Improving Situational Awareness to Enhance Firefighter Safety

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Appendices Not Included. Please visit the Learning Resource Center on the Web at http://www.lrc.dhs.gov/ to learn how to obtain this report in its entirety through Interlibrary Loan.

CERTIFICATION STATEMENT

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

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Abstract

   The problem was that the members of the Vista Fire Department and the fire service in general lack adequate situational awareness. The purpose of this research was to define situational awareness and identify methods for improving situational awareness at all levels of the fire service. Research questions to be answered using the descriptive method are: What is situational awareness, what are the best practices utilized by other organizations, how does a lack of situational awareness affect safety and operations at the Vista Fire Department, and how can situational awareness be increased? A questionnaire was sent out to the company officers of the Vista Fire Department. Two investigators from the National Institute of Occupational Safety and Health were interviewed to gain their insight into situational awareness issues identified during firefighter fatality investigations. The results of the report indicated that there was a lack of situational awareness at the Vista Fire Department at all levels of the organization and there was a lack of situational awareness in the fire service in general. Based on the research the recommendation was to improve the quality of training by increasing the realism of the training, developing a combination of subjective and objective measurements of the operator's results, and providing feedback to the operator.

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Introduction

A current problem at the Vista Fire Department and the fire service in general is a lack of situational awareness (SA) by company and command officers on the fire ground. SA is an important part of operations within the Vista Fire Department. SA includes a variety of skills ranging from the ability to identify hazards during a medical aid to identifying when a fire may reach flashover.   Overall, SA is the ability to identify and interpret the environment around a person and then to act on these interpretations in an effort to improve safety and contribute to positive outcomes on the fire ground. A lack of SA on the fire ground may lead to firefighter and civilian injury and death as well as to increased property loss.

The definition of SA provided above is specific to the fire service. There is considerable research that provides general definitions. A review of these definitions will be provided along with an identification of their correlation and relation to the Vista Fire Department and the operations of a fire ground commander.

Either the lack of SA or inadequate SA has been identified in numerous National Institute of Occupational Safety and Health (NIOSH) Line of Duty Death (LODD) reports as well as in various U.S. Fire Administration reports. The company officers of the Vista Fire Department (VFD) identified through a questionnaire that the VFD lacks adequate SA. The next logical step is to develop new methods and refine current practices so that improvements can be made and firefighter safety can be enhanced.

The purpose of the research for this project is to identify the factors that contribute to a lack of SA at the VFD. It is only with an understanding of the contributing factors that one can move onto the more practical and applicable portion of the research. The research will identify

practical methods to increase SA among the members of the Vista Fire Department and in the

fire service. The goal is to provide methods that, when employed, will increase fire service

effectiveness on the fire ground, decrease firefighter and civilian injury and death, and provide a

more rapid stabilization of the emergency scene.

Descriptive methods will be used in conducting the research. Through a review of

existing literature, surveys, questionnaires, and case studies the research will first answer what is

SA generally and specifically and also what it is specific to the Vista Fire Department. Next, a

review of literature will identify what best practices other organizations, such as the military and

airlines, are doing to address a lack of SA. These best practices will be reviewed to determine

their suitability for application. There are undoubtedly resource limitations that impact how the

Vista Fire Department implements new programs and training. The goal is to utilize the best

practices from other organizations and apply them as practical within the confines of available

resources. The third section will address how the lack of SA affects the safety and operations of

the Vista Fire Department. A survey of Vista Fire Department company officers will assist with

answering this question and the final question of how the current level of SA can be increased.

Background and Significance

The City of Vista Fire Department covers an area of approximately 40 square miles.

Within this response area multiple hazards exist. The southern section is comprised of

residential, commercial and industrial hazards. The eastern section is residential with a

significant wildland urban interface hazard as well. The north and west section of the response

area is light industrial and commercial and older single family residential and multi-family

residential. This is important because due to the multiple hazards present and the potential

complexity and scope of emergency incidents within the response area, company and command

officers are expected to perform at a high level and to be effective decision makers in stressful

situations. The fire department includes 81 suppression personnel and 11 support staff. Of the

81 suppression personnel 18 are company officers and three are shift command officers at the

Battalion Chief rank. During 2011 the fire department responded to 10,615 calls for service. Of

this, there were 221 fire calls (J. Napier, personal communication, August 30, 2012).

During the past few years significant changes have occurred at the Vista Fire Department.

The first significant change is that the number of fires has decreased, similar to the trend that is

happening across the country. According to the National Fire Protection Association, the

number of fires nationally has dropped from 3,264,500 in 1977 to 1,331,500 in 2010. Of this

number the drop in structure fires has been from 1,098,000 in 1977 to 482,000 in 2010 (Karter,

2011, figure 1). The pattern is similar in Vista. Vista Fire Department Senior Captain Duncan,

estimates that he responded to 12 fires per year when he first promoted to captain in 2001. Last

year he estimates that he responded to six fires (T. S. Duncan, personal communication, August

29, 2012). The actual response data corroborates what Captain Duncan estimates. In 2000 the

Vista Fire Department responded to 7,656 calls of which 384 were for fires (J. Napier, personal

communication, August 30, 2012).

The second change is the hazards that are presented by the fires that occur now compared

to previous fires. One of the hazards is due to the type of materials used in residential structures.

Underwriters Laboratory conducted a series of experiments and found that the furnishings found

in homes today have a higher heat release rate, burn faster and achieve flashover much faster

than in the past (Kerber, 2010, p. 75). Another contributing factor is the construction method

used today and the hazards inherently associated with lightweight construction. Lightweight

construction, when viewed holistically, with the increased heat release rate and more rapid

flashover creates additional challenges for fire ground decision makers.

This research is significant to the Vista Fire Department because these two changes have

a current impact and a future impact upon its members and the citizens they serve. The decrease

in number of fires creates a knowledge vacuum and may perpetuate a sense of apathy towards

the hazards. The hazards presented by the fires are increasing as well leading to greater risks to

firefighter and citizen.

According to a questionnaire provided to Vista Fire Department Company Officers, all

15 rated SA as very important to a Company Officer. 14 of the 15 also stated that more training

would be beneficial to them and the average self rating for SA skills was 8.27 out of 10. This

information indicates that more work is needed in this area. It is too often that command and

company officers fail to employ adequate situational awareness. The Vista Fire Department has

not had a LODD, but a cursory review of LODD reports indicates that inadequate SA is a real

problem. In Vista it has not manifested itself in the form of a LODD, but it does manifest itself

in the form of improper placement of units on hazardous materials incidents or a failure to

identify changing smoke conditions at a structure fire.

Facilitating and leading the growth and development of company and command officers

as they improve their SA falls within the context of the Executive Development course. The

development will occur only with strong leadership. Officers must be comfortable discussing

their weaknesses and shortcomings. Just this concept alone requires a cultural change away from

a punitive culture and towards a culture that strives to learn from mistakes. Although the

leadership of the organization as a whole has distanced itself from the punitive culture this

change has not been fully embraced by the floor personnel. To this day mistakes and

shortcomings are seen as problems to hide and not as opportunities for growth and development.

The research presented in this project relates to USFA goal number three by providing a

specific way to improve the response to and recovery from all hazards. The research identifies

opportunities to improve SA. This is one way the organization is achieving the goal of

improving the fire service's capability to respond to all hazards as stated by the USFA.

Although the majority of the discussion is centered on the fire scene, improvements in company

and command officers' SA will have impacts on all types of responses. The opportunities to

improve are abundant; the key is to identify them and to train to prevent future problems.

Literature Review

The literature review for this applied research project focused on defining SA in a

general, non-fire-specific, sense. This process included a review of information pertaining to the

psychology of decision making and human factors. Additional literature was reviewed specific

to other industries and fields that apply SA on a regular basis and have been doing so for many

years. These disciplines include Naval Aviation, platoon level Army operations, US Coast

Guard, law enforcement and civilian airlines. The techniques used for improving SA in these

areas were of particular interest as was the study of the methodology utilized to measure SA

among participants, where it was practical. Literature review of material specific to SA in the

fire service was also reviewed. Significant insight and detail was received during interviews

with two subject matter experts at NIOSH.

The Encyclopedia of Psychology states that "the term SA has emerged as a psychological

concept because it captures a characteristic of human performance that is not directly observable,

but that psychologists…have been asked to assess…due to its importance to everyday living and

working" (p. 291). Dr. Mica Endsley states that SA is simply knowing what is going on around

you (Endsley & Garland, 2000, p. 5). A more detailed definition describes SA as "the perception

of the elements in the environment within a volume of time and space, the comprehension of

their meaning and the projection of their status in the near future" (Endsley & Garland, 2000, p.

5). The important part of defining SA is determining the organizational or operational context

within which it is being utilized. This context can be seen as the situation side of the definition.

In the fire service the context or the situation is constantly changing, as it is for the pilot of a

navy jet and the platoon leader in a battle zone. The dynamic inputs create a dynamic situation.

Dr. Endsley further breaks down SA into three distinct levels. The first level is

perception. Without an accurate perception of the events occurring there is very little

opportunity for excellent SA. The US Naval Aviation School's Command references a study by

Jones and Endsley in 1996 that studied 143 aviation mishaps. This study identified a failure of

perception in 78% of the mishaps (O'Connor, 2007, p. 12). Factors that negatively impact

perception include distraction, focusing on inconsequential or irrelevant information, stress, and

external pressures. Fire service external pressures are frequent and include radio traffic from

crews operating on the scene and dispatchers as well as requests for information or direction

from law enforcement, the media and civilians. These external pressures hamper the fire ground

commanders' ability to perceive the important events that are occurring or may soon occur.

The second level of SA defined by Endsley is comprehension. Each of the three levels

builds upon the other with the optimum success being achieved when all three come together.

Once the accurate perception has been attained, the information and data must be appropriately

comprehended. The information must be put together into a plan that integrates the perceptions

in relation to the overall organizational or operational goals. Perception without comprehension

does not allow for relevant action. The physical elements and people in the situation must be understood in the dynamic operational environment in terms of their interdependent movements and purpose (Holmquist & Goldberg, n.d., p. 6-1).

The third level of SA is projection. That which separates a novice from an expert in the context of SA is the ability to accurately project future outcomes. The perception and comprehension provide for timely decision making in the moment. The ability to perceive the array of data and use it to formulate and forecast is the mark of a skilled expert (Endsley & Garland, 2000, p. 7). In the event that the projected outcome does not match the actual outcome, the expert is able to respond appropriately and develop a plan for dealing with the new reality. Part of the new reality will take into account the factors that impacted the projection.

Dynamic and changing situations create a series of problems for decision makers. The first problem is that most people will have some sort of a stress response. An individual with limited experience and knowledge will generally have a more significant stress response. As stress levels increase cognitive abilities tend to decrease which is manifested in compromised one's ability to maintain attention and gain awareness of the situation. Each individual will react differently to the same situation and will focus on different factors of the situation. At least two factors will contribute to these differences. "The first lies in the appraisal of the meaning of the stressor; the second lies in the resources available to the individual" ("Encyclopedia of Psychology," 2000, p. 482). Both of these factors can be improved through training. When an individuals are confronted with a situation that is new to them or a situation with which they have had limited experience, the stress level will be increased. The resources that an individual has available in this case are not physical resources but more a measure of one's self-esteem as it relates to the specific situation. "Our individual beliefs about our ability to meet the demands of

the situation come into play during this stage of the stress response" (Tomporowski, 2003, p. 149). The problem is that people become so preoccupied by the stresses around them and their inability to act appropriately is affected to the point that they are overwhelmed and either fail to act or act on limited or incorrect information. The only effect of their perceptions at this point is that it highlights their self-esteem issues relating specifically to their perceived or real inabilities to act.

A way to improve the chances of a successful outcome in these stressful situations is make to decisions based upon the most task relevant information (Tomporowski, 2003, p. 147). This falls within the perception category of SA. It is not only realizing the information that is available but more importantly it is determining the important information and using that to create a picture of the situation. Another way of improving chances for a successful outcome builds upon the discussion of responses to stress. If an individual's response to stress is based upon the appraisal of the meaning of the stressor and the resources available to the individual, then efforts can be made to improve the appraisal and the resources.

Laurence Gonzales discusses the theories of SA and the applicability of stress in his book *Deep Survival*. Although he does not reference SA or the construct of three levels generated by Endsley, there are multiple similarities between the work of Endsley and Gonzales. As Gonzales (2003, p. 71) states, people are bombarded with perceptions. He compares this bombardment to an internet search where six million hits are the immediate result. The two methods to handle this onslaught of perceptions are to create emotional bookmarks and mental models. Emotional bookmarks lead the way when making instantaneous or rapid decisions. The emotional system reacts to the circumstances the mind perceives and then finds previous examples in the past and makes the decision. The result is a very rapid decision that in hindsight may appear to have been

made without any thought. This emotional system, including the mental models, can be thought

of as intuition or a gut reaction. "As we work in any area, we accumulate experiences and build

up a reservoir of recognized patterns. The more patterns we learn, the easier it is to match a new

situation to one of the patterns in our reservoir" (Klein, 2003, p. 11).

Gonzales discusses these concepts in relation to survival and how people react to and

survive various situations. Based upon his research the first survival technique in stressful or life

threatening situations is to perceive and believe. People notice detail in stressful situations.

They are able to discern detail immediately that will not be apparent to them after the stress has

faded. Survivors recognize and acknowledge their situation and then calmly get organized and

develop their comprehension of the situation. Survivors are an example of successful decision

makers under stress. Just like the naval pilot or the fire ground company officer they begin

acting on their perception and comprehension with the expectation of success (Gonzales, 2003,

p. 287).

In order to execute a mission or succeed at a task, some leveling of planning occurs. It

may be a brief non visible occurrence or it may take the shape of a multi day development. The

hazard with plan development is that it sometimes remains in place despite all indications that it

should be abandoned. The successful deployment of a plan includes a caveat that allows for

changes to the plan. Gonzales (2003, p. 80) states that survivors and decision makers who are

open to the changing nature of the environment and demonstrate a keen curiosity perform with

more goal achieving success than those that fail to see and identify changes. The difficulty

begins when reality doesn't match the plan. Plans are important but so is the ability to let go of

the plan (Gonzales, 2003, p. 84). The plan requires constant modification and change to remain

relevant. It is imperative that the perception, comprehension and projection process within SA is

ongoing.

Many organizations outside of the fire service have seen the need to improve SA within

their operations. For industries such as airlines, the improvements have been going on for many

years. Other industries are relatively new to the discipline but have witnessed the successes in

the airlines and the military and see a potential for improvement and growth in their specific

industry or discipline.

The airlines initiated the discussion on a large scale within the context of crew resource

management (CRM). Reason (2008, p. 130) states that CRM is used by the major airlines to

train their flight crews and maintenance engineers to improve flight deck performance,

particularly with regard to better sharing of situational awareness, improved communications and

enhanced leadership skills. CRM was developed by the airlines to improve the overall safety

record and decrease the number of accidents in the industry. SA is one of the original tenets of

CRM and the concepts are still in use today.

The US Coast Guard has also utilized SA within the Afloat Safety Division with training

entitled Team Coordination Training (TCT). TCT is a program with the goal of reducing the

probability of human error by increasing the effectiveness of individuals and the team. It is

important to note that before any further discussion the training clarifies that all members must

be technically proficient in their assigned tasks. This same concept is the cornerstone of the

CRM program. In order to effectively integrate a new training program into an existing system

all members must be proficient at their current assignment. The introduction of the TCT

continues by revealing that 67% of human error caused mishaps over a seven year period were

due in part or in whole to a loss of situational awareness ("Team Coordination Training," n.d., p. 1-1).

The literature from the USCG provides an extensive background study on the issue of SA and the importance of it in relation to USCG operations. A seven year study of mishaps provides a validation of the need for training in SA and provides motivation for the students. The training covers techniques to be used for maintaining SA, common barriers to SA and an introduction to recognizing behaviors among team members. The reason for the section on recognizing behaviors among team members is to insure that others are aware of a person's normal operating style or tempo and can then look for signs that may indicate a loss of SA ("Team Coordination Training," n.d., p. 6-2).

In addition to the clues to loss of SA, the training also provides very clear direction for how to regain SA. When SA is lost, the optimum solution would be that the loss is identified rapidly so that corrective action can and will be taken. It is not uncommon for SA to be lost, and the acceptance of this fact is helpful for the command officer and also for the crew. If the crew is aware the command officer has lost SA there should be a predetermined procedure for regaining SA. Although the command officer is referred to as the individual losing SA, it can happen to anyone. In the USCG it can happen to the boat operator, in the fire service it can happen to the engineer, in the military it can happen to the soldier. "Understanding who are combatants, civilians, and allied personnel, as well as, knowing the rules of engagement for the given situation, are all part of the soldiers' situation awareness" (Holmquist & Goldberg, n.d., p. 6-1).

Within the fire service, there is a great deal of discussion about SA and its implications for safety on the fire ground. However, the benefits of teaching SA and having an understanding

of its implications goes beyond the fire ground. At the Vista Fire Department, a contributing

factor to the two most recent vehicle collisions was a lack of SA. The operators of the vehicles

failed to understand all of the components in their immediate environment. It was not until after

the collision that they realized their shortcomings.

       A common area for the documentation of a lack of SA on the fire ground is found in the

NIOSH LODD reports that are prepared and distributed by members of the Fire Fighter Fatality

Investigation and Prevention Program (FFFIPP). NIOSH report 2011-05 is an example of a

report that specifies the hazards associated with inadequate SA and a lack of SA maintenance

throughout the incident. In this report the SA discussion deals with the constant potential for

ceiling collapse at any time during an incident and on two rules regarding structure collapse.

The first is that there is always a potential for ceiling collapse and the second is that a collapse

zone must be established. The author(s) of the report state that "maintaining situational

awareness throughout a fire incident is paramount, particularly, the timelines since arrival on

scene and the effects of fire on structural integrity" (National Institute of Occupational Safety

and Health [NIOSH], 2012, p. 31). A definition by Dr. Mica Endsley is referenced by the

author(s) stating that SA is a highly critical aspect of human decision-making from an

individual's perception and includes understanding what is happening around a person, the

ability to project future situations and events, and then comprehending the information and the

relevance of the information to the situation at hand.

       Two members of the FFFIPP were interviewed during the research of this project.

Murray Loflin stated that the recent discussion of SA in the fire service is based upon the success

of using SA in other industries. Mr. Loflin continues that the fire service has talked about the

concepts relating to SA in the past, but applying the term "situational awareness" to the concepts

is a relatively new concept. Mr. Loflin provides a concise definition that is based on his

extensive experience in the field. He states that SA is "being attentive of the environment you

are operating within based upon the given scenario" (M. E. Loflin, personal communication,

May 7, 2012). Unlike other definitions provided, Mr. Loflin's definition of SA is not concerned

with any specific situations or environmental or situational cues. It is an overall awareness of

what is happening, regardless of whether the happenings are pertinent to the situation or not.

Mr. Loflin covers the basis of SA and how it is taught within the fire service. He

discussed the cognitive learning that occurs early on in the career and then continuing throughout

a firefighter's professional development. Mr. Loflin makes specific mention of the need for

getting experience from actual emergency operations. In addition to the necessary cognitive

learning, he ties SA together with operational risk management (ORM) and rapid prime decision

making (RPDM). Both concepts are unique discussions on their own. A common thread

between the two is SA and the ability to use it within the context of ORM and RPDM. Mr.

Loflin states that one of the most important components of SA is the ability to access and utilize

RPDM skills.

RPDM is decision making that is based on an individual's experiences. As opposed to

naturalistic decision making, RPDM is a process that occurs almost instantaneously with

experienced individuals. A situation develops in front of a decision maker and the decision

maker accesses previous similar experiences and makes a decision based upon the outcome of

the previous similar experience. Therefore, the success of a decision using the RPDM model is

that the individual has previous experiences to access.

"This is why training and education is so essential for fire firefighters. In many of our

investigations, one of the issues is that the officer or firefighter had nothing in the hard-

drive to match the scenario they encountered. When there is nothing in the hard drive,

the individual reverts to something they are comfortable with or familiar with, which

most times is the incorrect choice" (M. E. Loflin, personal communication, May 7, 2012).

Mr. Loflin provides examples of contributing factors to inadequate SA and provides

examples of each factor. Many of the examples that he provides are common to post incident

investigative reports and are more specific than a general failure to attain SA. For example, he

cites task saturation as a sign of inadequate SA. This method of viewing an incident after the

fact provides for a much broader scope than a narrow definition of the term. Additional signs of

inadequate SA are tunnel vision, inadequate size up and poor incident management (M. E.

Loflin, personal communication, May 7, 2012).

Stephen Miles was the other investigator who was contacted. He also responded to the

questionnaire and provided valuable and practical insight. Mr. Miles provides a broad definition

of SA that includes one's surroundings and anything that can affect operations on a strategic,

tactical or task level. The examples he provides include the building, weather, fire conditions

and personnel performance. He also provides specific examples of the important components to

SA and how they contribute to success and failure. Mr. Miles and Mr. Loflin both discuss the

importance of experience and of providing opportunities for firefighters to train and develop

their experiences so that the RPDM model can be employed with a high likelihood for success.

If personnel on the fire ground are seeing situations for the first time, their success will be less

likely than for those on the fire ground who have been in similar situations.

Mr. Miles provides references to NIOSH reports that illustrate his various points. For

example, he identifies the problem of firefighters using handlines that are too small for the fire.

With this precise problem he provides nine reports that illustrate this one point. Another specific

issue that he identifies is the problem of task saturation. For this situation he references three

reports that include a confined space rescue and two drowning incidents. The fact that he

references reports other than structure fires is important and allows a broader perspective on the

topic of SA. SA is not strictly tied to structure fires. It is an important part of all types of

operations within the fire service.

The final part of the literature review covers the survey that was provided to company

officers of the Vista Fire Department. Each member was asked a series of questions using the

Survey Monkey online survey tool. The survey and the results are provided in the appendix of

this project. The answers generally demonstrated that company officers are comfortable with

their level of SA but they agree that additional training would be beneficial. One of the issues

when discussing and studying SA is that an objective measuring device or method is not readily

available. The survey was subjective and all company officers rated themselves. Although they

were advised of the confidentiality of the survey there may have been hesitation to be completely

forthcoming due to the fact that the results were being reviewed by a chief officer of the

department.

Regardless of the potential shortcomings and problems with a survey of this nature, the

positive result is that ninety three percent of the respondents do believe that additional training in

SA would be beneficial. Additionally, one hundred percent of the respondents rated the

importance of SA as very important.

The literature review on the topic of SA demonstrates that there is room for growth in this

area within the fire service and the Vista Fire Department. It is a topic that requires more

understanding by the members of the fire service and more practical application in the fire

service. There is evidence that by applying the concepts of SA to the fire service and to the Vista

Fire Department, safety at all levels will be improved. The concepts can be applied to the fire

ground, the drill ground and the driving experience. The concepts that have been successfully

employed in other industries and in similar professions can be easily tailored to fit the needs of

the fire service.

<p style="text-align:center">Procedures</p>

Descriptive research methods were used to identify the background of SA, the current

applications of the concepts, and the potential for continued and increased use at the Vista Fire

Department.

The procedures utilized for this project included review of books on the topics of skill,

Crew Resource Management, organizational accidents, decision making and SA. Numerous

journals were reviewed with the intended goal of finding the application of SA concepts in

similar fields and industries. A questionnaire was emailed to two researchers at NIOSH who

perform firefighter fatality investigations. The final step was sending out a questionnaire to the

company officers to measure first their understanding of the concept of SA, second a self rating

of their own abilities, and third a determination for the need for further training and a measure of

their desire to spend time training on SA and developing their SA.

In order to achieve the stated purpose of this project, a broad scope of research was

required. As one area was researched, other areas were identified that applied to or impacted the

previous research. Although SA can be seen as a narrow topic it is impacted by many factors.

These factors include the individuals in the situation and their personal responses to a particular

situation. These responses are impacted by an individual's history in the same or similar

situation as well as their overall abilities and skills. Additionally, a different makeup of the team

and the interpersonal dynamics among the members of the team may impact the outcome.

Therefore, the research reached out to psychology, cognition, decision making, stress and intuition.

Additional research information was obtained from various accident analyses. These included analyses from vehicle accidents at the Vista Fire Department to multi-year studies of LODD among United States firefighters. The method used to determine the applicable accident investigation was primarily online searches of accident reports and a review of Vista Fire Department accident reports. Although this provided a broad view of various facets of SA, the selection of the reports covered was not based upon a reproducible formula.

Within the fire service, the NIOSH firefighter fatality investigators are highly regarded for their open and honest reviews of significant incidents. The resulting report is often used as a teaching tool at all levels of the fire service, from the new recruit to the senior fire captain. For that reason, NIOSH investigators were contacted for an interview. The contact link on the NIOSH website was utilized for the contact, and initial contact was made with Mr. Tim Merinar on April 24, 2012. Mr. Merinar forwarded the request for further information to two colleagues who then responded to the request for an interview. Due to the length of the questionnaire and the detail with which they wished to respond, both respondents chose to respond in writing to the questions. The responses are provided in the appendix.

The questionnaire that was sent to the fire captains at the Vista Fire Department had some limitations. The high return rate was beneficial and added to the validity of the questionnaire. However, the questions were intentionally limited so that the amount of time needed to complete it would not be a deterrent. Another limitation is that the captains were rating themselves on a variety of SA related topics. "People are typically overly optimistic when evaluating the quality of their performance on social and intellectual tasks. In particular, poor performers grossly

overestimate their performances because their incompetence deprives them of the skills needed

to recognize their deficits" (Ehrlinger, Johnson, Banner, Dunning, & Kruger, 2008, p. 98). The

researchers continue with examples of this deficit. Multiple researchers have shown that the

average person will rate themselves as above average when asked. This is obviously statistically

impossible. In another survey corporate engineers were asked how their work rated. Forty two

percent of the respondents rated themselves in the top five percent (Ehrlinger et al., 2008, p. 99).

This can lead to problems when trying to diagnose a shortcoming or an area where improvement

is needed. If the individual is not aware of their deficit they are not able to identify the need for

improvement. The research shows that the poorest performers are the same group that hold the

least accurate perception of their abilities and will grossly overestimate how well their

performances measure against their peers. For this reason, a recommendation for future

development of this topic is to create an objective method to measure SA successes and

shortcomings in the training scenario and during post incident analysis.

<center>Results</center>

The research provided answers to each of the four research questions. The first question

was as follows: How can situational awareness understanding and competence be measured?

One way to measure SA is to ask individuals to rate their understanding and competence as it

relates to SA. The questionnaire provided to company officers at the Vista Fire Department

utilized this format. Answers were provided and a high return rate was achieved. However, it

was identified that individuals are typically overly optimistic in their self-insight caused by the

Dunnig-Kruger effect. This effect states that to an extent, the higher the ignorance the greater

the confidence (Ehrlinger et al., 2008, p. 98). This problem may have been evident in the

questionnaire that was provided to the company officers at the Vista Fire Department. As Jones

stated, the self rating technique is not realistic because operators cannot be aware of their own

SA shortcomings (Endsley & Garland, 2000, p. 113). Therefore, the questionnaire method is not

a reliable method of measurement but it does provide some useful information. The

questionnaire did illustrate that the company officers were willing to train more to increase their

SA, and it also provided insights into how each company officer defined SA.

A solution to the questionnaire and an option that does not include the Dunning Kruger

effect is an objective testing method. An objective testing method is one where the human

observer is not an integral part of the measurement. Objective data is generated independently of

the observer and therefore should be more reliable and less subject to bias. However, as Herbert

Bell and Don Lyon state, objective data removes the flexibility of subjective measurement and

does not account for the vast diversity of human behavior (Endsley & Garland, 2000, p. 140).

There are different methods that have been used in various other disciplines. The

Situation Awareness Global Assessment Technique (SAGAT) is a tool that measures a

comprehensive set of specific SA criteria. The SAGAT includes queries of a range of SA

requirements that cover the three levels of SA; perception of data, comprehension of meaning

and projection of the near future. "SAGAT queries allow for detailed information about subjects

SA to be collected on an element by element basis that can be evaluated against reality, thus

providing an objective assessment of operator SA" (Endsley & Garland, 2000, p. 147). This type

of direct measurement of SA takes the subjective factor out of the analysis and creates an

objective assessment that is based upon perceptions made by the operator and not by behaviors

assessed by an evaluator. The SAGAT is an immediate measure involving a pause in the

simulation to administer the assessment and thereby receiving instant unbiased feedback from

the operator. This technique benefits the operator as well as the evaluator because it provides a

time specific context of the areas of strength and the areas where improvement is needed.

The second research question looked into the best practices of other industries and the

applicability to the Vista Fire Department. Based upon the literature review, the airlines industry

has the most accessible and comprehensive data available. The airline has been using the

concept of SA along with the other concepts of CRM for forty years. Additional information

was obtained from the School of Aviation Safety which is part of the Naval Aviation Schools

Command, the United States Coast Guard (USCG) and the Science and Technology

Organization of the North Atlantic Treaty Organization.

In the literature by Holmquist and Goldberg and the literature by O'Connor both begin

their discussion with a definition of SA followed by the three levels of SA as identified by

Endsley. These three levels are perception of the elements in the current situation,

comprehension of the situation and the ability to use the current information to predict a future

status of the situation. Although the USCG document does not provide a reference for their

definition of SA it is very similar to that provided in the other two documents which are again

based on Endsley's definition (Holmquist & Goldberg, n.d., p. 6-1).

Holmquist and Goldberg view SA from the perspective of an individual soldier on the

battlefield. Successful SA is achieved when the three levels are applied to the incident and a

overall view of activities, threats and operations come together. The authors refer to the

definition of SA provided by the U.S Army Training and Doctrine Command which requires the

ability to have accurate information about friendly, enemy, neutral and non-combatant locations

and then develop an overall view that is relevant to the specific level of interest (Holmquist &

Goldberg, n.d., p. 6-1).

The authors of the NATO study address various decision making processes with emphasis on SA. These best practices include procedures for use in various disciplines as well as in military specific programs. One multi discipline technique that is used is Recognition Primed Decision Making (RPDM) which explains how people can make good decisions without generating and comparing a set of options (Klein, 2003, p. 17). Recognition primed decisions only improve with repeated mental simulation and practice. Therefore, it is possible to improve decision making with this tool by repeated mental simulations and experiences where outcomes are realized and remembered (Klein, 2003, p. 17). The successful outcomes of recognition primed decisions and the ability to make better decisions with recognition primed decisions was based, in part, on better SA (Holmquist & Goldberg, n.d., p. 6-2). Recognition primed decisions are successful on the battlefield due to the ill defined nature of battle, which is why an ability to develop reliable and consistent SA is so important to the soldier (Holmquist & Goldberg, n.d., p. 6-4).

The USCG Team Coordination Training (TCT) document views SA from the perspective of a boat crew in the USCG. The TCT discusses how to maintain SA and provides examples of signs that indicate when SA is deteriorating or is already lost by the operator or team. Additional information from the TCT identifies the fact that losing SA is not uncommon and the text provides corrective action options to take in those situations ("Team Coordination Training," n.d., p. 6-7). Command concurrence is a process that empowers any crew member to inform their command that SA has been lost and that errors are occurring. The procedures for command concurrence are detailed on pages 6-7 and 6-8 of the TCT document and include a requirement that the procedures are discussed with all crew members prior to a mission. This requirement enhances the empowerment to the crew members and formalizes the responsibility that all crew

members have in maintaining SA during the mission ("Team Coordination Training," n.d., p. 6-8).

O'Connor's perspective on SA is from the seat of a Naval Aviator and is similar to that of the airline pilot and the other players in the larger game of airplane movement including air traffic controllers. The definition provided is from Endsley and includes the three levels of SA. Additionally, background information is provided that identifies poor SA as being the leading causal factor in 175 aviation mishaps that were reviewed. The guide provides clues that SA has been lost and also provides techniques for maintaining good SA. These techniques include getting the right information, maintaining an overview, and reviewing the situation (O'Connor, 2007, p. 12). The other best practice that is provided involves calibrating SA periodically during a flight. The pilot and crew must continuously work at maintaining an adequate SA and developing a more thorough SA. This is accomplished by asking relevant questions during the operation and reviewing the positive and negative results of how a situation was resolved (O'Connor, 2007, p. 13).

The third question is as follows: How does a lack of SA affect operations at the Vista Fire Department? This question can be answered by looking at the questionnaire sent out to the Company Officers and by a more global view of the issue as seen from the NIOSH investigators. Due to a lack of empirical data on this topic from the Vista Fire Department the reliability of the questionnaires is suspect. However, the information received from the NIOSH investigators is valid and despite not being specific to Vista, it is representative of the fire service as a whole, of which the Vista Fire Department is a part.

According to responses made by company officers, SA is rated as very important to the company officer. Additionally, all of the company officers that responded to the survey stated

they would be willing to spend more time per month developing their SA abilities. The Vista

Fire Department generates blue sheets following damage incurring collisions. A lack of SA was

identified in two blue sheets prepared by the Vista Fire Department. In one post accident review,

a lack of SA was identified as a contributing factor to the negative outcome and property damage

that occurred due to the perceived need for urgency (Vista Fire Department, 2010, p. 4). Another

report stated that a lack of SA caused property and vehicle damage and was the main

contributing factor to a vehicle accident (Vista Fire Department, 2011, p. 2).

Miles (personal communication, April 30, 2012) states that operations are negatively

impacted by a lack of SA in a number of ways. He describes communication breakdown as a

significant negative impact and provides an example. His reference to NIOSH report 201013

illustrates the communication breakdown as well as the failure of the victim to adequately

respond to an uncontrolled self contained breathing apparatus emergency. The combination of

lack of communication, task saturation and the unexpected event contributed to the firefighter

fatality.

Loflin (personal communication, May 7, 2012) reiterates the importance of SA relating to

adequate SA. The specific situation he refers to is the communication disconnect from the

strategic level to the tactical or task level. He continues that communication is a key element to

safety and a common denominator on fires with negative outcomes. During operations where

communications are lacking or insufficient for the operations, multiple issues surface including a

lack of accountability, freelancing, poor decision making and ineffective operations.

The final question is as follows: How can the level of SA be increased among the

members of the Vista Fire Department? The answer to this question was similar among all of the

researched material. Extensive research has been performed to answer this question for the

aviation industry. Endsley (2000, pg. 353-359) provides multiple recommendations for improvements which mirror the three levels of SA described earlier. Task management is seen as a priority and is the cornerstone of successful SA development and improvement. Task management includes the ability to deal with interruptions as they occur. Just as Miles (personal communication, April 30, 2012) cited who was in the example of the firefighter unable to effectively respond to the unexpected event, Endsley also identifies this ability as critical. "This understanding also allows pilots to actively manage their task and information flow so as not to end up in a situation where they are overloaded and miss critical information" (Endsley & Garland, 2000, p. 353).

As the ability of the operator increases, the next step is to develop the level of comprehension. The comprehension level in the fire service requires experiences or knowledge by which to gauge and develop a response to the situation. The firefighter must have the ability to recognize that a problem or condition exists and that corrective action needs to happen. Without previous exposure to a similar situation, the likelihood of a successful outcome decreases. "When there is nothing in the hard-drive, the individual reverts to something they are most comfortable with or familiar with, which most times is the incorrect choice" (M. E. Loflin, personal communication, May 7, 2012).

The only way to achieve success at the third level of SA is to be comfortable and competent with the first two levels. The third level is projection and planning and not only will that not occur without proficiency at the first two levels, but if it does occur it will be based on poor intelligence and data. There is a critical need for active planning for various contingencies and not just the expected (Endsley & Garland, 2000, p. 354). Holmquist identifies the need for timely sharing of quality pertinent information so that better coordination among units occurs

and decisions relating to future actions and plans are made quickly and accurately (n.d., p. 6-4).

The ability to project and plan is based on quality communication during the incident and also

quality communication following the incident in the form of after-action reviews. The Naval

Aviation guide identifies the need to review the situation and to identify both the good and bad

points (O'Connor, 2007, p. 13).

An excellent summation of the ways to increase SA comes from NIOSH investigator

Loflin. He identifies the need for scenario based practical training, live fire training, fire ground

survival training, skills repetition training, and post incident analysis (personal communication,

May 7, 2012).

<div align="center">Discussion</div>

It is clear from the results of the questionnaire that company officers at the Vista Fire

Department see value in developing SA skills. It is also clear from the interviews with the

NIOSH investigators that inadequate SA is a common contributing factor in fire fighter fatalities.

The research discussed in the literature review supported this assessment as well. The various

disciplines that incorporate SA training indicate that SA competence is viewed as important to all

levels of decision makers and operators.

The organizational implications of the results of the study and the research indicate a

need for a training program that encourages SA development among all members of the Vista

Fire Department. Bolstad and Endsley (2003) refer to firefighting as a profession that requires

individuals working as a team where performance is dependent upon the coordinated efforts of

the individuals. However, they also identify that this is difficult in dynamic environments where

team members are receiving new information at the perception level, comprehending the

information individually, and then working to determine future events and actions. The

challenge is integrating the information from a group of individuals and using the information that is deemed valuable in making decisions The challenge is for the involved personnel to determine the information that needs to be shared and what information can be withheld. The reality is that not all information from individuals will be shared among the team (Bolstad & Endsley, 2003, p. 1).

<div align="center">Recommendations</div>

The recommended next step for the organization is to develop realistic manipulative and simulation based training with the focus on measuring and growing SA among company officers. In order to gauge the success and benefits of the training a pre and post training evaluation process must be established. As identified in this project, self rating is an unreliable method on its own and an objective testing process should be developed to be used in conjuction with the self rating. For example, during a simulation questions can be asked of the operator while the simulation is paused which provides immediate feedback on the operator's performance. This process can continue throughout the simulation with a comprehensive review of all answers at the end of the simulation. The feedback received from this portion of the evaluation can be used with the self rating to provide comprehensive feedback and a plan for improvement and growth. The same process can be developed with realistic manipulative training; however, mid training pauses may not be practical.

For future readers, more study is needed to determine the effects of additional realistic training in the development of SA. The research clearly indicates SA training is beneficial to many disciplines including naval aviation, civilian aviation and military operations. However, the same level of research has not been dedicated to this area of study specific to the fire service. The challenge is to find opportunities to develop these skills. With the increased development of

financially affordable computer based multi station simulations, the potential for meaningful and

realistic training is growing. The need for SA growth is evident; the ability to measure and

develop SA is attainable. It is time to make SA development a reality.

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