EEG	Exercise Evaluation Guide
EMS	Emergency Medical Services
HSEEP	Homeland Security Exercise and Evaluation Program
IAP	Incident Action Plan
IP	Improvement Plan
IV	Intravenous
NFIRS	National Fire Incident Reporting System
NIMS	National Incident Management System
OEMC	Office of Emergency Management and Communications
PDT	Portable Data Terminal
PPE	Personal Protective Equipment
TCL	Target Capabilities List
WMD	Weapons of Mass Destruction

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I. INTRODUCTION

A. PROBLEM STATEMENT

The responsibilities of the fire service related to the asymmetrical threats to homeland security fall primarily within the response mission area of the emergency management cycle and focus on consequence management.¹ The asymmetrical threats for which the fire service must be prepared to respond include emergencies caused by weapons of mass destruction (WMD), such as weapons comprised of chemical, biological, radiological, and nuclear materials and/or improvised explosive devices. Consistent with traditional fire service priorities, consequence management for WMD incidents focuses on life safety, property preservation, and protection of the environment.

Many of the activities and tasks performed by the fire service during the response to emergencies caused by a WMD incident mirror the activities and tasks that firefighters routinely employ when responding to emergencies of conventional origin². However, specialized training and education programs that focus on homeland security issues are commonly conducted in a stand-alone manner and require a dedicated budget. Furthermore, the National Preparedness System promotes the evaluation of capability levels for responding to homeland security incidents through staged exercises without assessing responder performance during the mitigation of real-world incidents that require the use of comparable skill sets.

Sustainment of specialized training and education programs is often dependent upon the availability of grant funding. Since 2002, the fire service is one of many disciplines fortunate to receive federal funding dedicated to supporting specialized homeland security training and education programs. The costs associated with these

¹ Recent efforts to implement the Fire Service Intelligence Enterprise are expanding the scope of fire service responsibilities to include prevention activities, but overall prevention activities remain in the law enforcement arena and are not addressed in this paper.

² The author acknowledges that a situational assessment of emergencies scenes caused by asymmetric threats and those with origins unrelated to homeland security will yield some difference among variables that must be considered prior to making tactical decisions. Recommendations for incorporating these differences into training and education initiatives will be discussed in Chapter VI.

programs are allowable homeland security grant expenditures (Federal Emergency Management Agency, 2009). While this funding enables many fire departments to enhance capabilities, the human resources and time required to conduct these specialized programs are often limited and compete with resources required for other fire service responsibilities. As fire department corporate budgets continue to become leaner, the sustainment of existing specialized training and education programs become increasingly contingent upon the receipt of federal grant funding.

In comparison to the fire service's historical operational focus, the asymmetric threats to homeland security are relatively new. These current day threats are unlikely to disappear in the years to come. The influx of funding post- 9/11 created a unique opportunity for the fire service to procure specialized equipment and train personnel for responding to these new challenges. However, as the novelty of terrorism continues to wear off and the threats become more common place, the challenge of preventing preparedness and response complacency among first responders increases. Furthermore, if future homeland security grant programs are not maintained at the current funding level, it is unlikely that specialized training and education programs can be maintained at the current levels.

If specialized training and education programs are not sustained, the fire service faces the risk of responders becoming complacent. The consequences of responder complacency may include avoidable death and/or injury to first responders and members of the public. Additionally, excessive damage to property and the environment may occur if proper mitigation strategies are not employed in a timely manner. In order to decrease the risk of responder complacency, the fire service must integrate cost-efficient strategies for incorporating specialized training and education programs into routine operations and training plans.

B. RESEARCH QUESTIONS

The two research questions that this thesis seeks to answer are:

- What are the similarities and differences between capabilities required to mitigate emergencies caused by conventional and asymmetric threats to public safety?

- How can local fire departments use formal critiques and after action reports (AARs) to sustain specialized training and education for responding to emergencies caused by asymmetric threats?

C. RESEARCH ARGUMENT

Many of the activities and tasks identified in the Target Capabilities List (TCL) for mitigating emergencies caused by asymmetric threats to homeland security mirror the activities and tasks routinely employed by firefighters to mitigate emergencies of conventional origin. However, training and education that focus on responding to emergencies caused by asymmetric threats are commonly conducted in a stand-alone manner and require a dedicated budget. Sustainment of specialized training and education is often contingent upon the availability of grant funding.

Since the year 2002, specialized training and education programs within the fire service have largely focused on developing and enhancing the capabilities required to mitigate incidents caused by asymmetric threats to homeland security. Fortunately, state and local jurisdictions have received federal funding to support these initiatives. However, the continuation of federal funding for these programs at the current level is not guaranteed, although the asymmetric threats to homeland security that we currently face are not likely to be diminished. In order to sustain preparedness capabilities for years to come, the fire service must explore possibilities for maximizing training and education opportunities that come with a price tag that is cheaper than the costs associated with didactic training and full-scale exercises, but which provide similar learning opportunities.

There are a number of similarities between the capabilities required to mitigate emergencies caused by conventional threats to public safety and asymmetric threats to homeland security. Exploitation of these similarities can help a fire department to sustain the capabilities for mitigating homeland security incidents. By incorporating discussions on these similarities into formal critiques and AARs from real-world incidents, fire departments create a cost-efficient mechanism for increasing the frequency in which firefighters actively engage in preparing to mitigate incidents caused by asymmetric threats.

The infrequent occurrence of homeland security incidents within the United States limits the opportunities for firefighters to employ the specialized capabilities developed and/or enhanced since 2001 during the response to incidents of asymmetric origin. However, urban fire departments routinely employ many of the homeland security target capabilities when responding to incidents of conventional origin. For example, hazardous material response, decontamination, and search and rescue capabilities are used during incidents involving industrial chemical accidents and collapsed or structurally unstable buildings. The manner of execution for the core activities and tasks required for successful incident mitigation as defined in the TCL remains consistent across emergencies that originate from conventional and asymmetric causes. For example, establishment of an incident command post in a controlled area outside of the hot zone is required for structural fires, hazardous materials incidents, and emergencies that result from the detonation of an improvised explosive device. Confirmation that the activities and tasks employed to mitigate emergencies caused by conventional and asymmetric threats are indeed comparable is required.

Performance of the activities and tasks included on the TCL during the response to incidents that originate from conventional causes is found in standard incident documentation completed by members of a fire department. Company officers and fire chiefs are required to document actions taken to mitigate an incident by creating a report in the federally mandated and standardized National Fire Incident Reporting System (NFIRS). A NFIRS report provides an incident summary, including the responding companies, mitigation strategy, and sequence of events. Additional incident documentation is completed per the requirements of each individual fire department's documentation policies. Chief-level documentation routinely includes specific equipment used and tactical procedures employed. At the company officer level, documentation commonly includes a detailed accounting of the company's on-scene activities. Types of information in company-specific documentation includes positioning of the apparatus, company assignment, sub-assignments of each company member,

mitigation activities completed, equipment utilized, victims rescued and treatment provided, issues encountered, and information reported to on-scene supervisors and command personnel.

If the activities and tasks employed during the mitigation of incidents caused by conventional and asymmetric threats are comparable, then using formal critiques and AARs from real-world incidents can help to sustain specialized training and education for homeland security preparedness. Integration of “what if” questions regarding homeland security-specific variables during formal critiques of real-world incidents create cost-efficient learning opportunities. Integration of such questions provides opportunities for firefighters to immediately analyze and apply theoretical information to what was learned during the critique discussion. The constructs of adult learning theory and higher-order learning support this proposed strategy. This andragogical learning model provides both individual and organizational learning opportunities. The incorporation of the higher order learning construct of experimentation into the formal critique process supports the recommendation of Bazerman (2006) and Henning (2009) to consider multiple causes of the problem before deciding upon surprise avoidance tactics.

Formal critiques, the purpose of which is to critically analyze what worked well during the response, what did not work so well, and what can be done to improve future responses to similar types of incidents, are not difficult to conduct or document and are a recommended best practice within the fire service (Ockershausen, 2008). The conduct of formal critiques and development of AARs are not contingent upon the availability of specialized funding.

Formal critiques require the participation of all key personnel involved in the incident response. Within the fire service, this means representation from most, if not all, responding companies, chief officers, and at times, external agencies. To ensure an effective process and optimal participation, department leadership must prioritize opportunities for learning and performance improvement. This may require temporarily suspending some companies’ availability for assignment to emergency calls received during the critique. Critiques that critically evaluate the performance of both the company and command levels facilitate experiential learning.

Formal critique participants often possess different levels of experience and subject matter knowledge. A skilled critique facilitator can take advantage of opportunities to educate those in the group who are less knowledgeable on technical points that are critical to a successful response, such as ensuring proper strut placement during a trench rescue prior to responders entering the space. Although a formal critique centers on a historical event, it provides a dynamic opportunity to train for the future.

Situation-dependant variables prevent two emergencies from being exactly the same. However, these variables rarely change the activities and tasks required for incident mitigation. Instead, these variables provide different factors to consider when devising mitigation strategies. For example, a command post is always established during a hazardous materials incident. However, the location of the command post is determined based on the chemical(s) of concern and the direction of the wind. Firefighters, company officers, and fire chiefs must be skilled at recognizing situation-dependant variables and adjusting mitigation strategies accordingly. Formal critiques provide opportunities for the participants to consider how hypothetical variables may affect the mitigation strategy for the incident being critiqued.

By introducing “what if” questions during the critique process, the facilitator challenges the group to apply the lessons learned from the analysis of the recent response to a potential future situation that is of similar nature but occurred under different circumstances. The facilitator is positioned to teach the group about specific variables that must be accounted for when responding to incidents caused by asymmetric threats to homeland security. The structured but open dialog format of a critique provides a venue for group members to experiment with potential decisions by discussing how each option or consideration may impact operations. This process facilitates learning from each other through the exchange of information and drawing on the collective experience of the group without incurring expenses associated with a stand-alone training or preparedness exercise.

The establishment of a balance among the demands of administrative, training, emergency response and equipment maintenance responsibilities of a fire department is a difficult challenge. The primary responsibility of a fire department is responding to 9-1-1

calls in order to protect the health and safety of a jurisdiction's population. This responsibility, coupled with emergency response often being the true passion of those who occupy administrative command positions within a fire department, makes it easy for the response function to be prioritized at the expense of others. However, if this function is not balanced with training and organizational learning, the ability of a department to truly learn from their experiences and enhance capabilities is limited. By integrating "what if" questions into formal critiques of real-world incident, department leaders achieve both emergency response and homeland security training and education objectives.

The AAR is used to capture the discussion of both the analysis of the incident being critiqued and the hypothetical homeland security situation discussed. By incorporating the learning points from the critique into the AAR, a fire department provides vicarious learning opportunities to firefighters who are not part of the formal critique discussion. Written AARs are conducive to wide distribution and incur minimal expense for use as a training tool. Therefore, once a fire department commits to the formal critique and AAR processes, this training strategy becomes sustainable since the financial resources required are minimal when compared to costs associated with current-day specialized training and education programs.

An environment that cultivates learning opportunities and embraces change helps an organization to break the perpetual cycle of repeating the same mistakes. If department leadership is unwilling to accept constructive criticism and take action to address identified areas for improvement, the value of investing time and resources in conducting and documenting formal critiques is questionable. Such a department is likely to experience predictable surprises in the future.

Formal critiques that include "what if" discussions provide a cost-efficient and sustainable mechanism for educating first responders on incidents caused by asymmetric threats to homeland security. The introduction of new scenarios shortly after critique participants have evaluated the strengths and weaknesses of their performance to a similar situation provides an opportunity for the group members to solidify the content learned through immediate application, a core principle of adult learning theory

(Knowles, 1989). A responder's bank of experiences upon which to draw when confronted with a unique situation is expanded by comparing and contrasting the similarities and differences of incidents that have different origins. As theorized in the Bayesian theory of surprise, "surprise can only exist in the presence of uncertainty" (Itti & Baldi, 2005, p. 2). If responders are able to draw upon their experiences to identify parallels between responses operations to emergencies caused by conventional and asymmetric threats, the probability of surprise decreases and the probability of effectively executing mitigation strategies increases.

II. LITERATURE REVIEW

This literature review covers four topic areas that help to answer the two research questions posed in this thesis. The first two topics, adult learning theory and organizational learning theory, provide insight into the theoretical perspectives that are used to guide the development of training and education programs. Information on the strengths and weaknesses of the different training and education methods establish whether or not formal critiques and AARs are appropriate for consideration as strategies to help sustain specialized training and education programs. The third topic, surprise, addresses conceptual theories of surprise that relate to first responder preparedness for mitigating emergencies caused by asymmetric threats to homeland security. This discussion explores the assertion that exploiting commonalities between the capabilities required to mitigate emergencies caused by conventional and asymmetric threats helps to decrease the probability that firefighters will experience surprise when responding to homeland security incidents. The fourth topic, incident critiques, helps to establish a baseline understanding of incident critiques and how they are used by public safety organizations. This section shows how formal critiques and AARs utilize the principles of adult and organizational learning theories and identifies the current gaps in the literature in regards to using formal critiques and AARs from real-world incidents as a mechanism to sustain homeland security preparedness capabilities.

A. ADULT LEARNING THEORY

There are two theories of learning that should be considered when contemplating adult education: reinforcement theory and andragogy (Kelly, 2006).

B.F. Skinner, the behavioral psychologist who discovered operant conditioning and articulated the term “reinforcement” as a scientific principle of behavior, claims that reinforcements increase the probability that a certain behavior will occur (Epstein & Skinner, 1980). In their paper *Pavlov and Skinner: Two Lives in Science*, Catania and Laties (1999) discuss how Skinner built upon Russian psychologist Ivan Pavlov’s Nobel Prize winning work on classical conditioning to continue the scientific study of the

behavior of individuals, which eventually led to the development of reinforcement theory. Reinforcement theory asserts that rewards for correct behavior, called positive reinforcement, and punishment for inappropriate behavior, negative reinforcement, can help an individual to learn (Kelly, 2006). However, in a paper co-authored with his graduate student Robert Epstein titled *Resurgence of Responding after the Cessation of Response-Independent Reinforcement*, Epstein and Skinner (1980) question the probability of behavior occurrences decreasing once rewards are no longer provided; questioning whether or not true learning occurred. Furthermore, Epstein's (1991) paper *Skinner, Creativity, and the Problem of Spontaneous Behavior* questions the impetus behind the initial behavior that was changed through reinforcement. Without fully understanding the behavior and the logic for the behavior, how can the determination be made that the behavior change is directly related to the reinforcement? Reinforcement theory may be applicable to organizational learning during the early phases of transformational learning in order to initiate momentum for change. However, this theory should likely not be used in isolation if sustained behavioral change is desired or an organization wishes to promote the development of critical analysis and decision-making skills.

Alexander Kapp first introduced the concept of andragogy in his 1833 book *Planton's Erziehungslehre* (Plato's Educational Ideas) (Peterson, 2009). Andragogy is learner focused education that encourages the adult learner to move beyond dependency to self-directed learning. Reg Revans, the pioneer of the action learning theory, used the principles of andragogy to support the notion that people can use their daily jobs as the basis for learning. Revans challenged the conventional model of learning—learn first, apply knowledge second. In his seminal work, Revans successfully demonstrated that adults who exchange information can use the information learned from each other's experiences to make changes within their own organizations and/or individual practices (Margerison, n.d.).

Malcolm Knowles, considered the founder of adult education theory, used andragogy as the foundation for the development of adult education theory. In his theory, Knowles encourages the learner to draw upon personal experiences to learn how to

perform new tasks and solve problems. Knowles also promotes the immediate application of new information learned as a means of solidifying the new concepts and behaviors learned. However, in his document *Everything You Wanted to Know From Malcolm Knowles*, Knowles (1989) cautions that learners must not be dumped from the pedagogical learning model used primarily for childhood education into an andragogical model without orientation on how to adapt to and operate within a self-directed model. To omit the orientation phase may cause learning barriers. Knowles argues that by nature, adults are self-directed learners and can effectively take responsibility for their own learning.

Revans' action learning theory and Knowles' adult learning theory are both based on the principles of andragogy and share the same conception that adults can effectively learn from their own and other's experiences. Both Revans and Knowles challenge the traditional teacher-centric model of education, instead promoting learner-centric education. Charles Margerison (n.d.), one of today's leading researchers on continuing professional development systems, continues to use the work of Kapp, Revans, and Knowles by incorporating the principles of andragogy, action learning theory, and adult learning theory into workplace learning strategies.

When combined, reinforcement theory and the principles of andragogy are training and education strategies that introduce and help learners comprehend how to integrate new information into decision-making processes. Traditional training and education programs within the fire service capitalize on both reinforcement and andragogy-based theories. Repetitious review of information, techniques, and procedures is embraced in the form of training classes and daily drills. The fire services uses company schools and tabletop exercises as opportunities to exchange information and strengthen abilities for personnel to draw on one's bank of knowledge and past experiences to make effective decisions when confronted with a unique situation. Although not explicitly stated in the literature, the formal critique process incorporates the principles of reinforcement, action learning, and adult education theories. However,

the existing critique process does not routinely provide opportunities for immediate application of new information learned—one of tenants of adult education theory promoted by Knowles.

B. ORGANIZATIONAL LEARNING THEORY

There are multiple frameworks within organizational learning theory that describe how organizations learn and the barriers to an organization's ability to learn. While each framework has distinct differences, commonalities are also seen.

Norwegian researcher Bjarne Espedal (2008) claims that a commonly accepted notion found among learning theory frameworks is that lower and higher order learning must be balanced for a long-term adaptive or learning process to be successful. Although sometimes referred to using different terminology, lower order learning focuses on improving existing practices. In the exploitation-exploration framework, Stockholm University's Mikael Holmqvist (2009) defines this concept as exploitation, or focusing on specific competencies in order to refine current beliefs and strengthen knowledge in a specific area. In the single and double-loop learning framework, Carmeli and Sheaffer (2008) describe this concept as the process of error identification and correction, or single-loop learning. Smith and Elliott (2007), two leading European researchers in the area of crisis management, term this concept first order learning in their work *Exploring the Barriers to Learning from Crisis: Organizational Learning and Crisis Management*. Overall, the literature shows agreement that lower order learning aims to improve upon the known, enhancing core competencies but not expanding upon existing capabilities.

In his paper titled *In the Pursuit of Understanding How to Balance Lower and Higher Order Learning in Organizations*, Espedal asserts that higher order learning involves using experience to “challenge existing perspectives, routines, and practices and to develop new perspectives on the future” (p. 366). This mechanism of learning encourages experimentation with the unknown. Holmqvist's paper *Complicating the Organization: A New Prescription for the Learning Organization?* defines the exploitation-exploration perspective as exploration of experiences through creativity, risk

taking, and experimentation. From the double-loop perspective, in the paper *How Learning Leadership and Organizational Learning From Failures Enhance Perceived Organizational Capacity to Adapt to the Task Environment*, Carmeli and Sheaffer (2008) claim that learning occurs when the cause and effect relationship of problems is studied so that changes to prevent future occurrences or improvements can be instituted. There is agreement within the literature that higher order learning, which involves critical analysis of an issue and requires organizational willingness to embrace new and often innovative ideas, leads to organizational change.

Smith and Elliott (2007) identify three perspectives on organizational learning and crisis management: learning from crisis, learning for crisis, and learning as crisis. Of the three perspectives, Smith and Elliott assert that organizations are most resistant to learning from crisis. The availability of information, scape-goating, and lack of providing serious attention to the lessons learned from other organizations that have experienced a crisis are identified as the most common barriers to organizational learning from crisis. Carmeli and Sheaffer's (2008) study supports the notion that an organization can decrease the probability of future crisis occurring if one is able to incorporate lower and higher order learning to learn from past experiences, including failures.

Key factors that contribute to an organization's ability to learn include institutionalization of the learning process, the learning perspective and role of leadership in the change process, and the ability to incorporate and balance the different methods of learning (Smith & Elliott, 2007; Carmeli & Sheaffer, 2008; Holmqvist, 2009). Learning organizations must overcome the difficulties associated with balancing learning methods and guard against the easy temptation of adopting and universally applying a single learning method. There is agreement in the literature that the methods of learning described in each framework must be balanced in order for organizational learning to occur. The right method must be selected in order to achieve the desired outcome. Espedal (2008), Holmqvist (2009), and Carmeli and Sheaffer (2008) all agree that if methods are not balanced, the organization will inevitably miss valuable learning opportunities.

Lower order learning builds upon Skinner’s reinforcement theory by promoting the continuation of effective behaviors and identifying behaviors to improve or correct. From an organizational perspective, higher order learning is similar to action learning and adult education theories in that it encourages critical analysis and the use of past experiences to identify opportunities for learning and organizational change. Similar to adult learning theories, the literature supports combining lower order and higher order learning to optimize opportunities for organizational learning.

The process recommended by the U.S. Fire Administration for conducting formal critiques and developing AARs incorporates the use of organizational learning theory principles. However, as discussed in the *Incident Critiques and After Action Reports* section of this literature review, the critique process does not currently take full advantage of the higher order learning construct of experimentation to develop new perspectives on the future.

C. SURPRISE

The concept of surprise warrants consideration when discussing capabilities for responding to asymmetric threats to homeland security. Webster’s Dictionary defines the term “surprise” as “an attack made without warning” (Surprise, 2009). The literature on surprise provides much deeper insight on how this phenomenon can be applied to both conventional threats to public safety and asymmetric threats to homeland security.

U.S. Army War College Professor Michael Handel defines the theory of surprise in his article *The Yom Kippur War and the Inevitability of Surprise* as a theory that “possesses strong explanatory power” but “forms a weak basis for prediction” (Handel, 1977, p. 462). One of Handel’s main arguments is that misperceptions on the part of the defender facilitate the occurrence of surprise incidents. Incident deconstruction after an incident occurrence helps to re-interpret the information known pre-incident with the benefit of hindsight. However, this process does not result in accurate predictions which may help one to employ surprise avoidance strategies. In his research, Handel (1977) argues that predictive abilities are impeded by:

- The desire to maintain the status quo;

- Noise barriers, such as an international background that is asynchronous with preparations for attack and the enemy positioning forces to increase the difficulty of differentiating between decoy and targets;
- Overestimation of one's own capabilities and underestimation of the opponent's capabilities;
- Inaccurate evaluation of the enemy's intention; and
- False alerts that lessen the vigilance against attack.

In their book *Predictable Surprises: The Disasters You Should Have Seen Coming, and How to Prevent Them* (2004), Max H. Bazerman and Michael D. Watkins define predictable surprise as “an event or set of events that take an individual or group by surprise, despite prior awareness of all of the information necessary to anticipate the events and their consequences” (p. 1). Bazerman and Watkins, two of the leading authorities on managerial decision-making, defend the position that predictable surprises occur because policy-makers knowingly make decisions that facilitate the incident occurrence. These researchers propose six characteristics of predictable surprises:

- Leaders are aware that a problem exists and that the problem will not fix itself;
- An incident can be expected if the problem continues to worsen over time;
- Problem mitigation is expensive and the benefits may not be realized for a significant amount of time;
- The benefit of the financial investment made to avert the predictable surprise is avoidance of an uncertain, but likely greater cost;
- The tendency to maintain the status quo often impedes adequate preparation for predictable surprises; and
- Special interest groups that benefit from the status quo typically will work to block reform.

The claim that maintaining the status quo is a factor of surprise is the main point of consistency between Handel's and Bazerman and Watkins' arguments on why decision-makers with all the necessary data fail to correctly anticipate future incidents. The authors disagree on the appropriate application of surprise theories and whether or not surprise is avoidable. Handel contributes surprise primarily to misinformation and

misperception, while Bazerman and Watkins contribute it to the results of conscious decisions. The historical climate surrounding the different research endeavors and/or the advances in technology that improved access to information between the research time periods may contribute to the difference in perspectives. While both used contemporary examples at the time of writing to substantiate their assertions, the difference in Handel's examples being traditional military and Bazerman and Watkins' being asymmetric threats to homeland security may also contribute to the diversity among findings.

Larry Irons, a sociologist who specializes in organizational intelligence, organizational learning, and learning communities, uses the concept of predictable surprise to further the discussion on organizational learning processes. In his article *Hurricane Katrina as a Predictable Surprise* (2006), Irons claims that incidents with vivid outcomes tend to be taken more seriously. Cultivating an environment in which personnel remain vigilant to the conditions of predictable surprises becomes an on-going management challenge. To engage in surprise avoidance, Irons advocates that managers and organizational leaders:

- Define a clear mission that facilitates workers to function optimally;
- Promote professionalism;
- Invest in quality technical training;
- Cultivate leadership qualities in managers;
- Maintain an organizational structure that clearly delineates decision-making responsibilities at each rank; and
- Value ongoing improvements.

Harvard Business School Professor Bazerman recently argued in a paper titled *Climate Change as a Predictable Surprise* that focusing on only one possible cause of the problem is a common mistake made by leaders in relation to predictable surprise avoidance. Ronda Henning, an information assurances scientist, agrees that the failure to address multiple possibilities negatively impacts efforts to conduct a comprehensive assessment of vulnerabilities and risks, possibly resulting in missed opportunities to employ surprise avoidance strategies (Henning, 2009). Use of the elements of a learning

organization identified by Irons helps an organization identify opportunities to mitigate multiple factors that may contribute to the occurrence of a predictable surprise, increasing the likely effectiveness of surprise avoidance tactics.

Laurent Itti and Pierre Baldi, university-based computer scientists, put forth the Bayesian theory of surprise to quantify how the differences between an observer's posterior and prior distributions of beliefs affects their reaction to a stimulus that is considered a surprise. Itti and Baldi postulate that only data observations that substantially affect the observer's beliefs yield surprise. The Bayesian theory is based on two principles: "surprise can only exist in the presence of uncertainty, which can arise from intrinsic stochasticity, missing information, or limited computing resources" and "surprise can only be defined in a relative, subjective manner and is related to the expectations of the observer" (2005, p. 2).

The principles of Bayesian theory support Carmeli and Sheaffer's (2008) argument that learning from past experiences decreases the probability of an organization experiencing a similar crisis in the future since surprise cannot occur unless a stimulus causes a change in beliefs. Learning from previous incidents that share common characteristics with the incident at hand can facilitate surprise mitigation. Revan's action learning theory and Knowles adult learning theory support adults using personnel experience to learn.

Many of the principles of surprise found in the literature are commonly used by the fire service. However, incorporation of these principles into routine operations by the fire service pre-dates the formalization of the theories of surprise. While situation-specific variables of an emergency are practically impossible to predict in advance, the fire service has successfully identified the types of emergencies and categories of potential variables for which they must be prepared to respond. Fire service personnel are trained how to mitigate the consequences of incidents caused by these threats, decreasing the level of surprise firefighters experience when confronted with an emergency. Although the theories of surprise may be relatively new, their tenants are not so to the fire service.

D. INCIDENT CRITIQUES AND AFTER ACTION REPORTS

The Department of Homeland Security (DHS) uses the abbreviation “AAR” to mean “after action review” (DHS, 2007a). The United States Army uses “AAR” to mean “after action report” (Garvin, 2000). Although both terms are related since the discussion that occurs during the after action review is typically captured in the AAR, a distinction between the two is required since they involve different processes. For purposes of this thesis project, “AAR” is used for the “after action report”. The term “formal critique” or “critique” is used in place of “after action review.”

A critique is a training strategy used by many professions and organizations to help those involved in an incident or event learn by comparing the expected outcome with the actions taken to arrive at the actual outcome (Garvin, 2000; Ockershausen, 2008; DHS, 2007a; Turner, 2007; Emergency Response and Crisis Management Technical Assistance Center, 2007). Critiques are recommended for both the response to real-world incidents and staged preparedness exercises. The findings in David Garvin’s paper *U.S. Army’s After Action Reviews: Seizing the Chance to Learn* agree with the recommendations in the U.S. Fire Administration’s *Special Report: The After-Action Critique: Training Through Lessons Learned* (Ockershausen, 2008) on the four main questions around which a critique should focus:

- What did we set out to do?
- What did we actually do?
- Of the actions taken, what worked or did not work? Why?
- What should we do next time?

The first two questions help discussion participants to develop a common understanding of the incident through recreating the timeline. The last two questions require the participants to critically analyze the cause and effect relationship of each action. The U.S. Fire Administration, an agency within the DHS, supports the position that the analytic process helps to identify practices that should be maintained, training needs, effectiveness of organizational policies and standard operating procedures, and trends or patterns in errors during operations that must be corrected (Ockershausen,

2008). However, the introduction of theoretical variables that may occur during future incidents of similar nature to the incident being critiqued (a.k.a. “what if” questions) is not routinely incorporated into the critique discussion.

The formal critique methodology of structured but open dialog among participants is indicative of an appreciative learning system. Naval Postgraduate School Professor Frank Barrett states that appreciative learning cultures “accentuate the successes of the past, evoke images of possible futures, and create a spirit of restless, on-going inquiry that empowers members to new levels of activity” (Barrett, 1995, p. 4). A critique helps an organization to develop the four competencies that Barrett identifies as necessary for organization to survival and flourish: affirmative competence- focusing on strengths, successes, and potentials; expansive competence- challenging conventional practices; generative competence- developing integrative systems that promote realization of the effects caused by individual actions; and collaborative competence- facilitating ongoing discussion and exchange of ideas. Critiques embody many of Knapp’s principles of andragogy and concepts from both Revans’ action learning theory and Knowles’ adult learning theory.

The U.S. Fire Administration, whose mission is to foster a solid foundation in prevention, preparedness and response by providing leadership to local fire and emergency services agencies, considers the AAR to be the most important part of the critique process since it is used to document the lessons learned from an incident (Ockershausen, 2008). Although a standardized template for AARs for real-world incidents has yet to be created, the U.S. Fire Administration provides an overview of the recommended topic areas for inclusion in the written report. The recommendations are generic so that they can be applied to a wide range of incident and event types.

The DHS also advocates the incorporation of critiques and AARs into homeland security exercises. The Homeland Security Exercise and Evaluation Program (HSEEP) is a capabilities based program that provides national standards for conducting homeland security exercises. The Program helps exercise planners integrate elements of the

National Preparedness System³ to document achievement of preparedness capabilities in a standardized manner (DHS, 2007a). The component of the National Preparedness System that most closely tied to HSEEP is the TCL. The TCL provides guidance to state and local government agencies on the capabilities that the federal government deems are necessary to respond to terrorist attacks and/or natural disasters (DHS, 2007b). The HSEEP policy and program documents include a standard template for developing an AAR and an improvement plan (IP) and instructions on how to use the documents. Through use of the HSEEP AAR and IP, jurisdictions can systematically track progress in attaining desired preparedness capabilities. However, given the commonly accepted notion of the difficulties involved in simulating real-world conditions during an exercise, one may question the extent to which exercise AARs and IPs represent true preparedness capabilities since the findings are obtained using simulated conditions. Literature on this topic is not found.

Exercise Evaluation Guides, or EEGs, are standardized instruments for assessing responder performance during an exercise. Evaluators use EEGs to document player performance in relation to each target capability. DHS advocates the use of EEGs through the HSEEP program (DHS, 2007a). Christine Bradshaw and Thomas Bartenfeld (2009), scientists at the Centers for Disease Control and Prevention who are working to develop a national performance measurement system to assess all-hazards preparedness, also advocate the use of EEGs to measure performance during exercises. Bradshaw and Bartenfeld argue that the strength of the EEG lies in the fact that the evaluation is completed by a third party as opposed to self-reported assessments, which likely yields an assessment that is comparatively more objective. However, the authors note that EEGs commonly emphasize evaluation based on the timeliness of actions. Given that exercises

³ As a strategy to organize homeland security preparedness activities, DHS established the National Preparedness System. The goal of this System is to “achieve and sustain coordinated capabilities to prevent, protect against, respond to, and recover from all hazards in a way that balances risk with resources” (DHS, 2008). The six components of this System are the 1). National Preparedness Goal; 2). National Planning Scenarios; 3). Universal Task List; 4). Target Capabilities List; 5). National Incident Management System; and 6). National Response Framework.

are based on simulated conditions with artificial timeframes that often are not reflective of real-world conditions, one may question the utility of basing an assessment of preparedness capabilities on EEG documentation.

The literature confirms that the fire service has endorsed formal critiques and AARs a recommended practice for learning from real-world incidents and preparedness exercises. However, no literature is found on integrating the elements of the National Preparedness System into critiques and AARs from the response to real-world incidents to assess and document preparedness capabilities. Literature is not found on possibilities for expanding the critique discussion to include theoretical variables for increasing opportunities to draw parallels between similar types of emergencies that originate from different causes; potentially increasing the number of opportunities for organizational learning by fire departments. It is unknown if formal critiques and AARs from conventionally-caused incidents can be used by the fire service as a training tool to help avoid surprise during incidents caused by asymmetric threats to homeland security.

E. SUMMARY

In summary, appreciative learning cultures embrace the principles of andragogy-based and higher-order learning theories. Application of the concepts contained within each of these theories helps an organization to examine their existing norms in order to meet the challenges that they face. Learning through reinforcement and lower-order learning techniques is beneficial. However, strategies based upon these theories alone typically focus on only correcting the end result of a problem and do not strive to resolve underlying issues, commonly resulting in reoccurrence of the problem. The literature argues the importance of organizations learning to embrace multiple learning theories and finding a balance among them in order to ensure that learning opportunities are not inadvertently missed.

The principles upon which adult and organizational learning theories are based provide support for the U.S. Fire Administration's recommendation that fire service organizations use formal critiques and AARs as tools for learning. These tools incorporate concepts of reinforcement, action learning, adult education, lower order learning, and higher order learning theories.

The literature disagrees on whether or not surprise is avoidable and the appropriate application of surprise theory. The contemplation of surprise in relation to asymmetric threats to homeland security raises the question of whether or not incidents caused by asymmetric threats are truly predictable.

Finally, conducting formal critiques and developing AARs after real-world emergencies and preparedness exercises is recommended by the U.S. Fire Administration and the DHS HSEEP program. Critiques and AARs help individuals and organizations to learn by critically analyzing the actions taken to identify practices that worked well and should be continued and areas that require improvement through additional training, purchase of equipment, and/or policy changes. Although standardize templates for conducting critiques and writing AARs of real-world incidents do not exist, DHS does have templates for exercises and these elements are incorporated into the National Preparedness System. However, gaps in the literature exist in regards to the potential for using formal critiques and AARs from real-world incidents as tools to help sustain specialized training and education designed to prepare firefighters for responding to incidents caused by asymmetric threats to homeland security.

III. METHODOLOGY

Policy analysis is the methodology selected for analyzing whether or not formal critiques and AARs of the responses to real-world incidents can be used to support the long-term sustainment of specialized homeland security training and education. The subject matter being addressed in this thesis is local implementation of federally-prescribed recommendations. The purpose of this analysis is to assess the costs and benefits of incorporating a different learning mechanism into the existing training and education methods endorsed by the DHS as a strategy to promote the sustainment of capabilities required to mitigate emergencies caused by asymmetric threats to homeland security. Policy analysis is an appropriate methodology for exploring opportunities to improve upon existing practices.

This policy analysis is based on the claim that firefighters use comparable skill sets when responding to certain types of emergencies—such as hazardous materials incidents and structure collapses—that may originate from both conventional and asymmetric causes. To assess the similarities and differences between the mitigation procedures and technical skills used when responding to incidents of similar nature but of different origins, an analysis comparing the documentation from real-world incidents and the federally prescribed homeland security target capabilities is done. This approach is consistent with the National Preparedness System’s HSEEP guidance in which preparedness levels are assessed against the federally defined TCL⁴.

A modified cost-benefit analysis is performed to analyze the data from the selected cases and comparison sample. Efficiency, process values, and robustness and improvability are the criteria selected for the analysis. Each criterion is evaluated independently, followed by an assessment of similarities and differences between the cases and comparison group.

⁴ The capabilities that comprise the TCLs are arranged according to the five categories: common capabilities, prevent, protect, respond, and recover. The capabilities that apply to the fire service fall primarily within the common capabilities and respond categories.

Analysis of efficiency is necessary to assess the financial implications of the current and proposed policies. The factors analyzed are human resource and equipment expenditures. The results of the analysis are judged in terms of the number of additional firefighters who could attend technical training for developing tactical skills required to mitigate homeland security incidents if a more cost-efficient strategy for sustaining homeland security training and education is adopted.

Process values analysis (Bardach, 2009, p. 31) is used to assess the opportunities available under the current and proposed policies for responders to learn and/or have a direct influence on changes to departmental procedures. Each step of the training, exercising, and processes for conducting formal critiques is analyzed to identify the opportunities for responder participation. The analysis on strengths and weaknesses of the current and the proposed policy options is organized in terms of opportunities for individual learning, organizational learning, and surprise avoidance.

An analysis of strengths and weaknesses is also used to assess robustness and improvability of the current and proposed policies. The components for this analysis are budget, time requirements, administrative complexities, and flexibility for change during policy execution.

A. SAMPLE SELECTION

There are two issues addressed in this section on sample selection. The first topic discussed is the selection of the fire department from which the cases for analysis are drawn. The second subject is case selection.

The Chicago Fire Department (CFD) is the data collection site chosen for this thesis project. Chicago is the third largest city in the United States (U.S. Census Bureau, 2002). However, commonalities in the organizational structure⁵, demographic

⁵ The CFD is run by a Fire Commissioner, with day-to-day operations being managed by a First Deputy Fire Commissioner. The First Deputy oversees the five Department bureaus- Operations, Support Services, Fire Prevention, Administration, and Labor Relations. The Department operates over 160 fire suppression and rescue apparatus, six special operations teams, and 75 ambulances daily. The Department responds to over 650,000 calls for service annually (CFD, 2008)

characteristics of the population served⁶, geographic considerations⁷, and the types of incidents to which the fire department responds are found when comparing the characteristics of the CFD to those of urban fire departments from cities of smaller size. Similar to urban fire departments throughout the country, the CFD complies with the codes and standards established by the National Fire Protection Association; creating a means for comparing the capabilities among urban fire departments that serve cities with different population characteristics and physical attributes. The CFD receives federal homeland security grant funding to develop and sustain capabilities for responding to homeland security incidents and conforms to all grant requirements for equipment purchases, training, and exercises.⁸ The commonalities found among the characteristics of urban fire department suggest that findings from this study, which is based on Chicago-specific data, can be generalized and applied to other urban fire departments.

Four real-world emergencies—two hazardous materials incidents⁹ and two confined space¹⁰, trench rescue¹¹ incidents—that occurred in 2009 are the sample cases selected for this policy analysis. A conventional cause triggered each incident and the

⁶ Chicago is home to 2.8 million residents who reside in 198 economically, ethnically, linguistically, and racially diverse neighborhoods (OEMC, 2006).

⁷ The 225 square miles of land that comprise Chicago includes 28 miles of Lake Michigan shoreline, over 150 miles of inland waterways, 8 major highways, and 46 movable bridges. Chicago, which is one of the busiest recreational harbors in the country, has more than 1335 high-rise buildings, multiple manufacturing plants, and numerous entertainment arenas where thousands of people routinely gather. There are 193 DHS recognized critical infrastructures/key resources within the City. The City is a national hub for rail transportation since it is the geographic location where rail line tracks from the east meet those of the western rail lines. (OEMC, 2006)

⁸ Per the grant requirements, all equipment purchases must be included as part of the federal Authorized Equipment List, all grant funded training must be pre-approved by the DHS, and all exercises must conform to the HSEEP guidelines.

⁹ The CFD classifies hazardous material incidents according to three levels. A Level I hazmat is initiated primarily for investigative activities and/or to mitigate incidents involving small quantities of low-potential materials. A Level II hazmat is initiated for confirmed incidents involving a moderate to high and/or large quantity of hazardous materials, an incident requiring protective clothing above Level D PPE (e.g., structural fire fighting clothes), and/or if the incident requires an evacuation to be initiated. A Level III hazmat is initiated for extensive incidents that require additional manpower and/or more specialized equipment and supplies in order to mitigate, or if an expanded area requires evacuation. (CFD, 2004)

¹⁰ A confined space is defined as a space that is large enough and so configured that a person can enter and perform assigned work, has limited or restricted means for entry or exit and is not designed for continuous human occupancy (CFD, 2003).

¹¹ A trench is defined as a narrow excavation made below the surface of the earth that is deeper than it is wide and less than 15 feet wide (CFD, 2003).

technical skills employed for mitigation are characteristic of what is commonly required for each incident type. Emergencies involving both incident types can originate from conventional and asymmetric causes, urban fire departments routinely respond to these kinds of incidents, and both are included on the TCL. Furthermore, EEGs for the capabilities associated with each incident type have already been developed by DHS.

Selecting two different incident types for the sample creates the ability to compare and contrast findings. The processes for mitigating hazardous materials incidents and incidents requiring specialized search and rescue share some common attributes, but largely require the use of different technical skill sets. Hazardous material incidents typically require the use of metering equipment, modeling software, and specialized personal protective equipment (PPE). Incident that require technical search and rescue commonly require the use of construction materials (e.g., wood, nails, saws), carpentry skills, and at times, heavy machinery. Both require the use of reference materials and support from emergency medical service practitioners. Having a sample comprised of two incident types should increase the confidence of any recommendations that suggest a wider application of findings from the analysis.

A DHS-approved awareness-level course is the training standard selected for comparison with the expanded use of formal critiques and AARs that is being proposed. The course, *Emergency Response to Terrorism -Basic Concepts*, is a standardized curriculum that is endorsed by the U.S. Fire Administration that is used to train fire service professionals throughout the country. The CFD continues to use this curriculum as the baseline terrorism awareness training for all personnel. The expenses for the delivery of and participation in this training curriculum are eligible expenditures under the federal homeland security grant programs.

A City of Chicago exercise conducted in December 2009 is the exercise standard selected for comparison purposes. This multi-day exercise involved several agencies from different disciplines, however, each of the target capabilities and associated objectives were exercised in isolation as standalone drills. The CFD exercised target

capabilities for *WMD/Hazardous Materials Response and Decontamination and Search and Rescue (Land-Based)*. The exercise met the HSEEP requirements and was paid for with grant funding from the DHS.

B. DATA COLLECTION

1. Case Data

Documentation sources for each case include Computer Aided Dispatch (CAD) reports, electronic NFIRS reports, and AARs. In addition, the author reviewed photocopies of company journal entries or performed on-site journal review.

2. Training and Exercise Data

Sources of information for the training course include training rosters and reimbursement reports. The records include the number of class sessions held, the rank of each instructor, and the amount of instructor compensation. Planning records, participant rosters, the AAR, and reimbursement reports are the sources of exercise data.

3. Financial Data

CFD salary and cost-recovery tables serve as the basis for the financial data generated. The average salary for all department personnel within a given rank is used to determine salary costs. The calculations for personnel ranks covered by collective bargaining units reflect contractual obligations, resulting in the use of overtime rates for all activities that require re-hire or backfill of union members. Exempt rank personnel are not entitled to an increased hourly wage for hours worked in excess of normal obligations; therefore, these costs are calculated at the straight time rate. Calculations for on-duty activities use the cost-recovery rates.

An hourly apparatus and equipment charge is routinely included as part of cost recovery. Although apparatus and equipment are used during homeland security exercises, grant funding is not routinely used to pay for these expenses. Therefore, apparatus and equipment costs are excluded from exercise expense calculations. Equipment and supply costs for purchases specific to an event are included.

C. DATA COMPILATION PROCESS

1. Exercise Evaluation Guides

The HSEEP EEG for each target capability is completed using the documentation from each case. Each piece of information contained in the documentation is treated as an evaluator observation. If observations are recorded in more than one place, they are treated as a single observation. For observations that reveal inconsistent information, such as differences in the amount of time a company spent on-scene as documented in the CAD report and company journal, the least subjective source is used.

To complete each EEG, the author makes an assessment on whether or not each task is fully completed, partially completed, not completed, or if the task did not apply. Notes explaining how the information contained in the case documentation support the assigned measure are inserted under the task description for all tasks ranked as fully or partially completed. The *Target Capabilities List: A Companion to the National Preparedness Guidelines* (DHS, 2007b) is referenced as necessary to clarify capability, activity, task, and measurement definitions.

The author completes the EEG Analysis Sheets by identifying the strengths and weaknesses of the mitigation activities contained in the documentation. The strengths and weaknesses are readily apparent for cases that have a written AAR. The analysis for cases without a written AAR is based solely on the interpretation of available documentation and the critical tasks associated with each target capability.

2. Data Tables

A financial data table is constructed for each case. Using the cost-recovery tables and CAD reports, the length of time on-scene for each apparatus, the number of

personnel hours per apparatus,^{12,13} and the total cost per apparatus is calculated. The numbers in each category for all responding companies are added to produce incident totals.

The subject matter of this thesis focuses on formal critiques and the development of AARs as a strategy to sustain specialized homeland security training and education. Thus, the cost-recovery data table is used to establish the cost of a formal critique for each case. However, it is important to note that the majority of participants in a formal critique typically participate while on duty, which means that additional financial costs are not incurred¹⁴. Furthermore, critique activities do not include the performance of mitigation activities; precluding the eligibility of these activities for cost recovery. Although critique costs¹⁵ are not recoverable, the efficiency analysis includes this information as a cost comparison when discussing training sustainability. Supervisory personnel who were not part of the incident commonly participate in formal critiques, but are excluded from cost calculations. Computation of costs is based on each critique lasting three hours¹⁶.

Although strong similarities may exist, no two incidents or exercises are exactly the same. Therefore, personnel and resource requirements will vary between incidents and exercises. As part of the efficiency analysis, an estimate of time, personnel, and

¹² One engineer, three firefighters, and one officer staff an engine company. Four firefighters and one officer staff a truck company. Five firefighters and one officer staff a squad company. Two firefighters staff a command van. One paramedic and one paramedic officer staff an ambulance. Battalion and Paramedic Field Chiefs drive themselves, while Deputy District Chiefs and Assistant Deputy Chief Paramedics have drivers. Non-platoon exempt rank personnel drive themselves. Dedicated staff are not assigned to support apparatus but are instead assigned to a team company. A member of a team company, which is a fully staffed engine or truck company, drives the support apparatus to an incident as required. CFD is permitted up to 30 manning variances per day per the union contract. These variances are not taken into account for purposes of this study. (Chicago Firefighters Union, Local 2, International Association of Firefighters & City of Chicago, 2003).

¹³ Personnel assigned to support apparatus are accounted for by company of primary assignment. Equipment costs only are generated for support apparatus.

¹⁴ It is the CFD's practice that companies involved in a formal critique remain in-service on-the-air. However, to help facilitate the conduct of the critique, the Fire Alarm Office will prioritize companies that are not participating in the critique for dispatch, within defined parameters.

¹⁵ For purposes of calculating formal critique costs, it is assumed that all participants will be present for the duration of the critique.

¹⁶ CFD critiques typically last two hours. An additional hour is added to reflect time spent traveling to and from the critique location.

associated expenses for an exercise of similar scope and nature to the incident in each case is developed. The estimate comprises the same company configuration and personnel numbers dispatched for the case's response. However, the structure of an exercise requires all participants to be present for the duration of the event. During an exercise that replicates an actual event, companies that were on-scene for a limited time during the real-world incident spend an increased amount of time on-scene in the staging area during the exercise. Consequently, the time spent participating in an exercise is often not directly proportional to the real world role for some companies. Each exercise calculation is based on the actual work time of the incident plus four hours for the required pre-and post-exercise activities (e.g., check-in, safety brief, hotwash, site clean-up). Due to the impracticality of using such a large number of in-service companies for an exercise and the fact that reserve apparatus and re-hired personnel are commonly used for large-scale exercises, the salary tables instead of the cost-recovery tables are used to calculate personnel costs.¹⁷ Expenses for the development of the exercise AAR are not included since the AAR is typically written by a salaried employee. However, it should be noted that writing an AAR typically takes 12 hours.

The data table constructed for the homeland security class includes the number of sessions conducted, the personnel hours required to deliver the training, and instructor expenses. Instructors taught on their day off, which entitles them to the prescribed overtime rate for their rank. The table includes expenses related to participation in the train-the-trainer course. Participants attended the training while on-duty as part of routine in-service training, so no participant expenses were incurred.

The costs for equipment, supplies, and personnel comprise the homeland security exercise data table. The total number of personnel hours encompasses the time spent planning, executing, and evaluating the exercise. Data is separated for the hazmat incident and technical rescue incident components of the exercise.

¹⁷ The officer position on a truck, engine, or squad may be staffed by either a lieutenant or a captain. The officer position on an ambulance may be staffed by either a paramedic-in-charge or an ambulance commander. For consistency purposes, all rates are based on the suppression officer being a lieutenant and the ambulance officer being a paramedic-in-charge. Both titles are the junior ranking officers.

IV. CHICAGO FIRE DEPARTMENT INFORMATION SOURCES

The two sections in this chapter provide context for the reader on the data sources and sample cases used for this thesis project. The first section details CFD processes to capture incident response information. The second section provides a brief description of each case selected for the sample.

A. DATA CAPTURE PROCESSES

The purpose of this section is to validate the reliability of the sources used for data collection. With the exception of the AARs, the data capture for each source is governed by either a CFD general order or Office of Emergency Management and Communications (OEMC) Fire Alarm Office¹⁸ standard operating procedures. CFD uses a standardized template for AARs, however, the conduct of formal critiques and development of AARs is not governed by a general order.

Each time a 9-1-1 call is received and a fire company dispatched, the Fire Alarm Office creates an incident ticket in the CAD system. The CAD system populates the incident ticket with the time, date, location, type of incident, and companies dispatched. Information captured for each dispatched company includes the unit number and the times of dispatch, departure from the fire house, on-scene arrival, and release from the scene. Company officers press a button on the portable data terminal (PDT) that is installed in the apparatus to enter departure and arrival times. Since the PDTs are connected to the CAD system, all information inputs on the PDT are automatically transmitted to the CAD system and entered in the incident ticket. Dispatch personnel manually enter remarks in the ticket to document reports provided by company officers of on-scene conditions, mitigation activities, resource requests, and status of response operations. Incident tickets are archived in the CAD system as printable CAD reports.

¹⁸ The OEMC's Fire Alarm Office receives 9-1-1 calls and is responsible for dispatch of all fire companies.

Electronic NFIRS reports are pre-populated with data from the CAD incident ticket, but require company and chief officers to manually enter additional narrative information. Officers enter mitigation priorities and strategies, the assignment of each responding company, the role of on-scene support agencies, and additional resource requests and/or notifications into the NFIRS report. Some officers include the tactical strategies used by each company to carry out their specific assignment(s). Information on injured victims, both those who treated on-scene and released or transported from the scene for further medical care, is captured in the NFIRS report.

For incidents involving hazardous materials, the Hazardous Incident Team officer completes an electronic hazmat-specific NFIRS report. This report is appended to the main NFIRS report. This report contains information on the type of hazardous materials present, circumstances and equipment involved in the release, weather conditions, tools used for material identification, and equipment, supplies, and manpower assignments. The officer also writes a narrative detailing isolation, identification, notification, mitigation, and termination activities. Chicago-specific hazmat tactical worksheets and photographs to document the incident are often incorporated as part of the hazmat NFIRS.

Per CFD protocol, each company officer documents all of the company's activities for the shift in the company's leather-bound journal. For each incident to which the company is dispatched, the officer documents the type of incident, the CFD Incident Commander, the company's assignment(s), the specific assignment of each company member, tactics employed to complete the assignment, equipment used, and notifications made. Situation specific, journal entries may include the activities of other on-scene agencies, injuries to responders, equipment that needs to be repaired or replaced, and other unique circumstances encountered or actions taken. All companies and chief officers maintain journals.

Chicago Fire Department AARs contain a brief narrative of the incident, actions taken for mitigation, and an analysis of what worked well and areas for improvements.

Some CFD AARs contain additional information such as the impact certain training classes have had on operational capabilities and/or CFD's interactions with external response partners.

B. BRIEF CASE DESCRIPTIONS

1. Hazardous Materials Incident

a. Case 1—Level II Hazardous Materials Incident With an EMS Plan I¹⁹

On a July weekday, a 9-1-1 call reporting an explosion at a food processing plant is received. The initial responding companies confirm the report and identify the source of the explosion as a large outdoor chemical storage tank. A Level I Hazardous Materials Incident (hazmat) and EMS Plan I response are initiated; the hazmat is subsequently escalated to a Level II. After conducting metering operations to identify and establish hot, warm, and cold zones, personnel trained as hazardous material technicians don appropriate PPE and enter the hot zone. PH strips and chemical spillyter sticks are used to test run-off and stagnant water for chemical contamination. The chemicals involved are identified as glycerine and sulfuric acid. On-scene Fire Suppression and Rescue companies assist the Hazardous Incident Team with deploying drain covers to prevent chemical run-off from entering the storm sewer and with establishing emergency and technical decon. Two plant employees require decontamination and emergency medical treatment before being transported to a hospital for further medical evaluation and treatment. One injured CFD member requires decontamination before receiving on-scene emergency medical treatment and being transported to a hospital for further treatment. Representatives from the Chicago Departments of Fire, Police, Environment, and Buildings, Common Wealth Edison, People's Gas, and personnel who worked in the plant staff the unified command post.

¹⁹ An EMS Plan I sends five additional ambulances to the scene, which are above what has already been dispatched for the Level II hazmat (CFD, 2007).

The Fire Department Incident Commander secures the incident and turns it over to the Department of Environment for recovery operations. Incident mitigation took approximately four hours.

b. Case 2—Level II Hazardous Materials Incident

On a weekday morning in January, a 9-1-1 call reporting a broken ammonia pipe in a cold storage facility is received. A Level I hazardous materials response is dispatched. The companies who conduct the initial investigation confirm the report and escalate the incident to a Level II hazmat. The 17 employees in the facility are evacuated. EMS personnel triage and treat the evacuees, all of whom refuse transport to a hospital. CFD hazardous materials technicians don Level A PPE²⁰ to enter the building and conduct metering operations. The incident is mitigated by shutting off the supply valve to the broken ammonia supply pipe. The building interior is ventilated by the pre-installed exhaust fans. Fire department personnel conduct metering operations outside the building to ensure the safety of surrounding residents during building ventilation. One CFD member became ill during the incident for an unrelated medical issue and was transported by EMS to the hospital. Incident mitigation took two hours and 45 minutes.

2. Search and Rescue (Land-Based) Incidents

c. Case 3—Confined Space—Trench Rescue

On a weekday afternoon in May, a 9-1-1 call requesting emergency assistance to free a construction worker trapped in a below grade hole is received. The companies initially dispatched to the scene confirm that there one person is trapped in a 5' x 5' x 10' hole by an earth cave-in. The victim is buried up to his knees in an unsupported trench and reports that his legs are pinned underneath a pipe. A full confined space, trench rescue response is initiated. Plywood, struts, air bags, and shoring are used to stabilize the hole. Shovels and a vacuum truck are used to facilitate the

²⁰ Level A PPE is a fully encapsulating protective suit that is vapor and gas seal proof under which a self-contained breathing apparatus is worn.

removal of the debris trapping the victim. While the victim is still trapped, EMS personnel start an IV line on the victim and administer IV fluids, pain medications, and other medications as appropriate for a victim with crush injuries. The victim's blood sugar level is monitored throughout the incident. An A-frame is constructed to assist with packaging and removing the victim from the hole. Upon removal, the victim is treated on-scene and transported to a hospital. External departments brought resources to the scene as requested to assist with mitigation operations. Incident mitigation lasted approximately five hours and 30 minutes.

d. Case 4—Confined Space—Trench Rescue

On a weekend day during August, a 9-1-1 call reporting two victims trapped in a below-grade hole is received. The first companies on-scene confirm that two victims are trapped in an unsupported trench, with the earth cave-in trapping one victim to just above the waist. A full confined space, trench rescue response is initiated. The trench is stabilized with plywood, struts, and shoring. Rigging ropes are attached to the 1st and 2nd floor decks that are above the trench location. Responders use shovels and a vacuum truck to remove the soil. One of the victims requires the use of a Harty harness and hoist for removal from the trench. EMS monitors the victims throughout the incident and upon removal from the trench, transports both to a hospital. Incident mitigation is completed in approximately six hours and 15 minutes.

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V. ANALYSIS AND FINDINGS

This chapter is comprised of two sections. The first section discusses the similarities and differences between the response to real-world incidents and the federally defined capabilities that are needed to respond to homeland security incidents. The second section details the modified cost-benefit analysis conducted to assess whether or not using formal critiques and AARs of real-world incidents is a practical strategy for supporting the long-term sustainment of specialized homeland security training and education. The modified cost-benefit analysis is divided into three subsections: efficiency analysis, process values analysis, and analysis of robustness and improvability.

A. ANALYSIS OF SIMILARITIES AND DIFFERENCES

The TCL provides guidance to state and local government agencies on the capabilities deemed necessary to effectively respond to homeland security incidents (DHS, 2007b). The activities and tasks required to achieve each capability are identified, as are the specific actions performed to complete each task.

EEGs for each capability are structured so that evaluators can assess the performance of each activity by evaluating the task individually and then recording an overall assessment of progress toward achieving the capability. Achievement of activities is measured by assessing the level of task completion and the timeliness with which target benchmarks are attained. The categories for task completion are fully complete, partially complete, not complete, and not applicable. Benchmarks are measured by comparing the targeted time and the amount of time actually required for task completion. A narrative is used to record the overall assessment of strengths and areas for improvement.

To assess the similarities and differences between incidents that originate from conventional and asymmetric causes, each of the selected capabilities and cases are analyzed separately, followed by an assessment of whether or not the case demonstrates performance of the capability. This section concludes with a summarization of the similarities and differences of the findings for the two capabilities.

The differences between data collection methods for this study and HSEEP-compliant exercises may impact the assignment of level of completion rankings. During an exercise, evaluators observe player actions and conversations and make note of their observations on the EEG. Exercise evaluators may see or hear things that help to justify assigning a greater level of completion than what a company officer routinely documents to indicate performance of the same activity. For this thesis project, if documentation does not exist, it is assumed that the activity or task was not performed. Therefore, some of the rankings assigned may be more restrictive than the rankings assigned if an EEG is completed by a real-time evaluator. Additionally, exercise evaluation plans permit the exercise design team to eliminate some of the TCL activities and tasks from the exercise evaluation. This thesis project assesses the level of completion for all activities and tasks for each of the selected target capabilities.

1. Weapons of Mass Destruction/Hazmat Response and Decontamination Target Capability

Eight activities, 46 tasks, and 18 time sensitive benchmarks are identified for the *Weapons of Mass Destruction/Hazmat Response and Decontamination* target capability.

a. Case 1—Level II Hazardous Materials Incident With an EMS Plan I

Case 1 provides an opportunity to demonstrate performance of all eight activities that comprise the *WMD/Hazmat Response and Decontamination* target capability. Case documentation reveals that CFD personnel fully completed 35 of the 46 required tasks, partially completed three tasks, did not complete four tasks, and that four tasks are not applicable to the circumstances of this case (see Table 1). CFD met the target time for 14 of the 17 applicable benchmarks. Although performance of the activities for the three benchmarks not met is documented, the lack of recorded timeframes precludes an accurate assessment of whether or not the target was achieved.

Two of the three tasks ranked as partially completed received this measurement because the required tasks are not documented in the specified manner. The EEG requires the development of a written Incident Action Plan (IAP). Although

the case's plan of action is documented in the CAD report, NFIRS report, and company journal entries, this documentation does not meet the written IAP requirement. This requirement does not account for the fact that formal IAPs are typically not developed for incidents that only last for one operational period since the incident is usually mitigated in less time than it takes to develop the IAP. While the conduct of an informal critique prior to companies being released from the scene is standard for the CFD, neither the occurrence of a critique nor development of an AAR are documented as required in the EEG. The incident did not require performance of the third task judged as partially complete to the level prescribed in the EEG. Some of the specified actions were performed in a scaled manner, demonstrating cognitive ability to correctly identify the need and initiate performance execution.

Lack of documentation is the reason that three of the four tasks identified as not completed received this ranking. For the fourth task, plume modeling, there is neither documentation for activity completion nor an explanation on why plume modeling was not required.

This case demonstrates overall achievement of the target capability *WMD/Hazmat Response and Decontamination*. This case provides an opportunity for responders to execute different decontamination techniques, proactive protective activities, and use different metering and product identification equipment. Documentation of task performance indicates that the response to this real-world emergency provided CFD personnel with an opportunity to execute the critical activities and tasks deemed necessary to mitigate hazardous material incidents that originate from asymmetric causes.

Table 1. Summary of Target Capability Task Performance

	Total Number of Tasks	Number of Fully Completed Tasks	Number of Partially Completed Tasks	Number of Tasks Not Completed	Number of Tasks Not Applicable	Number of Benchmarks	Number of Benchmarks Achieved	Number of Benchmarks Not Applicable
WMD/Hazmat Response and Decontamination Case 1	46	35	3	4	3	18	14	1
WMD/Hazmat Response and Decontamination Case 2	46	25	6	10	5	18	14	4
Search and Rescue (Land Based) Case 3	28	22	2	0	4	17	10	7
Search and Rescue (Land Based) Case 4	28	21	3	0	4	17	10	7

b. Case 2—Level II Hazardous Materials Incident

Case 2 provides an opportunity to demonstrate performance of all eight activities that comprise the *WMD/Hazmat Response and Decontamination* target capability, but the nature of the case limits the number of tasks and actions required for incident mitigation. Full completion of 25 of the 46 tasks and partial completion of six tasks are contained in the case documentation. Ten of the target capability tasks are not completed and five tasks did not apply. All applicable benchmarks are met.

Again, the primary reason for a task receiving a partial or not complete ranking is lack of documentation. Although metering operations are documented and metering is typically conducted to establish the hot, warm, and cold zones for a hazardous materials incident, documentation regarding the establishment of zones is not found. Standard procedures for entry into a hazardous environment that requires the use of Level

A personnel protective equipment (PPE) requires establishment of a back-up team and emergency decon. While it is probable that both occurred, lack of documentation causes these tasks to receive partial and not completed rankings. Development of formal IAPs, plume modeling, and the conduct of informal and formal critiques are not documented.

This case demonstrates achievement of seven of the eight activities listed for the *WMD/Hazmat Response and Decontamination* target capabilities. Insufficient documentation exists to determine whether or not decontamination operations, the eighth activity, for first responders occurred in accordance with the required tasks prescribed in the TCL. This case provides an opportunity for responders to operate in Level A PPE, conduct metering operations, and triage and treat victims. Documentation from this case reveals that the activities and tasks performed in response to an incident originating from a conventional cause are consistent with the activities and tasks that DHS anticipates are needed to mitigate incidents with asymmetric origins.

c. Comparison of Cases 1 and 2

Both cases provide opportunities for responders to execute the activities and tasks that comprise the target capability *WMD/Hazmat Response and Decontamination*. However, neither case alone provides an opportunity to exercise all of the tasks associated with each activity. This finding is reflective of HSEEP allowances for selecting specific activities and tasks for inclusion in the evaluation that are specific to the exercise scenario.

The level of response required to mitigate each case may be less than what is required to mitigate an incident with an asymmetric origin. For example, the limited number of people requiring decontamination in the cases could potentially be a much greater number during a homeland security incident. However, the evaluation of the cases suggests that real-world incidents do provide opportunities to perform similar tasks. Routine execution increases abilities to successfully perform a task under different circumstances that may be more complex in nature.

In both cases, documentation of certain tasks does not consistently meet the standards established in the target capability. Without observing on-scene activities

or interviewing personnel involved in the incident response, it is impossible to know whether or not the tasks were performed but not documented or if the tasks were just not performed. There is consistency between the two cases in the items not documented, such as searching the scene for an improvised explosive device, plume modeling, and conducting informal critiques. This consistency may be the result of the tasks being standard in the response to every hazardous materials incident and therefore not documented as a special activity performed. Conversely, the lack of documentation may exist purely because the tasks are not performed. Possible reasons for non-performance include the lack of requirement by the circumstances of the incident, the tasks not being included in departmental operating procedures, and/or neglect by the incident commander or company officer. An on-scene evaluator would likely observe if such activities are performed but not documented and/or be aware of the reason(s) for non-performance. However, the structure of this thesis project limits the extent of observations to existing documentation only, impeding the ability to identify the true causes.

Overall, the cases suggest that the activities and tasks for this target capability are routinely performed when responding to incidents of conventional origin. The tasks performed are customized to the requirements for incident mitigation. The similarities between the responses to conventionally and asymmetrically caused hazardous materials incidents create opportunities for using conventionally caused incidents to prepare for ones of asymmetric origin.

2. Search and Rescue (Land-Based) Target Capability

Seven activities, 28 tasks, 13 time sensitive elements, and four numeric targets are identified for the *Search and Rescue (Land-Based)* target capability.

a. Case 3—Confined Space—Trench Rescue

Case 3 provides an opportunity to demonstrate performance of six of the seven activities that comprise the *Search and Rescue (Land-Based)* target capability. Case documentation reveals that CFD personnel fully completed 23 of the 28 required

tasks, partially completed two tasks, and that four tasks are not applicable. There are no missed opportunities to complete a task. Ten of the 17 benchmarks are met, seven do not apply.

One activity in this target capability is devoted completely to searching for possible victims. This case's victim is visualized from incident onset, obviating the need to perform search activities. In spite of this, documentation identifies the performance of some of the tasks associated with this activity since search and rescue activities are systematic, integrated, and commonly share the procedures used for scene control and communications. For example, the system used for accountability of search personnel and equipment is established since it is the same process used for tracking resources allocated to rescue operations. The communication and planning functions that are established on-scene for this case and a single visualized victim are consistent with procedures used in support of search activities for trapped and missing victims. The available documentation points toward four of the six benchmarks for this activity identified as not applicable as possibly receiving a fully or partially completed score based on the tasks performed. However, since these benchmarks are related to an activity that does not apply to this case, they are also categorized as not applicable.

Two tasks are ranked as partially complete. The first receives this ranking since the EEG requires the submission of documentation during the course of the incident. For operations that only last one operational period, CFD policy requires documentation to be completed after the incident is secured. Case 3 lasts for one operational period. The second task scored as partially complete is sanitation precautions. This ranking is assigned since the case does not require a significant number of actions to maintain sanitation. Documentation does exist in regards to medical waste removal and securing the scene prior to departure, but these activities do not fully address the comprehensive definition of sanitation. Partial credit is given since responders documented consideration of this task and completion of the limited actions required.

Benchmarks for this target capability include requesting search and rescue assistance from regional and federal partners and extracting victims from different types

of construction. Resources external to the City are not required for case mitigation. Only one type of construction is involved in this incident.

By and large, this case demonstrates performance of the target capability *Search and Rescue (Land-Based)* for the activities and tasks that apply to the case. Although the search activity is not required, this case provides an opportunity to execute complex rescue operations. Responders perform rescue operations using equipment specifically procured to enhance CFD preparedness for mitigating homeland security incidents. Responders demonstrate application of rescue techniques learned while attending specialized training that is funded with Homeland Security Grant Program funding. Documentation of task performance suggests that this real-world emergency provides an opportunity to execute critical activities and tasks deemed necessary by DHS to mitigate homeland security incidents that originate from asymmetric causes.

b. Case 4—Confined Space—Trench Rescue

The findings from Case 4 are similar to the findings from Case 3. Performance of six of the seven activities is documented with 21 of the 28 required tasks being fully completed. Case documentation identifies that three tasks are partially completed and that four tasks do not apply. Again, there are no missed opportunities to perform at least part of an applicable task. Of the 17 benchmarks, 10 are achieved and 7 do not apply.

Similar to Case 3, Case 4 does not require search activities and only lasts for one operational period. Extensive action to address sanitation and external resources is also not necessary. Although issues and accomplishments are documented by company officers, a formal critique and AAR are not documented, earning this task a score of partially complete. For reasons analogous to the ones listed for Case 3, documentation for Case 4 suggests that this case demonstrates achievement of the applicable activities and tasks for the target capability *Search and Rescue (Land-Based)*.

c. Comparison of Cases 3 and 4

Both cases provide opportunities to execute the activities and tasks that comprise the target capability *Search and Rescue (Land-Based)*. Although neither case requires search activities, the dual use of support mechanisms for search and rescue activities creates an opportunity to demonstrate competence for certain functions related to search activities. The search activity and tasks not applicable to these cases are important skills that must be mastered to fully achieve this capability. It is likely that a different type of conventionally caused incident, such as a building collapse, will provide opportunities to perform these tasks. This finding highlights the flexibility of the HSEEP for selecting activities and tasks that apply to an exercise scenario, acknowledging that not all activities and tasks apply to every scenario.

The number of victims in each case is small. While the victim number does not trigger a response on the scale of a mass casualty incident, the cases provide opportunities to utilize the same skills for victim rescue and medical treatment, but with a lesser quantity of personnel. Whereas scene control may become more complex for larger incidents, additional supervisory personnel are also dispatched for larger incidents to maintain an effective span of control. The National Incident Management System (NIMS) identifies the standard for span of control as one supervisor for every three to seven subordinates (Federal Emergency Management Agency, 2005). Larger incidents may require the establishment of additional levels of supervision, but tactical procedures and communication protocols remain unchanged.

Appropriate use of technical rescue techniques is a commonality found between the cases. Specialized training and education is required to learn the appropriate rescue techniques but practice is required for skill mastery. Evaluation of case documentation in terms of the *Search and Rescue (Land-Based)* target capability identifies that the execution of the technical rescue techniques performed to mitigate incidents that originate from conventional causes are the same as the those required to mitigate incidents caused by asymmetric threats to homeland security. While specialized

education and training remains necessary to develop technical rescue skills, the findings from this evaluation suggests that real-world incidents can be used to prepare for a possible homeland security incident.

3. Comparison of Capabilities

The findings from the cases for both the *WMD/Hazardous Material Response and Decontamination* and *Search and Rescue (Land-Based)* capabilities imply that similar activities and tasks are used to mitigate incidents that originate from both conventional and asymmetric causes. Incidents of conventional origin may be of smaller scope than those of asymmetric origin, but the mitigation techniques and procedures are largely consistent.

None of the cases provide an opportunity to demonstrate performance of all activities and tasks, which reflects HSEEP planning assumptions. Opportunities to fully complete some tasks are limited by the size of each incident. The benchmarks are consistently met, often being achieved in less than half the amount of the targeted timeframe. The geographic confines of the City of Chicago and richness of CFD's specialized resources are likely confounding factors for this finding. Fire departments that have fewer specialized resources may not be able to fully replicate these findings. However, departments that comply with National Fire Protection Agency response time targets should be able to initiate response, basic on-scene activities, and the request for mutual aid resources required to support specialized operational requirements within the targeted benchmarks.

The cases selected to evaluate the *WMD/Hazardous Materials Response and Decontamination* capability display a greater variability among tasks than the *Search and Rescue (Land-Based)* capability cases. This variance is attributable to the hazardous material incidents originating from different causes—a chemical reaction causing an explosion vs. a broken pipe leaking ammonia, while both trench rescue cases originated from the same cause—earth caving-in on an unsupported trench. This variance highlights the importance of not using a single incident or single type of case in isolation to assess overall achievement of a capability. Cases 3 and 4 demonstrate that the

activities and tasks used to mitigate similar incidents are consistent. Cases 1 and 2 demonstrate that there can be great variability in the tasks required to mitigate incidents with the same classification.

Documentation, particularly documentation of formal critiques and AARs, is consistently a weakness found among cases. Case 3 is the only case for which documentation of a formal critique and AAR is found.

Bazerman and Watkins (2004) assert that a predictable surprise will occur if a problem is allowed to worsen over time and/or the tendency to maintain the status quo impedes adequate preparation for addressing known deficiencies. Evaluation of the cases in terms of the target capabilities shows that the tasks performed during the response to conventionally caused incidents are consistent with the tasks required to mitigate incidents with an asymmetric origin. Fire departments know what activities and tasks they need to perform if called upon to mitigate an incident of asymmetric origin. Identifying areas for improvement during incidents of conventional origin and acting upon this information to strengthen areas requiring improvement can help a department to avoid a predictable surprise.

B. MODIFIED COST-BENEFIT ANALYSIS

Three analysis criteria are addressed in this section: efficiency, process values, and robustness and improvability. CFD financial data is used to assess efficiency. The U.S. Fire Administration's recommended processes for conducting formal critiques and writing AARs, DHS training catalog, and the HSEEP process for planning exercises are used to conduct the process values, robustness, and improvability analysis.

1. Efficiency Analysis

Efficiency is analyzed in terms of the four cases and the DHS-approved awareness level training course and HSEEP-compliant exercise selected as the training and exercise examples used to demonstrate the current policy. The results of the analysis are judged in terms of the number of additional personnel who could attend technical training if a more cost-efficient means of sustaining specialized training and education is employed.

a. *Case 1—Level II Hazardous Materials Incident With an EMS Plan I*

Incident mitigation took approximately four hours and required 113 responders, who comprised 46 companies (see Table 2). Responders collectively invested 226 hours²¹ in this incident. The response activities cost \$12,642.36²², of which 100% is eligible for cost recovery from the business owner since the incident resulted from a violation of hazardous material handling standards. Although not conducted, a formal critique of this incident requires an investment of 339 additional personnel hours²³, for a total cost of \$16,120.68 (see Table 3). An exercise of comparable size, scope, and length requires an investment of 904 personnel hours²⁴ and costs

²¹ Personnel hours for each case are calculated based on the actual time each fire company was engaged in responding to the incident. The number of hours per company is multiplied by the number of personnel assigned to the company. The total personnel hours for all companies is added together.

²² Costs for each case are calculated using the CFD's cost-recovery salary tables. The number of hours per firefighter and paramedic are multiplied by the average salary for the designated rank. Equipment costs are calculated based on the length of time each piece of equipment is dedicated to the response. The costs for all personnel and equipment are added together.

²³ Time investments in formal critiques are calculated based on the critique lasting two hours, plus an additional hour for transit to and from the critique location. It is assumed that all personnel who responded to the incident will participate in the critique; therefore, the number of incident responders is multiplied by 3-hours each.

²⁴ Personnel hours for exercises are calculated based on the duration of the exercise, plus an additional four hours for the pre- and post-exercise activities that are required by HSEEP.

\$44,858.24²⁵. Additional costs for an exercise include exercise-specific supplies, and personnel expenses to plan, control, and evaluate the exercise.

b. Case 2—Level II Hazardous Materials Incident

Case 2 lasted two-hours and 45 minutes and required 20 companies staffed by 57 personnel to invest a combined total of 68 personnel hours to secure the scene. The financial costs for human and equipment resources eligible for cost recovery are \$3,974.74. A formal critique of this incident requires an investment of 141 personnel hours at a total cost of \$7,981.08. A comparable exercise costs \$16,815.74, requiring a 317 personnel hour investment.

²⁵ Exercise costs are calculated based on the average overtime rate for the rank of each participant times the number of hours of participation.

Table 2. Resource Requirements for Exercises of the Same Scope and Duration as an Incident

	Length of Incident	Number of Responders	Number of Companies	Number of Personnel-Hours	Total Cost of Response	Number of Exercise Companies	Total Personnel-Hours per Exercise ^a	Total Cost of Exercise
Case 1	4 hours	113	46	226 hours and 19 minutes	\$12,642.36	42	904	\$44,858.24
Case 2	2 hours 45 minutes	57	20	68 hours and 23 minutes	\$3,974.74	17	317.25 hours	\$16,815.74
Case 3	6 hours and 30 minutes	99	36	439 hours and 27 minutes	\$25,004.82	28	987	\$52,870.44
Case 4	6 hours and 20 minutes	98	33	343 hours and 31 minutes	\$20,297.88	26	840 hours and 20 minutes	\$44,560.65
DHS-approved course	17 months		77 sessions	2250 (instructors only)	\$131,007.70			
HSEEP- compliant exercise- Hazardous Materials Incident	12 hours	106				9 companies plus role players	926	\$34,528.28
HSEEP-compliant exercise—Search and Rescue Incident	12 hours	35				16	546	\$25,570.04 (personnel); \$24,000 (supplies)

Note. The number of responders is the same for the incident response and the exercise.

^aFour hours are added to the time required for incident mitigation to account for required pre-and post-exercise activities. Personnel-hours include hours for planning, evaluation, scene staging, and venue clean-up.

Table 3. Resource Requirements for Formal Critiques

	Length of Critique	Number of Responders	Number of Companies ^a	Number of Personnel-Hours	Total Cost of Critique	Total Cost of Comparable Exercise
Case 1	3	113	42	339	\$16,120.68	\$44,858.24
Case 2	3	57	17	141	\$7,228.86	\$16,815.74
Case 3	3	94	27	282	\$15,190.44	\$52,870.44
Case 4	3	82	26	246	\$12,271.44	\$44,560.65

^aA lesser number of companies is listed for attending the critique than the number of companies that responded since some support apparatus are staffed by team companies.

c. Case 3—Confined Space—Trench Rescue

Mitigations activities for Case 3 lasted six hours and 30 minutes and costs \$25,004.82. Thirty-six companies with a combined total of 99 responders invested 439 personnel hours in response activities. Costs for this case are recoverable since the construction workers violated Occupational Health and Safety Administration safety standards. The formal critique conducted required 282 personnel hours and cost \$15,190.44. An exercise of comparable size, scope, and length requires 987 personnel hours, costing \$52,870.44. Additional expenses are incurred for exercise planning, evaluation, and control, plus supplies required to properly stage the scene.

d. Case 4—Confined Space—Trench Rescue

The confined space- trench rescue for Case 4 required 98 personnel on 33 companies. The incident lasted six hours and 20 minutes, but required an investment of 242 personnel hours. Expenses for the response total \$20,287.88 and are recoverable. A formal critique requires 246 additional personnel hours and \$13,176.99 while an exercise of similar nature involves 840 personnel hours and costs \$44,560.

e. DHS-Approved Awareness Level Training Course

Seventy-eight sessions of the class titled *Emergency Response to Terrorism: Basic Concepts* were conducted over a 17 month time period. Instructors invested an average of 28.8 hours per session, with the total instructor expenses for all class sessions equaling \$131,007.70. Additional expenses are not incurred since students participated while on-duty. Although opportunity costs are maximized by conducting this training while members are on-duty, delivery of this class took over a year since it had to compete with other departmental training mandates.

f. HSEEP-Compliant Exercise

The *Operations Springboard* exercise consisted of a series of drills on consecutive days to test isolated target capabilities. The target capabilities exercised during this event include the *WMD/Hazmat Response and Decontamination* and *Search and Rescue (Land-Based)* capabilities.

Exercise of the target capability *WMD/Hazmat Response and Decontamination* required 926 personnel hours and cost \$34,528.28. Expenses can be reduced by 640 personnel hours and \$21,254 if volunteer role players are used instead of candidate firefighters. However, the two week time period between the decision by the exercise host to conduct the exercise and the exercise dates precluded the CFD from recruiting volunteers. Although volunteers themselves may be free, using volunteers does require investments in recruitment, training, and on-scene management activities. The expense for the 56 personnel hours dedicated by 40-hour employees to exercise planning and execution is not included in the financial costs since these positions incur neither overtime nor require backfill.

Approximately \$50,000 was expended to exercise the *Search and Rescue (Land-Based)* capability. Expenses include the cost of materials for staging the scene and mitigation activities (e.g., nails, plywood, spray paint), personnel expenses for staging the

scene²⁶ and player participation, as well as charges for exercise planning and evaluation. The exercise required an investment of 546 personnel hours. The 92 hours invested by 40-hour employees are included in the personnel hour total, but not included in the financial expenses since these positions do not incur overtime or require backfill.

g. Discussion

The data suggests that conducting formal critiques of real-world incidents as a training and education tool is more economical than conducting a staged exercise to practice a similar skill set. The average cost of a formal critique for the four cases is 34% of the estimated cost of a comparable exercise, with a range between 28 and 43%. Formal critiques for the hazardous materials incidents cost an average of 34% of the expenses incurred by the HSEEP-compliant exercise, while the search and rescue formal critiques cost an average of 28% of the amount of money spent on the exercise. There is consistency between the different incident types with respect to the ratio of savings.

Opportunity costs are optimized by conducting training and education while personnel are already on-duty since personnel are paid irrespective of how their on-duty time is allocated. Although no additional costs are incurred for on-duty activities, assessing the issue in terms of financial impact creates a mechanism for a meaningful comparison of options. Fire departments must operate within a defined budget, which is often lean. Management is frequently challenged to find ways for accomplishing more with fewer resources, necessitating that full advantage be taken of all opportunities for cost-efficient learning.

Dedicating personnel time to participation in formal critiques may temporarily make a company unavailable for dispatch. However, if non-participating companies can “cover” for the limited time period without operational capabilities being negatively impacted, the cost of this learning opportunity has been minimized. As demanded by operational requirements, a company can be dispatched from the critique

²⁶ The exercise scenario required search and rescue operations in a collapsed structure. To ensure safety, trained personnel must stage and secure the venue prior to the initiation of exercise play. Staging the exercise venue, which consisted of one collapsed structure staged to permit internal access by players and three collapsed structures staged for external play only, required 240 personnel hours, incurring personnel expenses of \$10,745.76. This cost excludes the 48 hours invested by 40-hour employees.

location to the incident scene. While such an interruption may negatively impact the quality of the formal critique discussion, it is quite possible that an interruption will not occur. On a daily basis, CFD companies spend part of their shift drilling or attending mandatory on-duty training (e.g., CPR, NIMS compliance) without interruption. If a company is dispatched to an incident during the critique, learning still occurs during the time company members participated in the critique discussion. Including formal critiques as a routine practice for organizational and individual learning does not change daily training requirements or incur additional expenses, but instead minimizes the costs for providing an additional opportunity for meaningful learning.

When firefighters assigned to platoon shifts attend specialized technical training classes, another firefighter must be re-hired at an overtime rate to backfill the position on the firefighter's assigned company.²⁷ The special operations training classes attended by CFD personnel typically last five days, necessitating that two platoon shifts²⁸ be covered for each student. The average cost of tuition and backfill for a firefighter to attend a hazardous materials technician A or B class is \$2,591, with the backfill costs increasing for students of greater rank. On average, a class for one of the many technical rescue skills costs \$3,675 per student of firefighter rank.

The difference between the estimated exercise expenses and the critique costs for the hazardous material incident cases is \$38,325, or an average of \$19,162.50 per incident. Comparing the difference in savings between the average cost of a formal critique for Cases 1 and 2 and the expenses incurred by conducting the HSEEP-compliant hazardous materials incident results in a \$22,854 difference.

For the search and rescue cases, the difference between the estimated exercise expenses and critique costs is \$69,980, or an average of \$34,990 per incident.

²⁷ The Labor Contract between the Chicago Firefighters Union, Local 2 International Association of Firefighters and the City of Chicago, Illinois (2003) section 16.4 stipulates the minimum requirements for manning.

²⁸ The CFD uses a three-platoon schedule rotation for all fire suppression and rescue personnel. Each platoon shift lasts for 24-hours. Although some firefighters will only require coverage of one platoon shift while attending a training that lasts for five consecutive days, the calculations in this paper are based on two shifts per individual. This ratio produces a lower number in terms of the number of personnel who can attend training for the specified amount of funding available, but ensures that the number of personnel identified is the minimum number and that findings are not over estimated.

The numbers remain consistent when calculating the number of personnel who can attend technical rescue training if the HSEEP-compliant exercise expenses are instead allocated for training.

In summary, conducting formal critiques of real-world incidents that require the execution of capabilities listed on the TCL provides a cost-efficient means for maximizing learning opportunities. Since response operations and formal critiques are conducted while personnel are on-duty and already being paid, no additional financial expense is incurred. Learning objectives are still met, but less expense is incurred.

2. Process Values Analysis

Analysis of process values is conducted in terms of opportunities for individual learning, organizational learning, and surprise avoidance. The strengths and weaknesses of the current policy—DHS-approved awareness level training classes and HSEEP-compliant exercises—and the proposed policy option—expanding the scope of formal critiques and AARs from real-world emergencies to include “what if” questions as a method for sustaining specialized education and training—are evaluated. The section concludes with an assessment of the overall findings.

a. Individual Learning

The current policy focuses primarily on a pedagogical learning model. For both classroom-based trainings and HSEEP-compliant exercises, the designers determine the areas of content focus. Although management level staff have input into the content focus, frontline firefighters often do not. Furthermore, the process for selection of content is usually not transparent. Both curricula and exercise scenarios are designed to address specific learning objectives. While exposing firefighters to certain information to facilitate learning is a management responsibility, overly structured content may limit learning opportunities if the content is not perceived by participants as useful and/or adequate time is not allocated for discussing participant-raised issues and interests.

To become a successful self-directed learner, Knowles (1989) contends that adults must be oriented to the model of andragogy since childhood education focuses primarily on the pedagogical model. The formal critique process incorporates the recommended orientation. At the critique onset, the facilitator leads the group in establishing a common operating picture by recreating the incident timeline (Garvin, 2000; Ockershausen, 2008). Allowing each company to recount their actions and address facilitator-posed questions on what worked and did not work well and the reasons why creates opportunities for active engagement by participants. By the time the session progresses to the “what if” questions, participants are established as active instead of passive participants in the learning process, completing the transition from the pedagogical to the adragogical learning model.

In spite of the fact that new information may be learned during classroom-based training and HSEEP-compliant exercises, the current policy does not guarantee opportunities for immediate application of the information, contradicting one of Malcolm Knowles’ primary principles of adult learning. Knowles postulates that immediate application solidifies information retention. If the time frame between information acquisition and the need for application is of extended duration, retention abilities may be decreased. This consequence positions learning to be dictated by circumstances that may be beyond one’s control instead of empowering the learning to take charge of their learning environment.

The traditional formal critique discussion focuses on what went well, areas for improvement, and changes that should be made to operations for a future response of similar nature (Garvin, 2000; Ockershausen, 2008). Expanding the critique discussion to include “what if” questions for similar incidents with an asymmetric origin provides opportunities for immediate application of the new information learned. Knowles (1989) asserts that immediate application of new information helps to solidify the concepts and behaviors learned. By influencing the direction of the discussion and actively participating, participants take responsibility for their own learning while increasing their bank of experience upon which to draw when faced with a challenging situation.

Delivery of the DHS-approved awareness level training course to all Department members required 78 sessions conducted over a 17-month period of time. The structured curriculum requires uniformity of delivery by the instructors. The time constraints for delivery limit the opportunities for in-depth discussion on areas of interest to class participants, making the class more instructor-focused as opposed to learner-focused as recommended by Kapp (Peterson, 2009). The effect of the repetitive curriculum delivery by the small group of instructors is unknown. Instructors possibly became more knowledgeable about the content areas during the 17-month program, which can improve the quality of the program delivery. Conversely, it is also possible that the repetition may cause instructor enthusiasm to wane, leading to less effective delivery of the material and/or possible dilution of content.

Action learning theory asserts that adults can use their daily jobs to exchange information with peers as a means of learning from collective experiences (Margerison, n.d.). The proposed policy capitalizes on the use of formal critique participants' recent experiences with responding to a conventionally caused incident to frame the discussion on responding to a similar incident that originates from an asymmetric cause. Participants are provided with opportunities to actively direct the learning process by exchanging information from previous experiences to resolve proposed challenges. Although firefighters routinely respond to similar types of incidents, the unique circumstances of each response—in terms of conditions of the incident venue, the unique make-up of personnel staffing the responding companies, and individual company assignments—makes the experiences of each firefighter unique. It is conceivable that two firefighters of equal training and assignment will learn different lessons from the response to the same incident. Providing a structured but open forum to exchange information on application of activities and tasks to mitigate an incident focuses the discussion on the key areas of importance to the learner while creating vicarious learning opportunities for other participants.

Instructor-led training programs require direct participation by all individuals who wish to learn the content covered. Although training materials may be made available to non-attendees, the opportunities for vicarious learning are limited. The

HSEEP format for exercise AARs is neither user-friendly nor conducive to use as a training tool. The current policy does create learning opportunities for actual participants, but opportunities for vicarious learning are extremely limited.

The AAR developed from the formal critique discussion creates a vicarious learning opportunity for firefighters who were not part of the incident response and/or the critique. This document can be made widely available as content for company schools, independent study, and reference material. Although the circumstances of the incident are unique, those using the AAR for vicarious learning can still relate to the content since there is a high likelihood that the reader has been involved in a response to a similar type of incident. This association helps to create a vivid image when one chooses to use an AAR as a tool for self-directed learning. Research by Irons (2006) demonstrates that incidents with vivid outcomes tend to be more memorable, increasing the effectiveness of this learning strategy.

b. Organizational Learning

The current policy focuses primarily on improving existing practices, which is commonly referred to as lower order learning (Espedal, 2008). Instructor-led trainings and HSEEP-compliant exercises focus on developing and strengthening specific, pre-determined capabilities. These training mechanisms are important tools for promoting the development of core competencies required to perform desired capabilities. However, these training methods commonly limit the opportunities for learning to a fixed set of objectives (Holmqvist, 2009). For example, instructor-led trainings are based on a preset curriculum and HSEEP-compliant exercises commonly have artificial timelines and scenarios that are designed to test specific aspects of existing policies. Additionally, exercise critiques involving all of the participants are commonly conducted immediately following the conclusion of the exercise; limiting the amount of time participants can spend critically analyzing events and possible solutions for areas of identified deficiency. While the existing policy provides opportunities for organizations to identify and correct areas of weakness, forms of lower order learning do not promote the creation of new capabilities (Smith and Elliott, 2007).

The proposed policy of expanding the scope of formal critiques and AARs to include “what if” questions provides opportunities for using real-world experiences to critically evaluate existing practices, experiment with making critical decisions, and discuss potential policy changes that may be necessary to improve upon existing capabilities. This learning methodology is consistent with the principles of higher order learning as described by Espedal (2008), Holmqvist (2009), and Carmeli and Sheaffer (2008). Learning organizations must critically analyze issues and develop innovative solutions. The proposed policy provides a means for front-line and management personnel to work together in a constructive manner to study the cause and effect relationship of actions. The intent of this policy is to promote learning from experiences and to memorialize effective practices, while recommending ways to improve upon areas of defined weakness to expand existing capabilities.

The training strategies embraced by the current policy focus singularly on learning for crisis (Smith & Elliott, 2007). Learning for crisis is a fundamental principle of fire service preparedness initiatives for a jurisdiction’s specific hazards. However, Carmeli and Sheaffer (2008) have shown that learning *from* crisis, not learning *for* crisis, is a key factor in decreasing the probability of future crisis occurrence. These researchers recommend that strategies for both learning for and from crisis be incorporated into training strategies aimed to provide opportunities for organizational learning. Learning for crisis provides little opportunity for frontline personnel to contribute to overall organizational learning.

Conversely, the proposed policy is designed to help all levels of organizational responsibility to learn from crisis, the learning strategy that organizations are most resistant to using (Smith & Elliott, 2007). The process used to conduct formal critiques addresses the most common barriers for organizational learning from crisis: availability of information, scape-goating, and lack of attention to lessons learned, while providing opportunities for contribution by all stakeholders. The formal critique process embraces the constructs for developing an appreciative learning culture, which has been shown to support organizational learning (Barrett, 1995).

An organization's ability to learn is commonly affected by its capacity for institutionalizing the learning process and balancing the different methods of learning (Smith & Elliott, 2007; Carmeli & Sheaffer, 2008; Holmqvist, 2009). Formal critiques and AARs cannot be used as an isolated organizational learning strategy, but must instead be used in combination with lower order methods such as instructor-led training and staged exercises. The minimal to no additional expenses incurred when conducting formal critiques and writing AARs removes the financial challenges commonly encountered when expanding training programs. The level of commitment by organizational leadership to learn from crisis by institutionalizing the proposed policy is a primary consideration for whether or not this strategy can be successfully incorporated into existing homeland security training and education programs.

c. Surprise Avoidance

Surprise avoidance is one of the purposes for homeland security training and education initiatives. Although the current policy does help to prevent the occurrence of surprise by increasing one's knowledge in a specified area, the policy's effectiveness is limited because of the minimal stakeholder involvement in accounting for two factors known to contribute to surprise. Both noise barriers and the overestimation of capabilities can create preparedness vulnerabilities when the current policy is used in isolation (Handel, 1977).

Noise barriers may cause an organization to misallocate preparedness resources. Noise can be in forms such as grant requirements that do not match a jurisdiction's primary risks, competing organizational responsibilities, or the inability to effectively process the volumes of threat-related information available to accurately assess risks. The current policy for classroom-based training and education limits preparedness funding expenditures to course curricula that have been pre-approved by DHS, largely excluding stakeholder participation in content selection. Although the DHS-approved training catalog is extensive, and there are mechanisms in place to request the approval of additional curricula, the lengthiness of the approval process and time requirements for implementation make selection of training programs already approved

by DHS a more time efficient decision. If the topics that comprise a jurisdiction's primary risks are not included in the catalog, budget constraints and competing priorities likely prevent a fire department from pursuing the new training, decreasing the possibility that input from frontline personnel will influence training decisions. As discussed by Bazerman and Watkins (2004), the tendency to maintain the status quo often negatively affects abilities for effectively preparing to confront predictable surprises. Noise barriers may influence the ability of a fire department to move beyond existing levels of preparedness.

The proposed policy option creates a means for stakeholder involvement in the decision to memorialize existing policy and make recommendations for policy improvements. The collaborative efforts to critique the incident addresses the factors identified in the Bayesian theory (Itti & Baldi, 2005) as contributors to surprise. Collaborative discussion on how to apply the lessons learned from a real incident to a similar incident with a different origin helps to decrease the uncertainty of expectations because the cause and effect relationship of actions is studied. Confidence in expectations of actions by all stakeholders contributes to surprise avoidance at both the individual and organizational levels.

Successful execution during an exercise often equates to perceptions of capability mastery, which may or may not be accurate when attempting to execute the same skills under different conditions. The nature of exercises makes true simulation of real-world conditions difficult. Practicing tactical procedures, communications, and decision-making skills is beneficial; however, it is questionable as to whether or not exercises truly provide opportunities for learning how to manage and/or avoid surprise. Furthermore, the opportunities for firefighters to influence the policy process are limited.

In staged exercises, planners routinely develop the scenario to test existing capabilities and ensure that allocated resources for the event match the requirements for successfully meeting exercise objectives. The structure of an exercise usually limits the cause of the problem to the pre-defined scenario parameters, limiting opportunities to practice comprehensive assessment skills required to employ surprise avoidance strategies in real-world situations (Henning, 2009). Injects may be incorporated into an

exercise to evaluate abilities to modify operations when additional information is received. However, the scenario and injects are commonly developed to assess a limited number of activities and tasks and may not reflect realistic conditions. Exercise participants may be afforded learning opportunities, but the breadth of opportunity may be limited to the pre-defined scope of learning selected by the planning team. As Itti and Baldi postulate, “surprise is related to the expectations of the observer” (2005, p. 2). In staged exercises, participants are commonly briefed on the scenario in advance of the event and have some forewarning of what to expect, limiting the ability to practice skills for dealing with surprise.

The proposed policy creates opportunities for firefighters to actively engage in helping the organization to avoid surprise and learn how to effectively manage situations in which surprise is encountered through the creation of an appreciative learning culture (Barrett, 1995). By expanding the scope of formal critiques and AARs to include “what if” questions, frontline personnel and administration are positioned to learn collaboratively from past experiences in order to prepare for future situations in which similar challenges may occur under a different set of circumstances. Unlike a staged exercise in which the scenario is developed by a small group, the scope of the critique discussion is dictated by the participants as they work together to recreate the incident timeline and identify strengths and weaknesses of the decisions made and tactical procedures employed. As recommended by Henning (2009) and Irons (2006), the critique process creates opportunities to identify the multiple factors that may contribute to surprise and the tactics that can be used to avoid surprise while optimizing participation by the different levels organizational hierarchy stakeholders.

The proposed policy option also capitalizes on the principles recommended by Irons (2006) to avoid surprise. Stakeholder involvement in identifying and problem-solving areas for improvement promotes a common understanding of the overall mission while cultivating leadership skills in those of lower organizational rank. Engagement by frontline personnel in discussions about training needs helps management to allocate resources to training initiatives that most advantageously create meaningful learning opportunities for the end user.

d. Summary

The analysis of process values suggests that both policy options successfully create learning opportunities. The current policy primarily provides learning opportunities that focus on content that is pre-determined by a select group of individuals. Conversely, the proposed policy option creates a mechanism for the actual learners to influence both the content to be learned and organizational policy. Therefore, the proposed policy is found to be a more advantageous option when process values are a priority consideration in the selection of strategies to create an optimal learning environment.

3. Robustness and Improvability Analysis

Robustness and improvability of a policy are directly related to field implementation (Bardach, 2009). The analysis of this criterion is done as a comparison between the current and proposed policy options for each of the selected constructs – budget, time requirements, administrative complexities, and flexibility for change during policy execution.

a. Budget

The current policy requires a dedicated budget for execution of each training and education event. If federal funding is used to support an initiative, all expenditures must comply with federal requirements. Using the data from the DHS-approved awareness level course and the two HSEEP-compliant exercises used as case comparisons, the average cost per personnel-hour invested in the execution of activities in support of the current policy is \$52.42. Reducing this cost may be possible if a greater number of on-duty personnel are used as exercise participants and instructors are detailed from their daily assignments to teach. However, such strategies shift instead of reduce the burden. On-duty, exercise participation causes a large number of companies to be unavailable for dispatch assignment for an extended period of time, possibly creating operational vulnerabilities. Although detailing personnel to instructor positions does not

negatively impact the training budget, the overtime budget for operations increases since firefighters must be re-hired to fill vacancies created by detailed personnel in order to maintain manning requirements.

Alternatively, execution of the proposed policy does not incur expenses that are in addition to the existing financial obligations required to support daily operations. Formal critiques are conducted and AARs developed as part of routine operations for on-duty personnel. Duplication of AARs for wide distribution does incur expense, but the cost is negligible. Furthermore, use of technology to electronically distribute and archive documents reduces duplication costs. Although there are costs associated with establishing and maintaining technological systems, these systems are not exclusively required for execution of the proposed policy and should therefore not be attributed as such.

b. Time Requirements for Implementation

The HSEEP doctrine subscribes to a standardized template for planning that includes a series of planning and coordination meetings (DHS, 2007a). A minimum of three meetings to plan an exercise and one post-exercise debriefing meeting are required. HSEEP recommends that these meetings occur over a period of many months. Additionally, an investment of time is required between meetings to coordinate individual agency operations, secure the venue, and acquire resources for exercise support (e.g., port-a-potties, props, consumables). Time is also required to develop HSEEP documents (e.g., situation manual, master event scenario list, EEGs, safety briefing, role player cards) and to stage the venue. The size of the exercise impacts the number of individuals involved in planning and execution activities, which directly impacts the total number of hours invested.

Execution of HSEEP-compliant exercises requires that participants - players, role-players, evaluators, controllers, and observers—dedicate time in excess of the hours spent on exercise play. Participants invest time in picking up equipment before traveling to the venue, completing designated check-in procedures, attending a pre-event safety brief, participating in a hotwash immediately upon exercise conclusion, and

cleaning up the exercise venue and returning equipment and supplies to the appropriate locations. Data from the HSEEP-compliant exercises included in this study suggests that four hours per participant for pre and post exercise activities is a reasonable estimate of additional time requirements. Furthermore, some participants may have limited roles during the exercise but be required to be present for the event duration, creating inefficiencies in time usage.

In addition to hours spent on direct delivery of a DHS-approved training curriculum, investments of time are required for attending train-the-trainer sessions and coordinating location and participant logistics. An average of two hours per instructor per session in excess of instruction time were required to effectively execute the DHS course included in this thesis project.

The U.S. Fire Administration recommends that formal critiques occur within the days immediately following the occurrence of the incident to be critiqued (Ockershausen, 2008), which limits the time between the decision to conduct a critique and actual execution. While an investment of time is required to prepare for facilitating the critique discussion, this investment is commonly limited to a few hours by a few individuals since re-creating the event timeline and scenario and conducting analysis is accomplished by the participants during the critique discussion. Producing the AAR does take time, but again this investment is typically limited to a few individuals.

c. Administrative Complexities

Execution of both the current and proposed policies involves administrative complexities. But the complexities of each are different.

To maintain operational capabilities, HSEEP-compliant exercises commonly require that personnel be rehired as exercise participants. Procedures for re-hiring CFD union employees are governed by labor contract rules, which treat individuals of identical rank the same, irrespective of specialty training level. Homeland security exercises frequently require participation by firefighters with some level of advanced knowledge and training. This requirement necessitates that management confer with

Union officials to negotiate special re-hire arrangements in order to avoid the financial expense of personnel grievances for non-compliance with union contract rules. Negotiation requires a time investment and possibly concessions on a different issue in order to optimize the benefit gained from exercise participation. Grant funds cannot be used to pay grievances related to an exercise that are found in favor of the plaintiff even if a grant was used as the funding source for the exercise; requiring that corporate funds be allocated for this additional expense.

Personnel assignment to attend formal critiques also requires scheduling coordination to ensure that operational capabilities are maintained. However, the procedures to accomplish this are no different than those executed for assigning companies to an incident and changing the location of non-assigned companies to ensure coverage throughout the jurisdiction. Dispatch personnel frequently execute these procedures, which do not require advanced planning and negotiations since standing protocols already exist to facilitate dispatcher decision-making.

HSEEP recommends that the exercise planning process be completed over a number of months (DHS, 2007a), with 6–12 months being a realistic timeframe. Although this recommendation provides the time necessary to fully develop the objectives, scenario, and coordinate logistics with all stakeholder agencies, the extended timeframe also increases the probability that changes in organizational priorities and exercise design team members will occur. Changing priorities may lessen the resources that are available for dedication to an exercise or make the need to conduct the exercise obsolete. Personnel changes increase time investments since new members must be briefed on historical planning and decisions, as well as possibly re-negotiating the exercise objectives and scenario to incorporate the new member's input.

Duplication and distribution of AARs follows the existing process for distribution of internal paperwork. Hardcopies of AARs can reach all fire houses on the same day they are duplicated. Use of technology to distribute AARs electronically expedites the process.

d. Flexibility

The proposed policy is more flexible than the current policy in terms of implementation and meeting the learning needs of those affected. HSEEP-compliant exercises and delivery of DHS-approved curricula are frequently dependent on the availability of specific resources—dates, venue, stakeholders, and resources—and these events are routinely planned to accommodate a negotiated schedule. If an event must be cancelled, the process for coordinating all elements to reschedule within the desired timeframe can be a very complex process and often involves re-arrangement of other commitments. Alternately, formal critiques are scheduled in close proximity to the date of the incident being critiqued, facilitating the ability of critique planners to select a time and date that is sensitive to current operational schedules and conducive to accomplishing the critique goals and objectives. If an emergency necessitates that the critique be postponed, it is likely that the group can reconvene later in the day and/or be re-scheduled for the subsequent workday since department administration can make decisions on resource allocation. If companies are needed for dispatch during the critique, the rest of the participants can still continue during their absence. The focus of the discussion may change, but learning will still occur.

Delivery of DHS-approved curricula requires instructors to cover the pre-approved content and provides little flexibility for the instructors to change the course content. Often times, only minimal time for questions or for deeper exploration of areas of special interest to participants is incorporated. Conversely, the format of structured but open dialog recommended for formal critiques provides opportunities for greater discussion on areas of particular concern to participants (Ockershausen, 2008), embracing the concept of adult learning theory supported by Kapp (Peterson, 2009), Revans (Margerison, n.d.), Knowles (1989), and Margerison (2005). Additionally, if the facilitator determines that the critique is not progressing in a constructive manner or that learning is not being optimized, the critique format allows for the facilitator to change the direction of the conversation to topic areas that may better promote participant learning.

e. Summary

The findings from this analysis suggest that the proposed policy is more robust and provides greater opportunity for improving upon the process mid-course than the current policy. Formal critiques and AARs create minimal financial burden, require a limited amount of time for pre- and post-event activities, and are flexible to accommodate both learner needs and organizational responsibilities in a simple and straightforward manner. HSEEP-compliant exercises and DHS-approved training courses do provide learning opportunities, but also require execution in a manner that is neither as robust nor flexible in implementation as formal critiques and AARs.

C. CHAPTER SUMMARY AND CONCLUSIONS

In Chapter I, an analysis of the similarities and differences between the response to real-world incidents and the federally defined capabilities that are needed to respond to homeland security incidents is conducted. The four cases are examined to assess whether or not the targeted activities and tasks are performed and the benchmarks met in a manner that is consistent with prescribed standards. The findings from this analysis reveal that the real-world incidents do provide opportunities for executing the same tactics and procedures that DHS predicts are needed to mitigate a homeland security incident, although on a smaller scale.

Consistent with the HSEEP doctrine, none of the incidents in isolation provided an opportunity to perform all activities and tasks associated with a specific capability. The variability provided by the different case types to execute different activities and tasks suggests that the proposed policy should integrate the use of multiple incident types and causes of origin within a single incident type category in order to optimize learning.

Documentation of a formal critique and AAR exists for only one of the four cases, suggesting that opportunities for learning from crisis are not consistently being used advantageously. The process of learning from crisis can help both individuals and organizations identify areas of deficiency and initiate corrective actions, decreasing the possibility of a predictable surprise occurring.

In summary, the analysis in Chapter I found that there are many similarities between the response activities for similar type incidents that originate from both conventional and asymmetric causes. The exploitation of learning from conventionally caused incidents can create opportunities for preparing to respond to incidents with an asymmetric origin that may be of greater size.

A modified cost-benefit analysis is conducted in Chapter II. The three criteria used in the analysis are efficiency, process values, and robustness and improvability. Efficiency is analyzed using CFD financial data for the four cases and examples of current policy—DHS-approved awareness level training and HSEEP-compliant exercises. Process values and robustness and improvability are analyzed in terms of the federal recommendations for conducting formal critiques, DHS-approved training classes, and HSEEP-compliant exercises.

The findings from the efficiency analysis put forth that conducting formal critiques of real world incidents is a more economical method of training and education than conducting staged exercises that are designed to practice similar capabilities. Since both incident response and formal critique activities are conducted while firefighters are on-duty and already being paid, opportunities for education and training are increased without incurring additional expense. Utilizing formal critiques and AARs from real-world incidents is an efficient means for sustaining specialized training and education to prepare for responding to homeland security incidents.

The process values analysis supports the notion that the proposed policy provides greater opportunity than the current policy for stakeholder influence on individual and organization learning, as well as, surprise avoidance. The proposed policy capitalizes on the principles of andragogy to encourage learners to take responsibility for their learning through active engagement. The format used to conduct formal critiques promotes investigating topic areas that are of particular interest to the actual learners, as opposed to the content focus being selected by a small number of management personnel like is seen with the current policy. Using AARs as training tools creates opportunities for vicarious learning both immediately and in the future. Firefighters can choose to independently use

these documents at any point to further their personal bank of knowledge. Formal critiques and AARs provide multiple opportunities for stakeholders to engage in and influence the learning process.

Analysis of robustness and improvability reveals that the proposed policy is a more viable option in terms of budget, time requirements for implementation, administrative complexities, and implementation flexibility. Consistent with the findings from the efficiency analysis, formal critiques and AARs are a more economical option than traditional classroom-based training and HSEEP-compliant exercises. The time required for implementation is also less, with the shorter duration between the decision to hold an event and event execution improving execution abilities. Participant scheduling to attend each of the training option presents some challenges, but the current policy requires that special procedures be implemented while the proposed policy utilizes procedures used by the organization on a daily basis. Finally, the proposed policy is more advantageous in terms of flexibility than the existing policy since those in charge of execution have more freedom to customize the delivery in order to more fully address the individual needs of the group.

In conclusion, the analysis contends that the proposed policy provides greater benefit for the investment of resources than the current policy option. The proposed policy is more efficient in terms of financial cost and time investments. It also creates greater opportunities for stakeholders to influence individual and organizational learning, as well as encourages firefighters to assume a greater responsibility for their own learning. Lastly, implementation of the proposed policy is more robust than the current one and provides the ability for customization to meet the specific learning needs of stakeholders.

VI. RECOMMENDATIONS

The extent to which formal critiques and AARs can be used as training tools throughout an organization is only limited by the user group's level of creativity; providing a tool that empowers firefighters to build upon their existing bank of knowledge to enhance individual, fire company, and organizational capabilities for responding to incidents of asymmetric origin. The incorporation of the use of formal critiques and AARs from the response to conventional incidents into existing homeland security training and education strategies creates a dynamic opportunity for sustaining existing capabilities while building new ones. Integration of these smart practices (Bardach, 2009) into existing training and education programs helps to create a decentralized system for sustaining homeland security training and education that utilizes both instructor-led and learner-focused opportunities (Brafman & Beckstrom, 2006). A decentralized training approach is likely better able to withstand the ever-present challenges encountered in administering training and education programs within the fire service because the diverse tactics used in a mixed-methods approach are dependent on different enabling factors, such as time, money, and personnel resources. The inability to implement one tactic does not preclude the execution of another.

The analysis of the two target capabilities provides support for this thesis' claim that firefighters use comparable skill sets when responding to certain types of emergencies that may originate from both conventional and asymmetric causes. However, a single conventionally caused incident of typical scope and nature alone is likely of smaller scale than a homeland security incident and does not provide the opportunity to execute all activities and tasks for the designated capability. This finding supports the recommendation to incorporate formal critiques and AARs into daily operations instead of using them sporadically.

Expansion of the scope of formal critiques and AARs to include "what if" questions about variables that may occur during incidents of similar nature but of different origin creates a value innovation (Kim & Mauborgne, 2005) for homeland security training and education (see Figure 1). Value innovation is a business strategy

term used by Kim and Mauborgne (2005, p. 16) to describe actions that favorably affect both cost structure and the value to the customer. Cost saving are made by eliminating and reducing factors that the business competes on. Customer value is increased by raising and creating elements that the industry has never offered.

Formal critiques and AARs from conventional emergencies used as training and education tools to help firefighters prepare for responding to asymmetric incidents creates a new value proposition (Johnson, 2010) for sustaining homeland security training and education. A value proposition is a term used in business models that identifies a job that needs to be done and evaluates the possible options for accomplishing the job in a manner that is efficient, reliable, and reproducible. In this case, the job to be done is the provision of homeland security training and education to firefighters. The possible options for meeting the learning needs are classroom training, HSEEP-compliant exercises, and expanded formal critiques and AARs that include “what if” questions about variables that may occur during similar incidents that originate from different origins. The findings in this thesis project suggest that formal critiques and AARs embody the three criteria for a value proposition in a way that is more advantageous to fire departments for sustaining specialized training and education than the more traditional options for training and education.

A strategy canvas (Kim & Mauborgne, 2005) is another tool used in business models to pictorially graph the differences among possible options in terms of each option’s the level of offering for the primary factor under consideration. The main component of a strategy canvas is the value curve, or the graphic depiction of each possible option in relation to the other options. As seen in Figure 1, using expanded formal critiques and AARs from conventional emergencies as tools for preparing firefighters to respond to incidents with asymmetric origin redefines the existing homeland security training and education value curve.

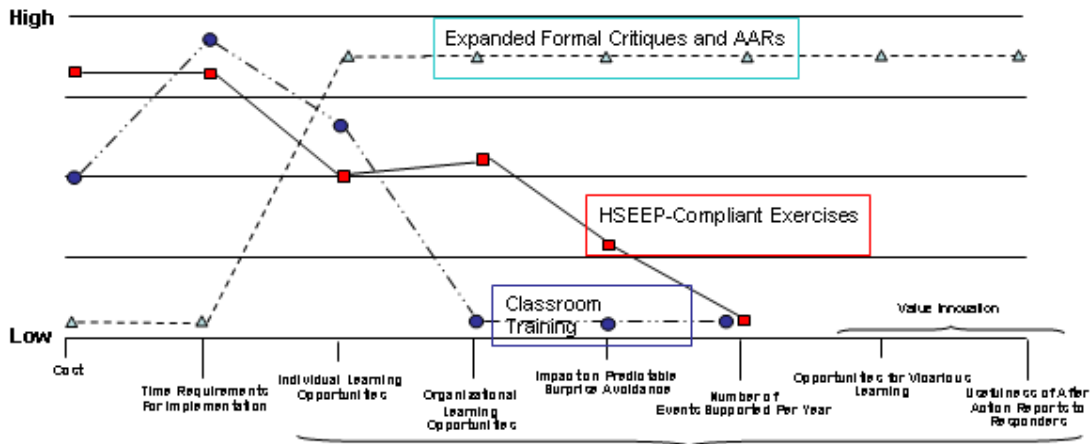


Figure 1. Homeland Security Training and Education Strategy Canvas

A. VALUE CURVE REDEFINITION

Value curves are redefined by completing four actions: eliminating factors that the industry takes for granted; reducing factors well below the industry standard; raising existing factors above the industry standard; and creating factors that the industry has never offered (Kim & Mauborgne, 2005) (see Figure 2). Expanded formal critiques and AARs accomplish these four actions by: *eliminating* the dependence of grant funding to create learning opportunities; *reducing* resource requirements and the probability of predictable surprise occurrence; *raising* the number of individual and organizational learning opportunities and the number of firefighters impacted by each learning opportunity; and *creating* a sustainable homeland security training and education strategy that promotes an andragogy-based learning environment and opportunities for front-line personnel to participate in policy development.

<p><u>Eliminate</u></p> <ul style="list-style-type: none"> •Dependence on grant funding for creating learning opportunities 	<p><u>Raise</u></p> <ul style="list-style-type: none"> •Number of opportunities for individual learning •Number of opportunities for organizational learning •Number of responders impacted by each learning opportunity
<p><u>Reduce</u></p> <ul style="list-style-type: none"> •Resource requirements •Probability of occurrence of predictable surprises 	<p><u>Create</u></p> <ul style="list-style-type: none"> •Sustainable homeland security training and education strategy •Andragogy-based learning environment •Opportunities for front-line personnel to participate in policy development

Figure 2. Eliminate-Reduce-Raise-Create Grid

1. Eliminate

Formal critiques and AARs from conventional emergencies eliminate the dependence on dedicated funding sources for the creation of learning opportunities. Firefighter salaries and equipment costs are expenses included in a department’s annual budget. These expenses remain irrespective of the types of on-duty activities in which firefighters engage. A change in the level of Homeland Security Grant Program funding, the funding source that is commonly relied upon by fire departments to support homeland security activities, does not negatively impact abilities to conduct formal critiques and write AARs.

2. Reduce

Expanded formal critiques and AARs reduce the human and financial resources invested in creating learning opportunities that help firefighters prepare for responding to incidents of asymmetric origin. The expenses of instructor fees and participant backfill/overtime are reduced since the frequency of need for standalone classroom-based training is decreased. Similarly, personnel and equipment costs associated with HSEEP-

compliant exercises are reduced since the need to conduct exercises to practice activities and tasks that are routinely executed in the course of conventional fire service activities is decreased. The new strategy does still require an investment of personnel time to prepare for a critique and write the AAR, but this investment is less than the typical amount of time invested in planning and coordinating department-wide training initiatives and HSEEP-compliant exercises.

Formal critiques and AARs position frontline personnel and administration to learn collaboratively from past experiences in order to prepare for future situations. The expanded critique process creates opportunities to identify the multiple factors that may contribute to surprise and discuss the procedures and tactical decisions that can reduce the possibility of encountering surprise during incident mitigation activities. Bayesian theory postulates that surprise can only occur in the presence of uncertainty (Itti & Baldi, 2005). Routine engagement in individual and organizational learning reduces uncertainty of abilities to make decisions and execute activities and tasks during situations of complex nature, ultimately reducing the probability of experiencing a predictable surprise.

3. Raise

Expanded formal critiques and AARs raise the number of opportunities for individual and organizational learning. The resource investments required for the delivery of a DHS-approved training curriculum and the conduct of an HSEEP-compliant exercise limit the number of events that can be supported per year, in turn, limiting the frequency and scope of opportunities to learn. Conversely, formal critiques and AARs provide an occasion to learn each time an incident requires the use of some of the activities and tasks contained on the TCL. The breadth of incident types, activities, and tasks covered during a formal critique is dictated by a fire department's capabilities and the types of incidents to which fire companies are routinely dispatched. This variety is likely greater than the focused content of pre-planned events, enabling each AAR to contain multiple learning points.

The number of firefighters impacted by each learning opportunity is also raised. The ability to conduct formal critiques and write AARs is dictated by the unpredictable

occurrence of specific types of emergencies. However, it is this author's experience that completing a minimum of six formal critiques and AARs in a 12-month time period is a reasonable expectation. Distribution of AARs to the entire workforce raises the number of firefighters impacted by each learning opportunity.

4. Create

Expanded formal critiques and AARs create a sustainable homeland security training and education strategy that is based on adult learning theory. In light of the ever-present challenge to do more with fewer resources, exploiting the use of formal critiques and AARs from conventional incidents provides an opportunity to leverage resources in a manner that supports the simultaneous accomplishment of multiple objectives. For example, the financial savings realized by exploiting the use of formal critiques and AARs instead of conducting staged exercises that duplicate practice of the same activities and tasks can be used to pay for firefighters to attend technical training. The analysis from this project suggests that between nine and 13 firefighters can attend technical training for each formal critique that is used in place of a staged exercise^{29,30}. The money saved can be invested in providing training to additional personnel, creating a mechanism for a fire department to sustain costly special operations training programs, without compromising overall learning goal and objectives. Furthermore, creating a resource bank of archived AARs facilitates learning at a later date by creating content for company schools and independent study.

Formal critiques create opportunities for front-line personnel to participate in policy development. Collaboration among frontline and supervisory personnel increases the perspectives from which an issue is considered. The more comprehensive the dissection of cause and effect relationships, the greater the probability that a fire department will identify which policies and procedures should be memorialized and those that need to be changed. Collaborative brainstorming helps to create options for

²⁹ For each hazardous materials HSEEP-compliant exercise not conducted, the cost savings can be used to send nine—12 firefighters to hazardous materials technical training.

³⁰ For each search and rescue HSEEP-compliant exercise that is eliminated, the money saved can be used to send nine—13 firefighters to for technical training.

strengthening identified deficiencies that are realistic in terms of implementation and adequacy for correcting the problem. Participation in policy development improves stakeholder buy-in, which helps to create an organizational culture that is conducive to enacting policy changes.

The use of these smart practices enables administrators to meet daily operational demands, while creating learning opportunities for effectively responding to incidents of conventional and asymmetric origin. Additionally, opportunities are created to build the collaborative capacity necessary to critically assess and improve department policy in a comprehensive manner.

B. ACTION STEPS

The desired value proposition for sustaining homeland security training and education can be achieved by expanding the scope of formal critiques and AARs from conventional incidents to include “what if” questions about incidents of similar nature with asymmetric origins. To successfully assimilate this strategy into routine operations, it is recommended that a fire department execute four activities:

- Commit to learning from crisis;
- Re-evaluate existing homeland security training and education programs;
- Establish policy for conducting formal critiques and writing AARs with an expanded scope; and
- Periodically evaluate response activities in terms of the TCL.

The findings from this thesis project suggest that formal critiques and AARs as mechanisms for learning have not been fully institutionalized and that valuable learning opportunities are possibly being missed (Espedal, 2008; Holmqvist, 2009; Carmeli & Sheaffer, 2008). These findings are consistent with Smith and Elliott’s (2007) assertion that organizations are resistant to learning from crisis. To effectively incorporate the use formal critiques and AARs from conventionally caused incidents as tools to sustain homeland security training and education, an organization must commit to not only learning for crisis, but to also learning from crisis. An environment that encourages constructive criticism from all personnel ranks must be created, with department

leadership willing to make policy modifications as necessary to support the findings from careful analysis of identified areas for improvement. A review of disciplinary procedures for job performance deficiencies may be necessary to promote a critique environment that is conducive to honest identification of cause and effect relationships. Cultivation of participant confidence that formal critique participation is purely for the purposes of individual and organizational learning without punitive ramifications improves the quality of the discussion and learning.

Consistent dedication of the resources necessary to conduct formal critiques and write AARs is necessary, even when this means adjusting the priority ranking of non-emergency organizational activities to accommodate the unpredictable schedule in which incidents that employ the activities and tasks contained in the TCL occur. The transition of moving from a culture that is focused on learning *for* crisis to one that includes learning *from* crisis requires a commitment of time, energy, and resources to overcome the challenges confronted when moving through the process of change. However, organizations that persevere in proactively working to learn from their own experiences will likely decrease the probability of experiencing predictable surprises and lessen the likelihood of firefighter death or injury from a cause that is retrospectively judged as preventable.

A department's homeland security training and education program should be re-evaluated, with the intent of identifying opportunities to adopt new strategies for achieving the defined goals and objectives. The opportunity for fire departments to lessen the possibility of predictable surprises during homeland security incidents exists, but requires policy-makers to incorporate different methods of learning into existing organizational practices (Smith & Elliott, 2007; Carmeli & Sheaffer, 2008; Holmqvist, 2009). Cross-walking the TCL with the agency's core mission, areas of responsibility, and emergency incident trends identifies potential opportunities for using expanded formal critiques and AARs from conventional incidents to support specialized training and education goals and objectives. Comparison of the newly created list with the expected outcomes when one of the traditional training and education tools are employed creates an awareness of possibilities for using new strategies to supplement the more

conventional methods. Adult learning theory principles, vicarious learning opportunities created, execution frequency, and the breadth and variety of content are factors to consider when selecting tools for meeting learning objectives. Similar to any policy decision, a compromise on some factors may be necessary. Policy-makers must make choices that best achieve the overall goals with respect to the available resources.

Policy creation clarifies the expectations for how formal critiques and AARs from conventional incidents are used to sustain homeland security training and education, as well as the roles and responsibilities of department members for policy execution. Specification of the procedures for policy execution creates implementation uniformity, while helping to ensure that the end product is a useful learning tool. For example, creating a formal critique facilitator guide provides individuals responsible for conducting critiques, both those who are new to the facilitation process and those who are experienced educators, with information on how to conduct the meeting in order to optimize participant and organizational learning. Similarly, developing an AAR document template that details the expected contents of each section helps to ensure that information is written and organized in a manner that promotes independent learning. A simple narrative of the incident with an analysis of actions, recommendations on how to strengthen capabilities, and pictures to provide context for the AAR content may be all that is required in an AAR to facilitate vicarious learning. This author has experimented with developing AARs for conventionally caused emergencies in Chicago and has found such a document structure to be an effective format for accomplishing learning objectives. See the Appendix for an example. Policy and procedure development for formal critiques and AARs as a means to sustain homeland security training will likely involve a process of trial and error. Uniform implementation of each documented policy version enables administrators to effectively assess which aspects of a policy are effective and those that require further refinement.

Periodic evaluation of response procedures in terms of the TCL is necessary to ensure the on-going relevance of the findings from this thesis project to a fire department's homeland security training and education goals and objectives. The new policy option is based on the finding that firefighters execute the same activities and tasks

for similar incident types, irrespective of whether the incident originated from a conventional or asymmetric cause. Therefore, assessing the continued accuracy of this assertion is needed in order to remain confident in the new strategy for training and education. Routine re-evaluation is recommended, but should minimally be done when the threats faced by and response capabilities of a fire department change and when there are changes made to federal capability recommendations. Duplication of the process used in this thesis project to assess the similarities and differences between the response to conventional and asymmetrically caused emergencies is likely sufficient to validate continued applicability of the new learning strategy. However, fire department management may wish to consider real-time evaluation of response procedures in terms of the activities and tasks for each target capability since a real-time evaluation by on-scene chief officers will likely be less time consuming than a retrospective analysis. The HSEEP EEGs can still be used for a real-time evaluation.

In summary, incorporating formal critiques and AARs from conventional incidents into homeland security training and education programs helps to decentralize a fire department's strategy for learning and improves the sustainability of specialized programs. The new value curve reduces resource requirements and the probability of predictable surprise. The dependence on external resources for creating learning opportunities is eliminated. At the same time, the redefined value curve raises the number of opportunities for learning and the number of firefighters impacted by each opportunity. A sustainable training and education program that is sensitive to the principles of adult learning theory and provides opportunities for all stakeholder levels to engage in the policy development process is created.

To achieve the new value curve, engagement in four activities is recommended: committing to the process of learning from crisis, re-evaluating current homeland security training and education programs, establishing policy to support implementation of this new strategy, and routinely evaluating emergency response requirements in terms of the TCL. Execution of these recommendations establishes an organizational culture in which formal critiques and AARs from conventional incidents can be used successfully to sustain homeland security training and education programs.

VII. CONCLUSION

Formal critiques and AARs from conventional emergencies are tools that can be used to sustain homeland security training and education. The numerous similarities between the activities and tasks performed to mitigate emergencies of similar type, irrespective of whether the incident originated from a conventional or asymmetric cause, creates opportunities for firefighters and their organization to use real-world emergencies to prepare for the homeland security challenges they may one day face. The cost-benefit analysis conducted in this thesis project suggests that incorporating the use of formal critiques and AARs into homeland security training and education programs is an efficient use of resources when compared with the resource requirements for conducting stand-alone, classroom based training and Homeland Security Exercise and Evaluation (HSEEP)-compliant exercises. Furthermore, the analysis indicates that the proposed policy option is more advantageous than traditional training and education methods commonly used to strengthen homeland security-related capabilities when process values, robustness, and improvability are factors considered by policy makers.

Integration of these smart practices into routine department operations increases the number of opportunities created for firefighters to learn, from both their personnel experiences and vicariously through the experiences of colleagues. The phrase “practice makes perfect” is commonly used to describe the value of routine performance of essential skills. However, the phrase “practice makes permanent” has greater applicability when working to decrease the probability of predictable surprises through training and education. The more frequent the opportunities that firefighters have to practice critical activities and tasks, the greater the probability of successful performance when called upon to execute these procedures to mitigate emergencies of diverse origin and complex nature. Very few emergencies occur according to a textbook script. Firefighters must be able to adapt to the situation encountered and safely execute the activities and tasks required to protect the health, safety, and property of those they serve.

A. LIMITATIONS

A primary limitation of this thesis project is the sample size and the fact that the entire sample is taken from the same data source. This project uses four cases to analyze two target capabilities. The cases selected are subjectively assessed as representative of the types of incidents to which the CFD responds. However, the small sample size allows one to question whether or not there is something unique about these cases that contributes to the findings that would not be found in the documentation from other incidents of similar type. While using data from the same source creates consistency among data elements (e.g., salary costs, fire company responsibilities), it does not account for differences among urban fire departments or assess how these differences may impact the findings. With Chicago being the third largest city in the United States and uniqueness of geography, demographics, and critical infrastructures, it is possible that the incidents to which CFD routinely responds may be of unique complexity when compared with other urban fire departments.

This thesis project relies entirely on historical documentation. No real-time or qualitative data is used. Real-time and qualitative data may provide a greater understanding of decision-making processes for why an activity or task was not performed or if it was performed and just not documented.

Finally, there is no control for variability among fire company assignments and the experience levels and documentation styles of each company officer and chief. Documentation for each case is aggregated, but the documentation style of each officer and chief varied. It is unknown if this is a result of experience level, personal style, the assignment that each company was given to perform, and/or a combination of multiple factors.

B. AREAS FOR FURTHER RESEARCH

To validate the findings from this thesis project, application of the research methodology to cases obtained from a different urban fire department is warranted to determine if the findings are replicable. Future researchers should consider including

real-time evaluation of emergency response operations and qualitative interviews in the research methodology to further enhance the quality of the information used for analysis. An increase in the sample size and including data from more than one fire department will strengthen confidence in the reliability of findings.

The TCL has 37 capabilities, of which 21 are solely focused on the response mission area. Future researchers may wish to analyze whether or not the activities and tasks for additional capabilities are routinely executed when fire departments respond to emergencies of conventional origin. If such findings are consistent with those of this thesis project, the proposed policy option can be expanded to include additional capabilities.

The response to a homeland security incident requires the involvement of multiple agencies and disciplines, or a megacommunity (Gerencser, Lee, Napolitano, & Kelly, 2008). Some of the individual target capabilities contain activities and tasks that reflect this megacommunity involvement. Future researchers may consider analyzing the comprehensive list of target capabilities that are executed by the megacommunity in response to a conventional incident, with the intent of expanding the proposed policy option beyond use by one agency. Incorporating the megacommunity into the formal critique and after action process may provide valuable opportunities for the entire group to prepare for homeland security incidents by optimizing learning opportunities from conventionally-caused incidents.

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APPENDIX: SAMPLE AFTER ACTION REPORT

Trench Rescue After Action Review

Incident Date: May 27, 2009

Incident Location: 5900 W. Belmont Ave

After Action Date: June 2, 2009

Incident Overview

At 1225, a member of a construction company called 911 to report that one of their employees was buried up to his knees in a below grade hole secondary to the earth caving in. Upon arrival at the scene, Engine 94 and the Battalion Chief confirmed that one person was trapped in an unsupported trench and that the trench was approximately five feet by five feet and ten feet deep. The victim reported that his legs were pinned underneath a pipe and that they hurt. The Chicago Fire Department (CFD) initiated a trench rescue response. Thirty-one companies responded to the scene and mitigation of the incident took approximately five hours.

Analysis of Actions

1. The first on-scene companies appropriately used the plywood that was available at the construction site to brace the hole, provided the victim with oxygen, tied a rope around the victim's body, gave the victim a shovel, and called for a full trench rescue response. The companies **did not** try to pull the victim from the hole. The companies followed departmental procedure and correctly implemented basic bracing techniques learned through training.
2. After using plywood to further brace the hole, squad company members assessed the situation further and learned that the most unstable area was the concrete on the north side of the hole, that a drain tile had broken and washed pea gravel into the trench, that there was a catch basin in the hole, and that the victim's legs were in fact bent underneath him and caught in a pipe. Members placed struts to further stabilize the hole, with a priority of protecting the victims head and chest. The air bags and plywood placed were successful in stopping the influx of pea gravel. Operations were stopped at frequent intervals so that supervisory personnel could ensure that the shoring was correct and that the appropriate safety measures were in place. Members followed established departmental protocols for trench operations.
3. Once the hole was stabilized, squad members rotated going into the hole to dig the debris away from the victim. At all times, two members were harnessed and

in position to initiate secondary rescue operations, if needed. Members followed established departmental safety standards for trench operations.

4. Team companies set-up the cutting station, brought struts and the paratech system for inflating the air bags to the hole, kept the area of the collapse clear of pedestrian traffic, and provided generalized incident support. The precision of measurements and wood cutting greatly decreased the time required for incident mitigation.
5. En-route, the Fire Alarm Office provided responding companies with a status update via the Mobile Data Computer. Receipt of this information prior to arrival on-scene helped responding companies pre-plan and prioritize the actions they would taken upon arrival.
6. EMS personnel started an IV and administered IV fluids, pain medications, and other medications as appropriate for a victims with crush injuries. Paramedics routinely monitored the victim's blood sugar and calculated rates of fluid replacement. EMS considered requesting a helicopter for transport; however, the amount of debris on-scene would have created safety hazards. EMS provided excellent care to maintain patient stabilization through the entire incident and subsequent transport.
7. The Water Department's vacuum truck was brought to the scene to help remove the earth faster. The truck's hose is 8" in diameter. Due to the size of the hole and the on-going caving of the surrounding earth, a smaller diameter nozzle was needed to better control the rate of removal. CFD and Water Department personnel worked together to create a makeshift nozzle of smaller diameter out of duct tape, a five-gallon bucket, and an orange traffic cone. The new nozzle worked to control the sucking and facilitate removal of the earth trapping the victim. CFD has since received the smaller diameter nozzles that were ordered prior to the incident.
8. Fire Ground was used for on-scene communications; however, a runner was used for relaying requests between the hole and the cutting station. A dedicated channel for communication between members operating at the hole and the cutting station is included in the general order on trench rescue operations that is being written.
9. While executing primary rescue operations, officers were actively developing contingency plans. If primary operations had failed and the victim was in fact found to be pinned behind the catch basin, companies had planned to dig through the catch basin to perform the extraction. This operation would have been complicated by the fact that there was a distance of 20' between the top and bottom of the catch basin. Officers displayed critical thinking in developing contingency plans.

10. Squad members prepared an A-frame to lift the victim from the hole, however, the victim climbed up the ladder himself and the A-frame was not needed. Preparation of this device in anticipation of possible need was appropriate.
11. Tape was put up around the perimeter and lines were painted on the ground to identify restricted areas, however, these measures were not independently sufficient to restrict access to the scene.
12. A responder rehab area was established and utilized. Officers did a good job of ensuring that members were given sufficient periods for rest and rehab.

Recommendations/Improvement Plan

1. Include the vacuum truck in the general order that is being written as a resource to be considered requesting.
2. Continue to include training on use of the vacuum truck during trench rescue training classes. Consider joint training with personnel from the Department of Water Management on using the truck.
3. Incorporate round trenches in training classes. Classes typically focus on rectangular trenches. Inserting struts to brace a round trench creates unique challenges.
4. Continue to send members of special operations and team companies to trench and confined space classes.
5. Assign personnel to restrict pedestrian traffic to unstable or dangerous areas within the scene. Response personnel who are not providing direct service or support should not access restricted areas.

Impact of Training

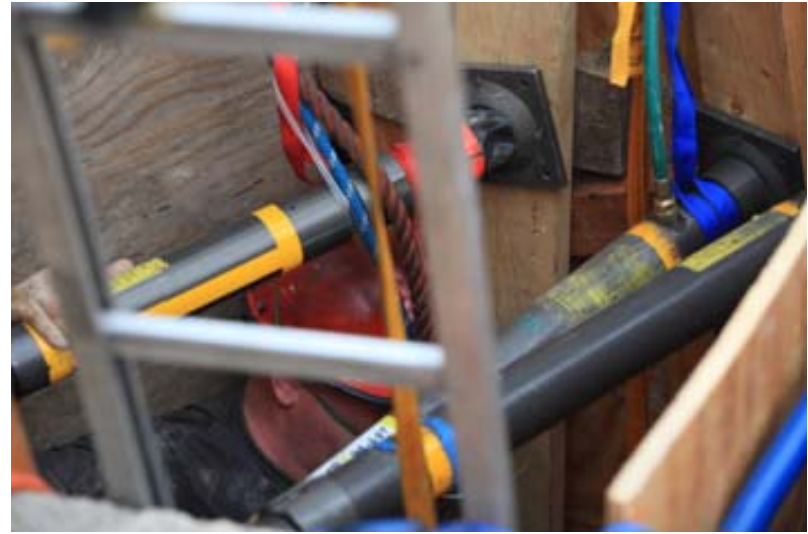
AAR participants were asked whether or not participation in special operations training classes has had an impact on the way response operations for trench rescue are conducted and, if so, to describe how.

1. A Lieutenant with 23 years of experience said, “Trench operations training has helped to minimize the risk to fire fighters. Previously, we jumped right in the hole. Now we stabilize the hole first.”
2. A District Chief with 29 years of experience said, “Training has really helped to facilitate companies working together. The impact of cross company training and drilling was evident during the entire incident. The technical knowledge of responding companies on trench operations was excellent.”

3. A company officer said, “Having all officers on the same page, using universal language, and having an understanding of what was going on and why really helped to facilitate operations.”
4. An officer of the squad said, “We knew that we had to have a Plan B and Plan C incase our initial strategy did not work. We started working on the contingency plans right away.”
5. A firefighter said, “Everyone knew what was being requested. We did not waste time trying to figure out what the different pieces of equipment are.”
6. The Assistant Deputy Fire Commissioner for Special Operations said, “Trench operations normally take 8-10 hours. This one took 5 hours. The teamwork and efficient manner in which operations were conducted really helped to spare the victim further injury.”
7. A squad officer said, “Skills learned during collapse, trench, rope, and confined space classes were used in this response.”
8. An investigator from the Occupational Safety and Health Administration (OSHA) complimented CFD on adhering to safety standards, especially wearing harnesses when working around the hole.

Summary

In many ways, this trench rescue operation was a success. The victim was transported to the hospital in stable condition and discharged from the hospital the next day. Throughout the rescue operation, teamwork among Fire Department personnel prevailed and Departmental safety standards were maintained. This incident demonstrates the value of the financial investment that has been made in training personnel to perform rescue operations in a safe and effective manner. The victim was successfully rescued and there were no injuries to any on-scene rescue personnel.





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