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Accelerating Expertise to Facilitate Decision Making in High-Risk Professions Using the DACUM System

Ralph Kuchenbrod
Eastern Illinois University

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Accelerating Expertise to Facilitate Decision Making

In High-Risk Professions using the DACUM System

(TITLE)

BY

Ralph Kuchenbrod

THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF

Master of Science in Technology

IN THE GRADUATE SCHOOL, EASTERN ILLINOIS UNIVERSITY
CHARLESTON, ILLINOIS

2016

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Abstract

The purpose of this research was to determine whether the process of achieving occupational expertise could be accelerated enabling operators in high risk vocations to make effective decisions earlier in their careers. Scholars have hypothesized good decision making skills are largely a result of relevant experience within the specific domain. The rationale being that the greater the experience an individual has the more likely the operator has experienced similar situations and can apply solutions that have been successful in the past. Two distinct methods of decision making have been identified: traditional decision making and naturalistic decision making (NDM).

The ability to implement the traditional decision making method effectively is contingent on the availability of sufficient information and adequate time for the individual to examine the information, construct and weigh options, and ultimately choose the action that the operator deems most appropriate given the data at the time. Naturalistic decision making is a process an operator can employ in a high risk, dynamic situation (e.g., military personnel in combat, fireground commanders on-scene, police officers confronting armed criminals) to make decisions when data may be incomplete and time is critically short. Both processes depend on the operator's domain expertise.

Research has shown the naturalistic decision making process is the method many high risk operators revert to when conditions do not permit a deliberate, analytical decision-making approach. These conditions include ambiguous situations, serious time constraints, or inadequate information. Studies have determined that the fundamental element of NDM is domain experience, i.e., the seasoned decision-maker compares the

current situation to a similar experience from the past. This pattern recognition enables the decision maker to apply tactics that successfully resolved previous problems.

The overarching limitation in NDM is gaining the requisite domain experience. One pedagogical process that has been recognized to enable occupational instructors to identify requisite skills and accelerate the process of placing operators in their chosen vocation is the method known as Design A Curriculum (DACUM). The DACUM process breaks an occupation down into areas of competence and the skills required within each area. Each skill level is given a numerical rating indicating the minimum performance standard for that skill. An operator with skills from a similar occupation can test for that skill and if the minimum performance level is achieved the operator is given credit for that skill and can focus subsequent efforts on other areas or skills. The DACUM process can help accelerate the training process and place an operator into the vocation sooner and thus begin gaining experience in the domain.

The DACUM process was employed for this research. A panel of expert firefighter instructors were assembled and spent two days analyzing the occupation of acquired structure live burn instructor.

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CHAPTER I

Introduction

An important element of effective leadership is the ability to make decisions in difficult circumstances. In high-risk vocations such as firefighting, police work, military combat, and surgery operators are often compelled to respond to situations that require immediate and appropriate action. The ability to make a good decision under severe constraints (e.g., ambiguity, immediacy, insufficient information) is a hallmark of the domain expert. The path to expertise is often the result of knowledge, skills, and attitude combined with experience, usually years, in a particular discipline. Organizations will realize distinct advantages if novices can attain domain mastery in their respective disciplines in a shorter period of time. The purpose of this study was to examine the path from aspirant to subject matter expert and explored whether techniques could be employed to accelerate the process of achieving domain expertise. More specifically, the study sought the perceptions of subject matter experts, noted their professional opinions as to the whether a specific training curriculum method could identify and qualify candidates in a high-risk occupation. Their findings were compared with the results of the academic research as part of the literature review.

Statement of the Problem

Expertise and the ability to make effectual decisions, especially in critical situations, are inextricably linked. A veteran airline pilot masterfully set his critically-stricken airplane down in the Hudson River less than six minutes after takeoff without loss of life (Prochnau & Parker, 2009); a ship-borne weapons control officer launched an anti-aircraft missile at a radar track not knowing if it was an Iraqi Silkworm missile attacking his task force or a returning U.S. Navy fighter—he only had ninety seconds to decide (Klein, 1998). These are examples of decisions made under stress by experts. How could high-risk vocations benefit if decision-makers such as these could be identified, trained, and put to work in a fraction of the time it currently takes? How many lives would be saved if operators could be trained to react instinctively in high-risk situations earlier in their careers?

Rationale

Expert performers, i.e., operators who perform at the highest level of their domain's capabilities, are able to do so because of many factors: they "actively work toward developing and honing skill", "testing themselves and their performance again and again, and endlessly practicing requisite skills" (Crandall, Klein, Hoffman, 2006, p. 134). Every profession benefits from having its operators possess a thorough knowledge of the discipline and demonstrate mastery of the domain's specific techniques. In vocations experiencing a high turnover of personnel (e.g., military operations) the loss of experienced operators is of particular concern and the sooner qualified replacements can be recruited, trained, and assigned the better for all concerned.

The focus of ab initio training is to prepare the novice to enter a specific profession at a certain level of competency. Knowledge can be transferred from expert to novice; skills can be taught, practiced, and mastered. Attitude is a function of an individual's motivation and can be influenced by instructors, mentors, and experts that the novitiate encounters. Given that the aspirant has no prior professional experience, it is reasonable to expect the novice will enter the field at a competency level below that of expert or master. This paper delved into the possibility, that through specific training techniques and curriculums, the process of accumulating experience can be compressed and the overall training process accelerated.

Purpose

The purpose of this study was to explore training techniques to determine if the development of expertise could be accelerated within certain high-risk vocations. Additionally, this study sought the perceptions of a panel of practicing subject matter experts within a high-risk vocation (firefighting) and solicited their opinions as to whether a specific curriculum development method could accelerate domain expertise.

Research Questions

Increased knowledge and experience distinguish the expert operator from the novice. Elements that comprise an individual's expertise include "diagnosis and prediction, situation awareness, perceptual skills...improvisation, metacognition...", (Salas & Klein, 2009, p. 98). This research sought to discover if novices can achieve accelerated expertise through the use of domain specific curricula and techniques. In order for operators to learn in less time to make better decisions this study sought to answer the following questions:

1. What are the competences and skills individuals require to be considered an expert in the occupation of acquired structure live burn instructor?
2. What is the level of skill required of individuals in order to be considered expert in the occupation of acquired structure live burn instructor?

Summary

The process of creating domain experts is rife with opinions from learned scholars. For example, Ericsson (2008) espouses the deliberate practice methodology where an operator masters one particular skill before moving to evolutions of increasing difficulty. Klein (1998) advocates that intuitive response gained from previous experiences can be a valid course of action. Military, aviation, and other high-risk occupations employ extensive use of simulation and training scenarios to transition novices into competent operators.

By examining the aforementioned methods and other elements that comprise expertise, this research examined the possibilities to accelerate the process of achieving domain expertise and enabling the operator to make the critical decisions required of the domain.

CHAPTER II

Accelerating Expertise to Facilitate Decision-Making In High-Risk Professions

Role of Expertise

Making sound, effective decisions as a professional in a specific domain is a learned skill. Soldiers in combat, pilots flying high-performance aircraft, and surgeons performing critical surgical procedures are expected to make crucial life-or-death decisions. "Good decision-making skill depends on the domain expertise of the decision maker (Pliske, McCloskey & Klein, 2001, p. 41). Depending on the specialty, many practitioners can expect to spend decades and in excess of thousands of hours acquiring and mastering the skills of an expert through instruction, training, and experience. Typically, the path to domain expertise is a logical progression from novice (beginner), to intermediate level (journeyman), to subject matter expert. Methods for identifying bona fide expertise can include empirical observation of expert performances (e.g., witnessing a master's move in chess or a surgeon successfully completing a complicated surgical procedure). Process-tracing techniques such as think-aloud reports or cognitive task analysis can also be employed to determine how the expert performer was able to operate at such a high performance level.

Customarily, society defines an expert as an individual recognized for their expertise by colleagues within the profession, extensive formal domain-specific training and education, accumulated knowledge and experience, and tenure within the profession (Ericsson, 2006). Ericsson (2006) argues that society's definition is flawed, citing examples where tenure and societal recognition are not true indications of an individual's expertise, rather the better indicator is the individual's ability to consistently produce superior performance on typical, genuine applications within the domain. Elliott (2005, p. 2) compares expertise to "any other cognitive skill" in that it is achieved through quality practice. True expertise is "demonstrated by measurable, consistently superior performance" (i.e., surgeons have successful outcomes, chess masters win matches) (Ericsson, Prietula & Cokely 2007, p. 3). For the average operator post-instruction job performance often peaks after two years, at this point the individual has usually achieved an acceptable level of performance and can perform in a journeyman's capacity almost indefinitely (Ericsson, 2006). The path to virtuoso or subject matter expert requires substantially more.

Definitions and Differences in Decision-Making Processes

A decision "is the commitment to an action whose aim is producing satisfying outcomes. And decision-making is the process of solving a particular type of problem, arriving at a good decision" (Yates, 2001, p. 17).

In the current scope of scientific decision-making studies there are two generally acknowledged methods of decision-making, the traditional or analytical method, and the naturalistic decision-making (NDM) method. When applying the traditional method, the decision-maker "systematically searches for relevant information in an unbiased manner and then carefully weighs the utility of each alternative before making a choice" (Pliske, et al., 2001, p. 38). The naturalistic decision-making method is best suited in situations where the decision-maker is operating in a field setting and will have to make decisions amid the difficulties of a dynamic environment that may include "missing information, time constraints, vague goals, and changing conditions" (Klein, 1998, p. 1).

The traditional or analytical method lends itself to applications where there is little or no time pressure to make a decision or the decision-maker has ample opportunity to gather and carefully analyze pertinent information. The analytical decision-maker formulates multiple alternatives, weighs the merits of each, and ultimately chooses a course of action that offers the greatest probability of success or perceived advantage.

Naturalistic decision-making is described as "how practitioners actually make decisions in complex domains rather than how they ought to make decisions" (Shattuck & Miller, 2006, p. 1). A relatively recent discovery, the naturalistic decision-making process has been the subject of scientific study for about thirty years. Klein first examined decision-making in high risk field settings in 1984 as the result of a study conducted for the United States Army (Klein, 1998). Klein's research led him to develop a decision-making model based on his observations of professionals making decisions in specific dynamic domains. Rather than relying on traditional analyses of the factors at hand, Klein realized experts made decisions based on recognition of similar characteristics from past experiences then compared them to the current situation. By implementing solutions or taking actions that had worked in the past the decision-maker was able to respond to a situation more quickly. Klein named his decision-making process the recognition-primed decision (RPD) model. Recognition-primed decision-making involves assessing the situation, mentally searching for familiar patterns, identifying and considering a positive solution from the past, and envisioning an appropriate course of action (Shattuck & Miller, 2006).

The recognition-primed decision-making model has been studied across a variety of domains including firefighting, mechanized combat operations, naval seaborne missions, tournament chess play, and nursing in neonatal intensive care units. In each of these applications successful use of the RPD model hinges on the decision-maker's level of experience (Pliske, et al., 2001).

Since they lack the necessary experience base, novices solve problems by thinking in terms of algorithms, arriving at solutions at the end of the mental exercise. The novitiate ultimately retains the solution in memory and can retrieve it should a similar problem be encountered. Acquiring expertise becomes a matter of being capable to draw from previous experiences to solve problems rather than perform lengthy mental computations (Gonzalez, Lerch & Lebiere, 2003).

Characteristics of the Traditional/Analytical Decision-making Method

One way of characterizing the analytic decision-making method is to think of it in terms of a linear model, that is, the decision-maker takes in information, sorts it by importance and relevance, constructs hypotheses, and compares the various hypotheses against a desired outcome (Bryant, Webb & McCann, 2003). The traditional decision-making method is derived from standard economics theory. The decision process progresses in a rational, logical sequence, options are created and weighed against each other until the most favorable option is identified and selected (Fallesen, Michel, Lussier & Pounds, 1996).

Important requisites to the analytical method are that the decision-maker has access to a sufficient supply of reliable data, the cognitive ability to quantify the relevance and importance of the data, adequate time to devise multiple solutions, an optimal outcome in mind, and the mental capacity to compare the solutions. The decision-maker selects the solution perceived to have the highest probability of success to achieve the preferred outcome. The implication becomes, given a good quantity of relevant data and sufficient time to analyze the data, the decision-maker should be able to choose the best decision for the situation at hand. The analytical decision method works well in circumstances that are clearly defined and have few time constraints. Two common examples include purchasing an automobile or selecting a candidate for employment or promotion (Simpson, 2001).

Critics of the analytic decision-making method point out that in complex or dynamic situations (e.g., military combat, aviation, surgery) a decision-maker may be confronted with ambiguous or insufficient data and inadequate time to generate multiple solutions. In high risk, fast-paced situations the analytical method would be deemed "cumbersome and time consuming" (Simpson, 2001, p. 1). These limitations "can make analytical theories intractable and highly implausible as descriptive models of human decision-making" (Bryant, et al., 2003, p. 30).

Traditional Decision-making in the United States Military

The traditional decision-making method is deeply-rooted in the American military. The United States Army has long adhered to a "linear and analytical decision-making approach" labeled the Military Decision-making Process (Vandergriff, 2006, p. 70). The United States military's decision-making culture evolved from the linear business practices espoused by Taylor and put into common practice by Secretary of War Elihu Root in the late 1800s. Grounded in efficiency, Taylor's model enabled the military to take large numbers of average citizens, indoctrinate and train them into relatively proficient soldiers. This was the training model employed during World War I and World War II, both wars being deemed linear as they were fought largely in conventional terms (i.e., declared wars fought between recognized combatant countries by organized, formally-trained soldiers). Taylorism is founded on a conventional top-down hierarchy where information flows up but decisions come from top down. Soldiers are indoctrinated in the chain of command and are not expected to think for themselves; people were treated “as unthinking cogs in a machine” (Vandergriff, 2006, p. 26).

In the modern era, relatively quick, decisive victories over conventional Iraqi forces in 1991 and 2003 reinforced the military mindset that the traditional model of training and preparing officers and soldiers for warfare in the twenty-first century remained valid. However, in retrospect, Iraq was a relatively weak military foe and waged mostly linear campaigns. The Iraqi military was vanquished by an overwhelmingly superior force particularly suited to fight a conventional war. Today, the United States military is largely unprepared for large-scale unconventional warfare as is currently being experienced in Afghanistan and post-invasion Iraq. Traditional thinking and top-down decision-making models are not effective in these theatres; the military finds itself in need of a paradigm shift. Soldiers operating in the environs of today’s insurgency-staged warfare must be innovative and capable of making decisions in a dynamic environment without reliance on a traditional chain of command (Vandergriff, 2006).

The United States military is only one of many organizations, industries, and domains that directly benefit from contemporary decision-making research. Examples gleaned from this research include the Navy’s Tactical Decision-making Under Stress (TADMUS) program and the aforementioned seminal work by Klein for the United States Army. In the private sector, Gladwell’s book *blink* and the Heath brothers’ book

Decisive are two civilian resources that delve into the intricacies of decision-making in business and personal settings.

Characteristics of the Naturalistic Decision-making Method

As previously described, naturalistic decision-making is the process experienced operators employ in real-world, dynamic situations to create solutions to immediate problems. Fadde (2007) states that NDM is best described as recognition-primed decision-making. Encountering a problem, the expert draws upon previous experiences gained in similar situations to devise a solution to the question at hand. Recognizing situational patterns from the past, the operator categorizes the situation as a specific type, is alert to any anomalies, generates a solution, performs a mental simulation of the intended action, weighs the chances of success and executes the decision. Monitoring the effectiveness of the solution, a new problem may arise and the operator may repeat the RPD process (Fadde, 2007). Professions that currently utilize the NDM and RPD models include military combat, aviation, law enforcement, firefighting, neonatal intensive care, and surgery.

In the 1980s United States Army officials recognized that the traditional or analytical decision-making method took an inordinate amount of time to reach a workable decision. Klein was contracted by the Army to study how decisions are made and devise a process whereby effective decisions could be reached quicker. Klein decided it was too risky for researchers to work in actual combat conditions and instead looked for a domain where stakes were still high and life threatening but not necessarily to the researchers. Klein decided to focus his studies on firefighting and fireground commanders.

Klein's (1998) research led him to learn that most fireground commanders are very experienced, averaging twenty-three years' time in service as firefighters, and are directly responsible for life and death situations in the field. The following is a list of defining characteristics within high risk NDM settings:

- Time pressure: most (80%) experienced fireground commanders can make decisions in less than one minute
- High stakes: poor decisions can result in loss of life
- Experienced decision-makers: persons with domain experience will be those charged with making the critical decisions
- Inadequate information: relevant information may be ambiguous, unreliable, or unobtainable
- Unclear goals: the optimal outcome must be determined
- Poorly defined procedures: NDM decision-makers can be innovative and pursue non-traditional methods
- Cue learning: decision-makers must be able to make distinctions and notice patterns
- Context: includes background conditions and higher level goals
- Dynamic conditions: goals can change, information can become outdated
- Team coordination: most domains involve teams (i.e., fire companies, helicopter crews). Exceptions include master chess players.

Recognition-Primed Decision-making

Klein (1998) interviewed fireground commanders in order to learn how these operators made their decisions, specifically, how options were identified and evaluated. Klein discovered the commander almost always instinctively knew what to do. The fireground commander did not consciously compare options; the commander recognized a situation as familiar, considered a reasonable course of action from the start, and knew what action to take. Klein (1998) learned experienced commanders quickly identify one workable solution and find no need to pursue other options. Klein called this process recognition-primed decision-making (RPD). Recognition-primed decision-making utilizes a singular evaluation approach as opposed to the analytical decision-making method's comparative evaluation. When operating under severe time constraints any workable solution devised by the decision-maker is considered "good enough"; comparing multiple options is not necessary and would consume valuable time. This strategy becomes an integral component of RPD and has been given the unique term *satisficing*, which is defined as, "selecting the first option that works" (Klein, 1998, p. 20).

Recognition-Primed Decision-making Characteristics

In his research with fireground commanders, Klein identified the following three decision-making characteristics (Elliott, 2005):

- Experience: The fireground commanders used their previous experiences to derive an appropriate response.
- Satisficing: The fireground commanders did not have to arrive at a perfect solution only one that would work.

- Mental simulation: Once a possible course of action had been identified the fireground commander would mentally simulate its success.

"Naturalistic studies show that *ideal* decisions are not realistic in complex, adversarial situations. Decision makers should recognize and adapt to the characteristics of the situation" (Fallesen, et al., (1996), p. vii). The RPD model allows a decision-maker to arrive at workable solutions without an in-depth comparison of multiple solutions. The decision-maker evaluates the situation looking for familiar, recognizable patterns. These patterns will prompt the decision-maker to mentally consider a viable solution and possible outcome resulting from that solution. Intuitive or recognition-primed decision-making typifies expertise in many domains (Fadde, 2007). In order to capitalize on the benefits of the RPD model Klein determined that successful fireground commanders possess four necessary qualities (Gasaway, 2011)

- Commanders must possess and maintain strong situation awareness.
- Commanders must possess tacit knowledge.
- Commanders must be able to conduct mental simulations of future events.
- Commanders must possess a high level of self-efficacy (confidence) in their decision- making abilities.

Situation Awareness

Most naturalistic decision-makers operate in a field environment where situations are fluid and dynamic with constantly shifting conditions. The practitioner must continuously monitor his or her surroundings as the action evolves in order to maintain an in-depth understanding of the context. This continuous observation and assessment process is referred to as situation awareness (Elliott, 2005).

Klein discovered that one of the requisite attributes of the effective operator when employing the recognition-primed decision making process is situation awareness. Situation awareness is more than just knowing what is going on in the immediate environment. It is an acute sense of paying attention to events and time; it is looking for cues and signs that could signify a change in the situation; and it is thinking ahead, considering "what if" (Gasaway, 2011, Recognition-primed Decision-making Process, para. 1). "Cue pattern recognition is an integral part of the situation assessment process and familiarity with environmental cues is argued by many to drive expert situation assessment" (Fiore, Jentsch, Oser & Cannon-Bowers, 2000, p. 24). Simpson (2001) contends that "situation assessment and awareness is a crucial process for intuitive decision strategies and there exists a positive correlation between situation awareness and decision accuracy" (p. 8). The assertion becomes "naturalistic decision-making is characteristically driven by situation assessment" (Lipshitz & Strauss, 1997, p. 158). Orasanu contends that good decisions depend on accurate situation assessment (2005).

The decision-maker pays particular attention to the situation specifically looking for recognizable or familiar patterns. The practitioner achieves understanding and conceptualizes possible remedying actions by noting the unfolding cues and comparing them to experiences from the past. Atypical or unfamiliar situations will not provide the practitioner with recognizable cues and will thus be unable to discern which patterns are relevant. In an atypical situation the practitioner may have to resort to a heuristic approach in order to form an appropriate plan of action (Gonzales, et al., 2003).

"Experts often have superior situation awareness that is built on tacit knowledge and enables rapid and largely uneffortful (i.e., intuitive) decision making. Research suggests that situation awareness can be systematically trained" (Fadde & Klein, 2010, p. 7). Through observation of the physical situation and mental simulation of his or her options, the decision-maker decides on a course of action, initiates that action, and observes the effect. If the selected action does not produce the intended effect the decision-maker must modify the decision or perhaps devise an entirely new solution based on the situation as it evolves. Continuous observation and assessment are the foundations of situation awareness.

Tacit Knowledge

Knowledge is gained from many sources including formal industry-specific training, job experience, self-instruction, and mentoring. This knowledge is structured in an individual's memory and has been variously described as "*scripts, schema, mental models,* and *cognitive maps*" (Smith, Ford & Kozlowski, 1997, p. 94). Novices and experts differ in that experts have knowledge structures that contain "strong links between problem types and specific solutions" whereas novices "possess separate knowledge structures for problem definition and problem solution" (Smith, et al., 1997, p. 94).

A dominant characteristic noted throughout the documented naturalistic decision-making research is the central role in which expertise plays. Novices are not yet prepared to assume the domain responsibilities of the expert performer. A novice is a person who has received training in a specific domain but has not yet attained the acknowledged abilities of a skilled operator. Though the definition of an expert is subjective, Kahneman and Klein (2009) quote Shanteau: "Experts are operationally defined as those who have been recognized within their profession as having the necessary skills and abilities to perform at the highest level" (p. 519). Many scholars accept that in a specific domain "it takes 10 years to develop expert-level knowledge and performance" (Gasaway, 2011). Klein further qualified that it is not just tenure in the vocation that defined the expert but also the quality of the experience (Elliott, 2005).

There is debate among researchers regarding the decision-making differences between experts and novices. Novices will use heuristics in situations because they cannot relate what they see to a previous experience. The expert can draw upon previous experience from a similar situation to arrive at a decision much quicker (Gonzales, et al., 2003). It has been suggested that experts and novices are each capable of making decisions but the experts can apply their knowledge to enhance their own situation assessment and mentally facilitate the decision-making process. "Decision-makers retrieve previous knowledge of situations similar to the current one and abstract the common features from the past to direct the attention to the important cues in the present" (Gonzales, et al, 2003, p. 598).

Within specific situations subject matter experts recognize elements that enable them to define the problem, mentally visualize a solution to an acceptable outcome, and initiate the action necessary to achieve the desired outcome. Novices though familiar with the domain, given identical circumstances may be unable to comprehend the gravity of a situation in a timely manner, lack the ability to quickly devise conventional or, if necessary, novel solutions, and be unable to formulate a viable action plan in the time available. As a result of their greater experience, training, and knowledge, experts are able to recognize the critical elements of a situation and act much quicker than the novice who may have to rely on additional information and further analysis of the situation before initiating action.

Mental Simulation

A vivid mental model allows the decision-maker to view the problem in terms of a satisfactory solution by quickly forming judgments and crafting decisions that lead to action. Experts maintain situation awareness by observing the situation looking for familiar patterns; the expert is able to discern what is relevant information and that which is superfluous. The novice may be unable to filter out the important cues from all of the information available and become overwhelmed.

Experts have a greater knowledge base than novices and this base is founded on inferences and principles gained from their experiences. Greater knowledge enables the expert to form mental models, cognitively construct workable solutions, and visualize an acceptable outcome. Experience allows experts to recognize patterns from situations in the past and apply techniques that can lead to a satisfactory resolution to the current situation. Novices are often unable to recognize typical patterns and may have to resort to an analytical process to devise a suitable solution (Elliott, 2005).

Due to their extensive subject knowledge experts are better enabled to attend to novel problems. The process begins by taking information from the environment and creating a mental picture from which the decision-maker can make a choice (Vandergriff, 2006). “Thus, through experience, the expert builds up a repertoire of instances, indexing them in such a way that they are readily accessible when triggered by environmental cues” (Fiore, et al., 2000, p. 24). Relying upon their knowledge base and the ability to perceive relevant details, experts can cognitively devise a possible option and mentally simulate whether the outcome of that option will be satisfactory or if a variation of that option will be necessary. If the current situation lacks similarity to any past experience, the decision-maker can draw upon tacit knowledge and construct a viable, creative solution. For the NDM proponent, a decision is made and it need not be perfect only workable (Elliott, 2005).

Confidence

In a naturalistic environment, practitioners utilizing the RPD model must be able to make decisions with conviction using the facts gleaned from assessment of the situation and comparison with patterns recognized from similar situations from the past. Naturalistic decision- making can appear to be based on instinct or intuition. The prudent decision-maker does not rely on instinct but backs up what appears to be intuition-based decisions with domain-specific experience and tangible evidence. Intuition is difficult to validate, fortunately in most cases the situation at hand has provided a cue. "This cue has given the expert access to information stored in memory, and the information provides the answer. Intuition is nothing more and nothing less than recognition" (Kahneman & Klein, 2009, p. 250).

Operators often appear to make intuitive split second decisions in life or death situations and have difficulty explaining how they know they have made the right call. Klein (1998) gives examples of anti-aircraft operators and neonatal nurses making decisions and saving lives with seconds to spare without being able to adequately explain their actions at the time. Klein (1998) believes intuition grows out of experience. Intuitive judgment can be developed if two conditions are satisfied: "First the environment must provide adequately valid cues to the nature of the situation. Second, people must have an opportunity to learn the relevant cues" (Kahneman & Klein, 2009, p. 250). Experience enables the practitioner to make the best decision possible in the least amount of time the circumstances permit.

Developing Expertise

The process of developing expertise in "complex, dynamic, and uncertain domains, is a combination of formal training, on-the-job training, and experience" (Kirschenbaum, McInnis & Correll, 2009, p. 284). Elliott (2005) posits that an individual can develop the skills to become an expert decision-maker and that success is dependent upon enhancing two cognitive abilities: recalling specific domain information (knowledge) and mental processing of domain specific information (decision process). A third skill, execution, comprises the implementation aspect of the decision-making process and is considered to be a motor skill (performance) and will not be covered in this paper.

In addition to Elliott identifying two cognitive abilities, there are other academically acknowledged models that recognize the various stages an individual moves through on the path to expert: Rassmussen's three phases consisting of knowledge-based behavior, rule-based behavior, and skill-based behavior. Dreyfus's five stages: novice, advanced beginner, competent, proficient, and expert. Glaser's four skill areas: performance, judgment, perception, and locus of control. All of these models move the learner from an ab initio introduction to the field to domain expertise through increases in declarative knowledge and cognitive skill development. As cognitive skills improve the decision-making process becomes "more effective and efficient" and it can appear that an expert is making decisions intuitively (Elliott, 2005, p. 27).

All of the models listed share at least one common theme: the individual gaining experience through graduated exposure within the domain. Lack of experience deprives the novice decision-maker of the ability to form accurate mental simulations of possible solutions to the current situation. Without the ability to recognize patterns the novice must revert to a time consuming detailed analysis in order to construct a suitable solution. When training decision-makers to operate in naturalistic settings there is no substitute for exposure to multiple experiential cases. Ericsson (2008) states that once individuals gain extensive experience and become experts they are able to respond "rapidly and intuitively" (p. 988). Training is a supplement to achieving expertise but is not a substitute for real world experience (Klein, 1998). The challenge becomes how to gain experience in the shortest period of time.

Recruiting Decision-makers

An essential element to effective decision-making in dynamic environments is a motivated operator possessing a solid professional foundation of domain-related experience, knowledge, and technical proficiency. "The development of expertise involves interest, motivation, and hard work" (Fallesen, et al., 1996, p. 76). Deliberate training requires greater effort on the part of the learner; the motivation must be intrinsic and will come from the sense that the learner is improving his or her skills (Shadrick & Lussier, 2009). The path to expertise is a result of the operator's practice and learning rather than physiological attributes and innate talent (Fadde, 2007).

Decisions are made by people and, in the risk-filled environs described within, most are made by leaders in positions of responsibility (i.e., fireground commanders, surgeons, military personnel). Leaders are expected to make decisions, from the mundane to the critical. Therefore, considerable care and thought should go into the selection of the individuals charged with making decisions in dynamic, stressful, and sometimes dangerous situations. "The first step in assuring good decisions is to select individuals who are flexible, adaptive, competent, and resilient with respect to stress" (Orasanu, 2005, p. B159). Administrators, managers, and military officers should continuously observe and assess their subordinates looking for the traits that would identify them as potential leaders/decision-makers within their respective organizations. Early identification of key performers can enable the administrator to place the candidate in increasingly challenging situations to monitor performance and the presence of desired attributes (i.e., adaptability, character, composure) (Fletcher, 2009). Candidates should be held to high standards and discipline maintained—discipline gets them through stressful field problems (Vandergriff, 2006).

The successful candidate should recognize that learning is a life-long process and take personal responsibility for his or her own continuing education. The candidate should be aware that the organization is investing capital and time in his or her education and would be wise to take advantage of the opportunity for personal improvement. It is the responsibility of both the candidate and the organization to enable the candidate to be successful (Leland, 2008). Learners, regardless of where they are on the training continuum are expected to be responsible for their personal growth (Fletcher, 2009). "Professionals must be highly flexible, both in the sense that they must be able to deal with unfamiliar situations and must act as lifelong learners who continuously update their competencies" (van Merrienboer, Boot, 2009, p. 132).

Fadde (2007) quotes J. R. Anderson, "One becomes an expert by making routine what to the novice requires creative problem-solving" (p. 364). Fadde suggests it is possible to train "advanced learners and practitioners who are on a clear trajectory to expertise" in the recognition aspect of recognition-primed decision making to hasten expertise (2007, p. 360).

Hastening Expertise

There are compelling reasons to explore the possibilities of accelerating an individual's passage from novice to expert. For example, overall there are fewer fires to fight therefore the opportunities for fireground commanders to gain domain experience from actually fighting fires are diminished; trained military personnel can muster out of the service after as few as three years active duty taking expensive and hard-earned experience with them. Thus, a wide variety of industries will benefit if curriculums and techniques can be developed that accelerate achieving expertise within the specific industry.

Lajoie (2009) suggests that the transition from novice to expert can be accelerated when the path to expertise has been established and made clear to the learners. The paths toward expertise are domain specific and should first be documented by instructional designers. Set within instructional contexts, training is created to promote knowledge transitions. Assessing learners along the path to expertise is essential in order to provide appropriate feedback to enhance experience, knowledge, and skills.

There are many academically-recognized training methods and processes designed to enhance, foster, and achieve expertise. The following is a short list: Fadde's four-step recognition approach to hasten the development of expertise; Vandergriff's

Adaptive Course Model; Ericsson's Deliberate Practice method, Design A Curriculum model. All methods essentially have at least one common element: the individual learner achieving recognized milestones on the path to gaining experience/expertise within the specific domain.

Training for Expertise

The processes to hasten achieving domain expertise are not meant to supplant a well-grounded ab initio training regimen to the domain. There are no short cuts, after an introductory period, expertise is achieved by many methods. These methods can include rigorously applied self-study, formal education supplied by trained educators, apprenticeships under recognized masters, or a combination of these. Ericsson (2007, p. 2) succinctly states "*experts are always made not born.*" Novices require an initial instruction to the intricacies of the domain and often introductory or probationary periods. The novice receives basic instruction relative to the domain and is expected to eventually achieve a level of proficiency that enables them to perform at a functional level (Ericsson, 2006). The term "novice" is applied to someone familiar with the domain (competent) but has not yet achieved "expert" status. Ideally, the novice aspires to master the intricacies of the domain and either through the novice's own initiative, the encouragement of others, or a combination of both, the novice seeks or is provided with opportunities for improvement through instruction and experience.

Traditional training methods, such as overtraining and rote memorization, are most effective for predictable and routine work situations. As technology increases in both complexity and application practitioners must be able to adapt to a fluid environment where the problems faced may be "unstructured and ill-defined" (Smith, et al., 1997, p. 89).

"Traditional training methods also rely heavily on developing procedural skills. Traditional methods are appropriate for training routine expertise and are designed to develop automatic behavioral responses to performance requirements that are familiar to the performer" (Shadrick & Lussier, 2009, p. 289). The effectiveness of traditional training methods is measured by how well a trainee can apply the knowledge, skills, and attitudes gained from the training to the specific domain. Training novices using traditional techniques may take too long; an organization may have an acute need for expert operators and cannot wait for the supply to catch up to the demand.

To achieve hastened expertise in dynamic environments a paradigm shift in training must occur. Experience is one of the critical components of attaining expertise. The key becomes how to increase the learner's experience in the shortest amount of time yet ensure the learner ultimately attains domain mastery.

Intense, rapidly changing environments, as found in most NDM settings, ask more from an operator. Training to make decisions under stress is integral to basic decision skills training Klein learned that by exposing learners to stress, such as time pressure or ambiguity, the experience better prepared the operator to handle other types of stress including taxing mental challenges and extreme environmental factors. (Klein, 1998). An important indication of an operator's grasp of the fundamentals of decision-making is how well the individual responds or adapts to atypical or evolving situational demands (Smith, et al., 1997). There are two critical processes necessary for an operator to achieve the ability to adapt (a) gain detailed domain knowledge and (b) develop metacognition skills (Smith, et al.).

Metacognition

"Metacognitive skill refers to the decision-maker's awareness of her/himself as thinker in relation to the demands of the situation" (Orasanu, 2005, p. B159). Metacognition is the term used to describe "the concept of thinking about thinking" (Klein, 1998, p. 244). It is, in essence, the awareness by the individual of his or her thinking processes.

Metacognition skills can be imparted onto the learner through the use of verbalization techniques employed by the instructor. The instructor talks a student through an exercise and shares the thought processes used as the instructor draws upon his or her knowledge. The instructor's expert knowledge then becomes available for the student to note, employ, and put into practice. This process is repeated and the student gains tacit knowledge and the ability to internalize the thinking process; as the learner's abilities improve the instructor gradually inputs less to the student (Lajoie, 2009).

"Metacognition is important because it is a mental operation that occurs that can moderate the natural recognitional process. Calling attention to metacognition makes it more explicit so students can become more aware of it and it can be practiced" (Fallesen, 1996, p. 51). Metacognition encompasses a conscious awareness that includes cognitive activities, mental strategies, and reasoning. Experts have greater metacognitive skills than novices and are able to continually observe problems or situations and adjust their actions accordingly to achieve a desired outcome. Metacognition can be achieved through two approaches, (a) "increasing learner control over the learning process" and (b) "directing the learner to take a mastery orientation to the learning task" (Smith, et al., p. 106).

Learner control consists of enabling the learner to choose the content, sequence, and pace of the task learning materials. This process allows an individual to become more involved in the learning process through increased motivation and the ability to focus on material that may be difficult for the learner to grasp. An instructor provides the learner with advice regarding specific training needs, monitors the learner's progress, and directs the learner to the next step in the training. Using this strategy, learners have the opportunity to set goals, create new ideas, and achieve greater overall understanding of the task.

Mastery-oriented training proposes that concerted effort leads to success; the focus is for learners to develop new skills, attain a greater understanding of the task at hand, and achieve self-established goals. Mastery-orientation differs from the typical method of measuring learners against other learners or against established standards (performance orientation). Researchers found that learners utilizing the mastery-orientation approach led "students to use more effective learning strategies, prefer challenging tasks, have a more positive attitude toward the class and have a stronger belief that success comes out of effort" (Smith, et al., p. 107). Learners pursuing mastery goals persist when encountering difficulties as compared to those with performance goals who tend to avoid challenging tasks in order to prevent failure (Smith, et al.). An example of a specific mastery-orientation technique is a method referred to as deliberate practice.

Deliberate Practice

"Experience, although necessary for the full flowering of expertise, is not the same as deliberate practice—and it is deliberate practice that is the single most important contributor to the development of expertise" (Fadde, 2007, p. 373).

A central component of the deliberate practice method is that intensive preparation and training over a period time results in improved performance (Shadrick & Lussier, 2009). Deliberate practice is the method espoused by Ericsson to attain superior performance. Ericsson argues that an aspirant must, over time, engage in activities "specifically designed to improve performance" (2006, p. 693). These specific activities are created and assigned by the novice's instructor, coach, or mentor and consists of domain-related tasks of ever-increasing difficulty. The student practitioner works at the assigned task concentrating on mastering the lesson, ultimately performing it to the satisfaction of the instructor who provides feedback. Successful completion of the assignment brings a new, more difficult task from the instructor. The process is continuously repeated, each successfully completed task is a step towards the attainment of genuine expertise. "Such deliberate practice maximizes cognitive adaptation and increases performance" (Shadrick & Lussier, 2009, p. 307).

Failure on the part of the learner to produce a satisfactory outcome results in an explanation of the deficiency, additional instruction, and repeating the lesson. The deliberate practice training method has been adopted by many different domains including sports, medicine, chess, and music. This method can be applied to improve the skills of learners as diverse as an aspiring musician practicing basic etudes to a Navy SEAL candidate moving through prescribed training evolutions. The concepts behind deliberate practice (expert instructors and specific exercises) can serve as the foundation for other experiential training models.

Developing an Accelerated Training Program

"The goal of hastening expertise calls for instructional designers to create efficient instructional tasks that target key cognitive skills such as recognition-primed decision-making" (Fadde, 2007, p. 373). Klein (1998, p. C-1) proposes a three part strategy when designing a program to improve decision-making performance.

1. Provide a framework where the organization can identify key decision requirements and use that knowledge to design effective training simulations and exercises. Knowing these requirements enables the organization to create specific training that meets the unique decision-making needs of its personnel.

2. Help individuals identify the challenging decisions that are integral to the position. Once the organization's personnel recognize and understand the particular decision-making challenges they can expect to encounter then a specific training program can be designed and implemented to address those challenges.

3. Provide personnel with opportunities to reflect on their own abilities to make decisions and offer expert feedback and additional training to gain expertise. Detailed and explicit feedback from experienced instructors enables the learner to know exactly what skills need improvement and which have been mastered.

As Klein (1998) notes in Items 1 and 2 above, each domain has unique characteristics and an instructional designer must identify the particular requirements of the organization that apply to the decision-maker. The designer creates a training regimen that prepares the learner to make the most effective decisions for the organization. Several modern training methods have common elements with Ericsson's deliberate practice model. Two of these contemporary models include the U.S. Marine Corps Decision Skills Training program and Vandergriff's Adaptive Course Model. These two training programs, as well as Klein's third point listed above, share Ericsson's employment of an expert instructor to assign domain-specific exercises to a learner, have the learner practice the exercise, and upon completion, offer critical feedback on the learner's performance.

Vandergriff's and the Marine Corps' programs are intended to be included as a normal part of the operator's work day and not interfere with assigned duties and responsibilities. The exercises associated with these programs are designed such that the learners are not limited to a formal classroom setting. Training exercises utilized in these programs are often low-fidelity simulations or table-top exercises that the instructor administers and can be spontaneously assigned to the learner with a severe time constraint to add stress.

Deliberate Performance

Similar to the USMC and Vandergriff models, Fadde and Klein (2010) have proposed a method to accelerate expertise called *deliberate performance* that increases domain expertise while the operator is engaged in his or her normal day-to-day vocational activities. Deliberate performance utilizes many of the same characteristics of traditional skill building drill-and-practice type exercises (i.e., repetition, timely feedback, task variety, and progressive difficulty). Like Ericsson's (1998) deliberate practice model, the operator performs domain-related activities with the intent of performing them better each time but in a work setting and not always with expert feedback (Fadde & Klein, 2010).

The concepts of deliberate performance are that the exercises must relate to the operator's everyday job performance, not interfere with the operator's normal workday responsibilities, provide job-related repetitions with feedback, and not depend on expert feedback (Fadde & Klein, 2010). The operator can engage in self-directed deliberate performance for self-improvement by monitoring their work performance. The operator compares the results against those of co-workers or key performers, the time it takes to perform an activity, or the quality of the end product. The operator makes adjustments to his or her technique or routine and looks for improvement the next time they perform a particular activity.

Expertise

Expertise is the culmination of an operator's training, personal experience, and cognitive reasoning. Experts can respond to novel or unique situations because they possess a deep understanding of the subject domain and can create new solutions based on their experience and knowledge base. Experts are also capable of "mindful processing and abstraction" which enables them to recognize situations and mentally prepare solutions (Smith et al., p. 93). Experts' adaptive thinking skills are a result of focused, intentional domain-specific training that enables an operator's cognitive behaviors to become automatic. "It is the natural and effortless execution of reaction skills that often typifies expert performance" (Fadde, 2007, p. 360).

Automaticity of cognitive skills enables the operator to free up mental resources in times of stress and allows for higher level thought, improved situation awareness, and better able to deal with complex problems (Shadrick & Lussier, 2009).

Adaptability and Automaticity

Adaptability is defined "as the process by which individuals and groups decide rapidly, almost instinctively, to changes in their situations" (Vandergriff, 2006, p. 43). The fireground commander, the military leader, and the surgeon are just a few examples of operators who must be able to recognize and respond to dramatically changing conditions and adjust the actions of their teams accordingly. "Teams with records of superior performance have one common critical characteristic: they are extremely adaptive to varying demands" (Kowalski-Trakofler, Vaught & Scharf, para. 2.2). Relying on an operator's tenure in a domain to gain "mental models – and hence, adaptability… is obviously inefficient from a time and resource standpoint" (Shadrick & Lussier, 2009, p. 307). As was noted earlier, organizations often cannot wait for a novice to become an expert solely on experience in the domain. The process for an operator to gain experience, and ultimately an expert's store of mental models, must be accelerated. The decision-maker must "actively attend to his or her own cognitive strengths and limitations to conform to the situation" (Fallesen et al., 1996, p. 47). Agility, the capacity to react quickly to change, is another hallmark of the effective leader. Vandergriff states, "Adaptability and agility are closely related" (2006, p. 43).

Vandergriff proposes an innovative training model known as the adaptive course model (ACM) that is a radical shift from the traditional instructional method of "a prescribed list of procedures and exercises" (2006, p. 12). Like Ericsson's deliberate practice method, ACM is largely dependent on qualified, expert teachers to provide exceptional instruction and appropriate feedback to their students.

Adaptive Course Model

The Adaptive Course Model employs traditional academic methods such as small group lectures, small group training exercise, exercise simulations, and self-study relative to the domain (Vandergriff, 2006). In addition to formal domain-related instruction the expert instructor spontaneously administers relevant scenario-based exercises or problems called tactical decision games (TDGs). Tactical decision games require the learner to respond to a training based-scenario while under time constraints and uncertainty, devise a strategy to resolve the problem, and justify the solution to the instructor. These exercises add to the learner's experience base (Klein, 1998).

Tactical decision games are desktop simulations of situations the operator can expect to experience in their career field. These extemporaneous exercises require the student to quickly review the problem, prepare a solution, suggest a course of action, or make a decision to remedy the problem. Each tactical decision game contains the description of a situation or problem typical to the domain. The instructor establishes a predetermined deadline and allows the student to work on a solution for only that limited amount of time. Drawing on his or her knowledge and experience, the learner devises a solution. At the end of the allotted time the student presents the resolution of the TDG to the instructor. The crux of the process is that the student must be able to defend that solution, action, or decision to the satisfaction of the instructor. The instructor reviews and discusses the solution with the student and offers constructive feedback. Often multiple students are given the same scenario simultaneously and their solutions are critiqued by the instructor and openly discussed in a group setting. As the student's abilities and quality of decisions improve the tactical decision games become more difficult. The overall success of the ACM rests on the abilities of the instructors; Vandergriff considers good teachers who can teach and facilitate learning to be the core of cognitive education (2006).

Critical Thinking

Adaptability requires mastering metacognitive and critical-thinking skills. The ability to understand and evaluate problems requires critical thinking skills as well as the capacity to find and implement creative solutions to those problems (agility). If an operator lacks a bit of key knowledge then he or she must rely on the ability to reason. Reasoning allows the practitioner to consider what is likely or unlikely, what is important, and what is possible. Deficiencies in situational knowledge can be mitigated through imaginative and critical thinking (Fallesen, et al., 1996). Vandergriff (2006) maintains that critical thinking skills must be introduced early in a leader's education process. "Critical thinking does not replace experiential knowledge, training, and protocols but rather enhances these tools and improves...ability to focus on making better decisions. Critical thinking is metacognitive, as it involves thinking about...thinking" (Lambert, 2010, p. 96).

The effective leader will possess the ability to make difficult decisions, to devise solutions to complex problems in shifting conditions that "are based more on intuition than on analysis, deliberate planning and doctrine" (Vandergriff, 2006, p. 44). Naturalistic decision-making is often referred to as intuitive decision-making. Leaders need to "know 'how to think' in order to develop intuition" (Vandergriff, 2006, p. 110).

An additional reason for teaching critical thinking skills is legal liability. Decisions made based on intuition may be sound but could prove difficult to defend. A decision-maker may be called upon to justify a decision made or an action taken in court. A detailed description of the situation and the actions taken based on circumstances, training, education, and experience may provide a rational defense for the operator if later questioned by attorneys or superiors (Lambert, 2010).

Like Ericsson's deliberate practice method where the instructor assigns the learner increasingly difficult exercises, the adaptive course model's program of instruction and application of tactical decision games subjects the student to an ever increasingly complex set of situations. The ACM uses "experiential learning to build student experience using the 'recognition primed' decision-making process" (Vandergriff, 2006, pp. 83-84). The goal is to instill in students the will to act, as they deem appropriate, in their situations to attain a desired result (Vandergriff, 2006). Similar to the concept of satisficing, the basic premise of adaptability is an optimal end result not the process of how the result was achieved.

The ACM program enhances several desirable attributes including cognitive ability, problem-solving skills, and metacognitive skills (Vandergriff, 2006). Evaluation criteria includes: 1) "Did the student make a decision?" and 2) "Was the student's solution based on changing conditions that made it a viable decision?" (Vandergriff, 2006, p. 108).The practitioner who learns from the lessons presented in the adaptive course model will have gained the skills to be able to quickly distinguish between information that is relevant to the situation and that which is unnecessary. The operator will not succumb to the temptation to delay making pertinent decisions but be able to make critical decisions in seconds. The ACM process enables students to "find answers for themselves and build intuition" (Vandergriff, 2006, pp. 80-81).

The adaptive course model is not limited to military settings, it can be successfully applied in corporate settings as well (Vandergriff, 2006).

Declarative Knowledge

Expertise is dependent upon "detailed domain knowledge" (Smith, et al., 1997, p. 92). To achieve superior performance an operator must possess a base of field-specific declarative knowledge. This knowledge enables the practitioner to have a deep understanding of the domain and be able to use this information to solve problems and make decisions that ensure success to the organization, mission, or task at hand. Knowledge consists of personal experience, education, and training (Vandergriff, 2010).

> This is a vitally important point, for you to have the tacit knowledge to trigger an intuitive decision, you must first have the knowledge and experience stored in your brain. If you lack the training and experience to be a subject matter expert ...you're not going to be able to make intuitive decisions because your brain will be searching for the pattern match and will come up empty. (Gasaway, 2011, para. 2)

Individuals must "develop detailed and organized knowledge about the task domain, as well as the capability to monitor and control their knowledge and behavior, in order to adapt to novel or changing task demands (Smith, et al., 1997, p. 96). Experts have the opportunity to expand the knowledge base of novices by sharing with them the strategies and heuristics they employ when operating within the domain (Lajoie, 2009).

Experts can invent new methods to solve problems based on their domain knowledge and be able to predict novel events. This capability hinges on the expert's comprehension of the basic elements of the domain and enables him or her to quickly address novel problems (Smith, et al., 1997). Only by being thoroughly familiar with the domain can the leader adequately understand the situation, make decisions based on personal knowledge, and implement the solution. To be effective, leaders and their followers need to possess domain knowledge and a perception of what problems to expect and the type of decisions that may have to be made (Orasanu, 2005). Experts are cognizant of what they know and do not know and have the capacity to keep themselves from overextending their abilities. The experienced operator is more efficient at problem solving, relying on the recognition of significant patterns to determine an appropriate strategy (Lajoie, 2009).

"An adaptive leader's education and training builds knowledge that in turn is enhanced by experience. This enables an adaptive leader's ability to carry out 'pattern matching'" (Vandergriff, 2006, p. 46). Pattern matching is a significant element in Klein's RPD model. Experience produces specialized domain knowledge which is a crucial component of making decisions in naturalistic environments (Elliott, 2005). Individuals gain experience through formal training, on-the-job training, and performing tasks associated with their work. Their declarative knowledge becomes structured into memory and researchers have "developed various concepts to describe this knowledge structure such as *scripts*, *schema*, *mental models*, and *cognitive maps*" (Smith, 1997, p. 94).

"Leaders must be exposed to many learning situations – a loop of experiencing, learning, evaluating, and reviewing" (Vandergriff, 2006, p. 47). Intense real world experience (e.g., combat, emergencies) can also enhance the hastening of experience: Wong proposes that "certain 'crucible experiences' can accelerate the development of adaptable thinking that would otherwise require long experience" (Shadrick & Lussier, 2009, p. 302). "The main point here is that the experiential learning that takes place over a long period in the real environment can be gained in a much shorter time using a more deliberate focused training approach and research-based scenario development" (Shadrick & Lussier, 2009, p. 303).

Similar in concept to tactical decision-making games, experiences can be preloaded "by conducting realistic and repetitive training evolutions; reading near-miss reports, case studies, and journal articles...and through scenarios that are based on reality" (Gasaway, 2011, Lessons Learned, para. 9).

Technical Proficiency

Every novice, early in their career, is unable to perform domain-related tasks at an acceptable level and it becomes evident that he or she must achieve domain knowledge and expertise through learning and skills training (Ericsson, 2009). In fields where there is great risk to personnel or property (e.g., military combat, firefighting, medicine) the practitioner must be cognizant of the stakes involved and work towards becoming technically proficient in the domain to mitigate hazards. Technical proficiency is that level where the practitioner is able to work at a journeyman's level, usually achieved after a period of two years of instruction and experience in the domain (Ericsson, 2006).

There is a link between proficiency and automaticity. Every operator versed in the basic skills of the domain is expected to be able to perform job-related tasks in a competent manner. What distinguishes the expert from the journeyman is mastery of the skill (proficiency) and the instinctive ability to apply that skill at precisely the time it is needed (automaticity). "Students need to be well trained in the proficient or automatic performance of given procedures, so that they will be able to reinstantiate them without much cognitive effort and they can discern the conditions to which they apply" (Baker, 2006, p. 336).

"Research has shown that extensive practice on task components that are consistent across conditions allows automaticity for these components to develop. Schneider suggested that training should focus on automatizing the consistent components of tasks so that attentional and memory resources are available for the inconsistent portions of the task" (Smith, et al., 1997, p. 98). As Smith and Schneider write, rote training should focus on the routine aspects of the domain, once the basics are ingrained these processes become automatic. In a crisis or high risk situation, automaticity enables the expert to attend to the ordinary functions of the situation while the expert's cognitive resources can work towards resolving the problem.

Many fields, such as the nuclear power industry, aviation, and the military, have introduced high fidelity simulations in their training programs. These simulations are designed to expose learners to scenarios as realistic as they can expect in actual conditions. The simulations allow the novice to practice domain-related tasks in a controlled environment under the watchful eye of an instructor. Depending on the sophistication of the simulator, the instructor may be able to reset the device at the point where the learner struggles during the exercise and repeat just that portion. The training associated with simulations becomes experiential rather than classroom based. The underlying theoretical premise is that learners learn complex cognitive procedures by doing them rather than learning about them in an abstract manner (Lajoie, 2009).

Another advantage of the use of high fidelity simulations is the ability to train operators to respond to dangerous or high-risk situations without putting the learner in harm's way. A student does not have to actually fly an airplane with an engine fire or react to a malfunction in the core of an operating nuclear power plant to learn the proper procedures for dealing with such calamities.

One serious drawback to high fidelity simulation is the exorbitant cost. A full-motion simulator for a modern business jet can cost as much as or more than the actual aircraft it is intended to replicate. Fadde proposes that "lower fidelity simulation that focuses on part-task training of the recognition aspect of recognition-primed decision-making can supplement, although not supplant, much more expensive high fidelity, full-task simulation" (Fadde, 2007, p. 373).

An expert is an operator with a superior cognitive, knowledge, and experience base in the domain. The expert is prepared to match current problems or conditions with similar situations from past experiences and apply a solution. If the problem is anomalous, the expert will revert automatically to the application of cognitive skills to assess the novel situation and implement critical thinking to create a workable solution. Cognitive skills can only be acquired through practice, learners must have the opportunity to work an actual problem or participate in a simulation (Schraagen, 2009).

Fallesen puts the onus of gaining knowledge on the shoulders of the learner; conscious effort to learn in both the formal teaching and on-the-job elements of the domain enable the practitioner to add to his or her base knowledge. This knowledge contributes to the learner's critical thinking ability which allows the decision maker to employ "cognitive economy", that is, the more the decision-maker can do automatically the greater the mental reserve available when increased intellectual demands are called for (Fallesen, et al., 1996, p. 15). Schraagen (2009) proposes that knowledge should be taught in a classroom setting, whereas skills and attitudes are best learned on-the-job or in a simulation.

Experts in high-risks fields fully understand the conditions in which they operate, for example, pilots are thoroughly familiar with aircraft systems and meteorology, surgeons know the human body and its maladies, and nuclear power station operators comprehend the inherently dangerous science at work and are capable of dealing with any emergency. These professionals are able to perform their work (i.e., fly the airplane, perform surgery, operate the power station) even as problems occur within their system. They are able to do this because part of them are able to automatically perform some tasks and then use a cognitive reserve to deal with the immediate problem.

Individual Improvement

There must be the opportunity for the novice to learn. Once an operator has reached a satisfactory performance level, improvement does not occur automatically or without a tangible cause. Attitude of the operator is the key to personal improvement. Much as driving a car or performing key boarding skills, routinely performing a task does not automatically transfer into task improvement. Like Fallesen, Ericsson believes it is up to the individual to seek new opportunities that challenge his or her abilities. Ideally, the operator has access to resources that provide for individual improvement and expert and immediate feedback, as can be found in the properties of the deliberate practice method (2009).

Bransford and Schwartz (2009, p. 446) write,

> "It takes expertise to make expertise…the process of expertise development is a social process where one's success is affected by (1) people's motivation to learn something that is important to them; (2) access to relevant teaching expertise; (3) the fidelity of the feedback cycles available to both teachers and learners; and (4) the management of affect that accompanies struggles to truly improve".

Operators seeking to become experts never allow their skills to plateau. Instead, "they continue to seek out, with the help of their teachers, new training activities where they need to engage in problem solving to alter their cognitive representations that allow them to keep improving the mechanisms mediating performance" (Ericsson, 2009, p. 417).

Characteristics of the Expert

Experts are intimately familiar with the fundamental principles of their domain and possess a very detailed knowledge that enables them to recognize relevant situational patterns. They are cognizant of their own strengths and weaknesses in regards to what is required in specific situations and are able to generate appropriate responses. Experts use cognitive skills and pattern recognition to create solutions to solve problems. An expert is more efficient at problem-solving than a novice and can tap into a domain-specific memory much quicker (Lajoie, 2009).

Experts, because they possess a deep understanding of the subject, are capable of "mindful processing and abstraction" which enables them to respond to unique or unfamiliar situations and are able to create new solutions based on their experience and knowledge base (Smith, et al., 1997, p. 93). Expert performance can be recognized by the expert's "natural and effortless execution of reaction skills" (Fadde, 2007, p. 360). Operators with extensive domain experience are capable of better responding to atypical or unusual situations as they arise because they are able to identify when a situation is anomalous and a novel solution may be called for (Kahneman & Klein, 2009).

Training for Hastening Expertise

Knowledge and skill acquisition is the product of self-study or formal education and training programs or combinations thereof. Gaining experience, however, is the result of performing domain-related tasks in the operator's environment and is considered to be outside the realm of instructional design (Fadde, 2007). Fadde believes that to hasten the expertise process, instructional designers should formulate instructive exercises that focus on the acquisition of cognitive skills such as recognition-primed decision-making (Fadde, 2007).

Expertise lies in the ability of the expert to perform ordinary tasks extremely well; that the better the expert can perform at the routine the more cognitive reserve he or she can devote to the extraordinary (Fadde, 2007). "In complex activities such as tactical decision-making, expert performance levels cannot be attained without relying on the effortless access resulting from the acquisition of skilled performance. To develop the immediate accessibility characteristic of expert performance, it takes deliberate practice with opportunities for performance improvement. (Ericsson, Krampe & Tesch-Romer, 1993)" (Shadrick & Lussier, 2009, p. 294). The ability to master the routine aspects of a particular domain is the result of training that is expressly designed to inculcate specific knowledge or techniques to the learner.

By focusing training efforts on the recognition aspect of RPD, the expert will be able to utilize automaticity (gained through training and experience) to make effective decisions quickly. One of the distinguishing characteristics of an expert is the ability to rapidly make decisions. Speed and cognitive load are inextricably linked; speed becomes "an operational representation of cognitive load" (Fadde, 2007, p. 364). The fewer the cognitive resources required the quicker the expert can reach a decision.

Summary

The literature and research in regards to achieving domain expertise is vast. The researcher can find volumes of scholarly data from subject matter experts who have developed or examined dozens of training methods and techniques intended to lead an individual from novice to competent operator. Is there a universal training method that would be appropriate for all professions?

Would all domains benefit equally from incorporating a discriminate recruiting campaign that sought only the best candidates, included decision-making games as part of its curriculum, or contracted highly-skilled, veteran operators to serve as mentors to the novitiates?

Are there some domains where accelerating expertise might be a grave mistake (e.g., surgery)? Would these vocations be best served by requiring its aspirants to study or practice the equivalent of ten years or 10,000 hours?

Additional research is warranted to address the afore mentioned questions. Subject matter experts need to be surveyed and their opinions sought in regards to ideas such as the use of skilled mentors to train novices and provide expert feedback. Do these experts harbor any strongly held opinions that their particular vocation would be harmed or benefit from accelerated expertise?

CHAPTER III

Methodology

Design of Study

The purpose of this study was to identify the skills required by operators in high risk occupations to competently perform their duties and acquire domain expertise. High risk occupations are those vocations where injury, death, or destruction of property is likely if the operators within those occupations are ill prepared or inadequately trained to respond to dangerous situations. Knowledge, skill, attitude, and domain experience constitute the foundation on which expertise is achieved. Acquiring expertise in the shortest time possible creates subject matter experts who can take their place within the vocation sooner and begin to contribute to the betterment of the occupation and those whom which they serve.

Specifically this study focused on the occupation firefighter and acquired structure live burn instructor. An acquired structure live burn instructor is responsible for training firefighters during instructional evolutions using acquired structures that are intentionally set ablaze. Training in live-fire situations can be very dangerous and in order to effectively instruct others one must have expertise (Adams, Hogan, & Steinke, 2015).

A Midwest fire service training institution was used to identify the curriculum needed to train individuals to become acquired structure live burn instructors. This fire service institute serves as the statutory-mandated fire academy for the Midwestern state and is operated as a continuing education and public service facility by a Tier One University.

The goal of this study was to provide the fire service institution with a viable curriculum plan and evaluation instrument for the occupation of acquired structure live burn instructor. Fire service institutions require very high capabilities and standards for those individuals they consider for instructor positions; utilizing the DACUM (Develop A CUrriculuM) process would enable these professional organizations to identify and vet potential faculty members. The DACUM method employs domain experts to identify specific skills required within the occupation and determine minimum acceptable standards to demonstrate those skills. To be considered for an instructor position these organizations can require a candidate demonstrate expert proficiency of those identified skills to ensure occupational expertise. The research provided the fire service institution with a comprehensive list of the domain-related competences and skills required of an expert acquired structure live burn instructor. In addition, the research identified the level of performance an acquired structure live burn instructor must achieve in order to be considered an expert in the occupation.

An acquired structure live burn instructor is utilized when a structure (e.g., single-family dwelling, farm outbuilding, apartment complex) is offered to a firefighting organization for the express purpose of intentionally setting it on fire and allowing firefighters the opportunity to practice extinguishing the blaze. This type of live burn training is hazardous and can endanger lives and property if the activity is not strategically planned in advance by an expert instructor well trained in the art of firefighting.

Identification of individuals qualified to lead or instruct others in high risk vocations is certainly not limited to the firefighting profession. Other high-risk occupations, including law enforcement, military combat, and medical first responders require mastery of identifiable esoteric skills and recognition of the inherent dangers (e.g., injury, loss of life, significant damage to property) within the profession. The experts charged with creating the DACUM chart recognize and list the specific competences and skills required of the profession and rate the level of expertise (mastery) necessary to be proficient in the occupation (i.e., safety of personnel, protection of property). Based on their experience these experts establish the minimum rating for each skill determining exactly what level of performance must be demonstrated in order to prove domain expertise in a high risk environment.

Research Questions

This study sought to answer the following research questions:

1. What are the competences and skills individuals require to be considered an expert in the occupation of acquired structure live burn instructor?
2. What is the level of skill required of individuals in order to be considered expert in the occupation of acquired structure live burn instructor?

In order to determine the skills needed to be considered an expert or to be qualified to instruct within a high risk profession, an analysis of the occupation needed to be conducted. According to Horton (1980, p. 813), nominal group technique has been determined to be a useful method of decision-making within groups, as it fosters the generation of both novel and conventional ideas from the panel members and permits the ideas submitted to be numerically weighed and ranked. For this study, the DACUM (Develop A CUrriculuM) process was utilized as the method to conduct an occupational analysis. A key product of the DACUM development model is the creation of the

DACUM chart tailored specifically to the assigned occupation, in this case, acquired structure live burn instructor. The completed DACUM chart includes all competences and skills needed to perform within the occupation, as well as the level of skill needed to be considered an expert using the DACUM rating scale.

The DACUM process utilizes a panel of expert workers (i.e., exemplary performers) from the occupation who formally identify key general areas of competence and the requisite skills necessary to perform those competences. Once the competences and skills are determined the panel assigns a numerical rating from the DACUM rating scale of 0 (no skill) to 6 (expert) to each skill which is used as a metric to evaluate task performance by an operator (Adams, Hogan, & Steinke, 2015).

A proposal was composed and submitted to a Midwest fire service training institution to perform the initial information gathering process and develop the DACUM chart in the block-type flow chart format specific to the DACUM model. The faculty members within the Midwest fire service training institution agreed to the proposal, selected and recruited the panel of subject matter experts, and provided the facility for the activity.

Population

In order to determine the skills needed to develop expertise within high risk environments, a high risk occupation was selected for further study. For the purpose of this research, the occupation of professional firefighter was selected, specifically the subset of acquired structure live burn instructor—professional firefighters were selected due to the high risk nature of the vocation (i.e., possibility of injury or death, damage to property). Other factors included access to a significant population for sampling and the

Midwest fire service training institution expressed an interest in the results of the research and a willingness to support the study. Five subject matter experts were selected to participate in the occupational analysis. These individuals were selected by the Midwest fire service training institution based on their extensive experience as professional firefighters, the opinions of their peers, as well as their tenure with the organization as senior instructors. Inclusion was voluntary and all agreed to serve on the panel as a result of having the time available to participate. The panel members were compensated by the Midwest fire service training institution for their time and travel expenses.

Data Collection

These individuals met as a group for two days at the Midwest fire service training institution's training facility. The panel members were given a formal orientation to the DACUM model as an introduction to the process. Initial questions from the panel members concerning the DACUM model were answered. The panel was guided through the DACUM process by a co-ordinator assisted by several graduate-school students.

Site

The DACUM exercise was performed in a classroom setting at the Midwest fire service training institution's instructional facility on October 22 - 23, 2015. This facility was selected because it has classrooms and dedicated infrastructure to support instructional activities and was centrally located for panel members traveling to serve on the panel.

The classroom was inspected in advance of the exercise and determined to meet the unique physical requirements of the DACUM exercise (i.e., long blank wall, seating facing long wall) (Adams, Hogan, & Steinke, 2015).

Selection of this particular location enabled interested members of the staff and faculty of the Midwest fire service training institution to periodically visit the classroom and observe the DACUM chart development process. The director of the Midwest fire service training institution's Curriculum and Testing Office was able to be present throughout most of the exercise, yet did not participate as outlined in the DACUM process (Adams, Hogan, & Steinke, 2015).

DACUM is a multi-step process that ultimately provides the user with a practical outline for occupational curriculum development, skill identification and sequencing, and learner evaluation. The keystone to the process is the development of the DACUM chart. The DACUM chart provides a visual representation of the occupation's general areas of competence, the necessary skills required within the areas of competence, the sequence that the skills should be learned, and a minimum performance rating for the learner.

The DACUM rating scale also allows experienced operators with previous experience or training within a similar occupation who aspire to become fully qualified to select and perform particular skills listed on the DACUM chart. If the aspirant can demonstrate that he or she can perform the skill to the level listed on the chart the operator is given credit for knowing that skill and may then concentrate on learning the other skills within the DACUM chart's bands. This unique feature of the DACUM model accelerates the vetting process of the individual creating a qualified operator is less time.

After an orientation to DACUM the panel of firefighting live burn instructors, facilitated by the co-ordinator, met for two days collectively identifying general areas of competence, discussing attendant skills required of a live burn instructor and the preferred sequence in which the skills should be taught to instructor candidates. Lastly, the panel assigned a numerical rating to each skill to denote the minimum performance standard for each skill.

Data in the form of the panel's opinions and expert recommendations were recorded, noted, and displayed in the classroom by the co-ordinator with assistance from a select group of graduate students. As per the DACUM protocol, the panel collectively agreed to their compiled list of general areas of competence and proceeded to sequence the requisite skills in a logical and practical order (Adams, Hogan, & Steinke, 2015). The panel reviewed each skill and assigned a minimum performance numerical rating to that skill.

The DACUM rating scale consists of seven levels numbered '0' through '6'. The '3'level constitutes the baseline for acceptable performance (i.e., an individual can perform skills within the occupation without assistance or direction from others). There are three levels above and three below this baseline that are used to further assess an individual's performance. The rating '0' indicates that an individual's performance is unsatisfactory (e.g., lack of quality, taking too long to perform the skill). A person receiving a '1' demonstrates that he or she can perform the skill but must work under supervision or with considerable assistance in order to produce satisfactory results. A rating of '2' denotes the operator can perform the skill and can assist with making decisions on a limited scale because of an increased knowledge of the occupation. The DACUM level of '4' is the proficiency expected of an experienced performer. A level '4' worker accomplishes the work quicker and with higher quality than those with lower ratings. An operative receiving a '5' rating has demonstrated technical skill at the highest vocational level. This operator can resolve unique problems and would be considered an expert within the vocation. The highest level within the DACUM rating scale is the '6' rating which signifies that the individual can perform at the level of supervisor to lead others or serve as an instructor to teach skills to new entrants within the occupation (Adams, Hogan, & Steinke, 2015, pp. 258-259). See Figure 1.

0	Cannot perform the skill satisfactorily for participation in the work environment
1	Can perform the skill but not without constant supervision and some assistance
2	Can perform the skill satisfactorily but requires periodic supervision and/or assistance
3	Can perform the skill satisfactorily without assistance and/or supervision
4	Can perform the skill satisfactorily without supervision or assistance with more than acceptable speed and quality of work
5	Can perform the skill with more than acceptable speed and quality, with initiative and adaptability to special problem situations
6	Can perform the skill with more than acceptable speed and quality, with initiative and adaptability and can lead others in performing

Figure 1. DACUM Rating Scale (Adams, Hogan, & Steinke, 2015, p. 163)

The panel of experts assembled for the DACUM process were initially briefed on the rating scale during orientation on the first day. After the areas of competence and their specific skills were identified and sequenced late on the second day the co-ordinator reviewed the purpose and levels of the rating scale with the panel. Members of the panel felt that a firefighter put in charge of a training evolution involving a live burn should test well above the baseline. This attitude is reflected in the fact that no skill was assigned a rating of less than '4' and most skills were rated '5' or '6'.

The panel was thanked for their participation and dismissed. The co-ordinator compiled the data collected from the panel and created a draft of the information gathered during the two-day session. This draft was forwarded to the members of the panel for their review in regards to completeness and accuracy of the data. No corrections were recommended by the panel. Using the reviewed data the co-ordinator created the DACUM chart). A copy of the DACUM chart was presented to the Midwest fire service training institution.

Treatment of Data

The DACUM process and data gathering were initiated to accommodate a request from the Midwest fire service training institution to address a needs assessment gap in the occupation of acquired structure live burn instructor. The panel of subject matter experts was selected and recruited from the Midwest fire service training institution's faculty. The data obtained from this panel during a two-day session was organized in a logical and sequential format and sent to the panel as draft findings. After review by the panel the findings (i.e., areas of competence, skills, ratings) were put into the DACUM chart format as a visual representation of the competencies, skills, and performance ratings required of an individual to become an acquired structure live burn instructor.

CHAPTER IV

Results and/or Findings

The purpose of this research was to study operators in high risk occupations in order to identify what competences, skills, and skill levels are required to be considered an expert. High risk vocations are inherently dangerous and operators who are not technically proficient in the attendant competences and skills put lives and/or property in jeopardy. Expertise in high risk professions becomes a precious commodity that must be renewed through recruiting and qualifying new operators and recurrent training of those already practicing in the field.

This study utilized the nominal group technique and the DACUM process to assemble a group of expert firefighters to identify specific occupation-related competences and relevant skills for the occupation of acquired structure live burn instructor. This instructor position intentionally places firefighters, both novices and veterans, in a live fire training evolution to give the learners experiences as close to an actual structural fire as can be realistically expected.

The panel of experts convened and met for two days discussing specific requirements (competences) and the individual skills that are considered integral to each competence. Towards the end of the DACUM exercise the panel assigned a numerical rating to each skill that represented the minimum score an individual must attain to be qualified for the occupation of acquired structure live burn instructor.

This study sought to answer the following research questions:

1. What are the competences and skills individuals require to be considered an expert in the occupation of acquired structure live burn instructor?

2. What is the level of skill required of individuals in order to be considered expert in the occupation of acquired structure live burn instructor?

This chapter reports responses and presents the analysis of responses obtained from firefighting live burn instructors from a Midwest fire service training institution. This includes general demographic information, the competencies and skills required, and the level of skill needed as identified through the DACUM rating scale.

Demographic Information

The DACUM panel of domain experts consisted of five individuals employed by the fire service institution. All were veteran firefighters with Illinois residences and served in the instructor cadre of the institution. They ranged in age from thirty-five to about sixty years of age. All had in excess of fifteen years of firefighting experience and were solicited by the fire service institution because of their occupational expertise.

The first research question asked: What are the competences and skills individuals require to be considered an expert in the occupation of acquired structure live burn instructor? The panel identified six general areas of competence and an average of fourteen skills per general area of competence. The second research question asked: What is the level of skill required of individuals in order to be considered expert in the occupation of acquired structure live burn instructor? The panel assigned ratings to each of the skills listed in the DACUM chart.

Summary of Results

The DACUM chart is a unique product of the DACUM process. A summary of all general areas of competence, skills, and ratings can be found in the chart prepared as a result of this research. The panel identified six occupational competences and listed the attendant skills for each competence. Table 1 presents the panel's formal findings related to general areas of competence and skills in a conventional format. The left-hand column lists the competences in the recommended order of mastery. Skills for each competence are listed in the right-hand column in the recommended order to be learned. Table 2 presents the skill performance levels required for acquired structure live burn instructors.

Table 1

List of General Areas of Competence and Skills for the occupation of acquired structure live burn instructor.

General Area of Competence	Skill
Perform Firefighter Functions	Demonstrate department knowledge
	Use personal safety equipment
	Extinguish incipient Class A, Class B, and Class C fires using hand fire extinguisher
	Use self-contained breathing apparatus (SCBA)
	Perform SCBA emergency procedures
	Explain personnel accountability systems, emergency communication procedures, and emergency evacuation methods
	Operate communications equipment
	Initiate calls for emergency assistance
	Locate a safe haven
	Identify and turn off building utilities
	Connect a fire department pumper to a

(continued)

	water supply
	Illuminate an emergency scene
	Extinguish an exterior fire consisting of Class A materials
	Use ladders
	Use knots and ropes
	Perform a forcible entry into a building
	Demonstrate an attack to an interior fire
	Perform horizontal ventilation of a building
	Perform vertical ventilation of a building
	Perform an overhaul of a fire scene
	Conduct a building search and rescue
	Conserve/preserve building, building contents, and evidence
Communicate with Learners	Identify and consider local firefighting culture
	Assess the learners along the training continuum
	Actively listen to learners
	Speak in terms the learners will understand
	Verbalize and demonstrate vocation-related instruction
	Adjust instruction style to learners
	Establish relationships with learners
	Relate career experiences with learners

Ensure On-Scene Safety	Monitor learner performance
	Identify and adhere to relevant industry safety standards
	Assess situational fire dynamics
	Prepare safe interior environment
	Prepare safe external scene
	Identify and remove closed containers
	Remove or repair all hazardous structures
	Recognize and mitigate hazards
	Intervene to prevent unsafe acts
	Monitor learners' physical condition
Lead within the Training Environment	Maintain a positive example to learners
	Maintain standards of the organization
	Teach established curriculum
	Motivate personnel
	Demonstrate command presence
	Receive and acknowledge feedback
	Correct developing hazards
	Implement conflict management techniques
Perform Duties of Instructor during a Live Burn Exercise	Follow instructions of instructor in charge
	Recognize dangerous environmental conditions
	Demonstrate accountability for personnel

(continued)

Monitor security

Select and appoint qualified safety officer(s) internal/external

Ensure adequate water supply, monitor setup, establish backup water supply, calculate water supply (pressure, hoses, etc.)

Locate and setup fuel packages

Ignite fuel package

Recognize ideal fire condition (fire is ready to fight)

Recognize unsafe fireground conditions

Demonstrate when to terminate evolution

Select and assign Rapid Intervention Team members

Brief and monitor fire control team (ignition)

Monitor ongoing attack of objective

Assure Backup Readiness

Monitor truck operations, ventilation assignments, search and rescue assignments, and emergency egress routes/safe haven locations

Assess learners' awareness of matters immediately dangerous to life or health

Document learners' performance of objectives

Provide constructive feedback to participants

(continued)

	Perform evolution debrief
Perform Duties of Instructor in Charge	Monitor rehab of participants (heat stress, EMS)
	Organize acquired structure live burn evolution
	Ascertain all required paperwork is completed
	Recognize and respond to changes in the fireground
	Prepare building for live burn
	Ensure all relevant agencies are notified
	Ensure all consumables are on scene
	Ensure all firefighting apparatus are on scene
	Ensure all firefighting equipment are on scene
	Ensure rehab and EMS are on scene
	Arrange/recruit personnel support (porta-potty, food, shelter)
	Arrange staff
	Establish burn sequence
	Make staff assignments
	Attest and validate instructors
	Verify communications
	Establish and document objectives

(continued)

	Create overall plan
	Demonstrate appropriate incident command
	Perform after action review

The DACUM process expands on the nominal group technique by asking the panel of experts to rate each skill on a scale of 0 (cannot perform the skill satisfactorily) to 6 (can perform the skill with more than acceptable speed and quality). Table 2 in addition to the listing the general areas of competence and skills presents the skill performance levels required for acquired structure live burn instructors. See Figure 1 for an explanation of the skill ratings.

Table 2

List of Minimum ratings for each skill in the occupation of acquired structure live burn instructor.

General Area of Competence	Skill	Rating
Perform Firefighter Functions	Demonstrate department knowledge	6
	Use personal safety equipment	6
	Extinguish incipient Class A, Class B, and Class C fires using hand fire extinguisher	6
	Use self-contained breathing apparatus (SCBA)	6
	Perform SCBA emergency procedures	6

Explain personnel accountability systems, emergency communication procedures, and emergency evacuation methods	6
Operate communications equipment	6
Initiate calls for emergency assistance	6
Locate a safe haven	6
Identify and turn off building utilities	6
Connect a fire department pumper to a water supply	6
Illuminate an emergency scene	6
Extinguish an exterior fire consisting of Class A materials	6
Use ladders	6
Use knots and ropes	6
Perform a forcible entry into a building	6
Demonstrate an attack to an interior fire	6
Perform horizontal ventilation of a building	6
Perform vertical ventilation of a building	6
Perform an overhaul of a fire scene	6
Conduct a building search and	6

	rescue	
	Conserve/preserve building, building contents, and evidence	6
Communicate with Learners	Identify and consider local firefighting culture	5
	Assess the learners along the training continuum	6
	Actively listen to learners	5
	Speak in terms the learners will understand	5
	Verbalize and demonstrate vocation-related instruction	6
	Adjust instruction style to learners	5
	Establish relationships with learners	5
	Relate career experiences with learners	5
Ensure On-Scene Safety	Monitor learner performance	5
	Identify and adhere to relevant industry safety standards	6
	Assess situational fire dynamics	6
		6
	Prepare safe interior environment	6
	Prepare safe external scene	6
	Identify and remove closed containers	6
	Remove or repair all hazardous	6

(continued)

	structures	6
	Recognize and mitigate hazards	6
Lead within the Training Environment	Intervene to prevent unsafe acts	6
	Monitor learners' physical condition	6
	Maintain a positive example to learners	6
	Maintain standards of the organization	5
	Teach established curriculum	6
	Motivate personnel	5
	Demonstrate command presence	6
	Receive and acknowledge feedback	4
	Correct developing hazards	6
	Implement conflict management techniques	5
	Follow instructions of instructor in charge	6
	Recognize dangerous environmental conditions	6
	Demonstrate accountability for personnel	6
	Monitor security	4

(continued)

Select and appoint qualified safety officer(s) internal/external	6
Ensure adequate water supply, monitor setup, establish backup water supply, calculate water supply (pressure, hoses, etc.)	6
Locate and setup fuel packages	5
Ignite fuel package	5
Recognize ideal fire condition (fire is ready to fight)	5
Recognize unsafe fireground conditions	6
Demonstrate when to terminate evolution	6
Select and assign rapid intervention team members	6
Brief and monitor fire control team (ignition)	5
Monitor ongoing attack of objective	5
Assure backup readiness	5
Monitor truck operations, ventilation assignments, search and rescue assignments, and emergency egress routes/safe haven locations	5
Assess learners' awareness of matters immediately dangerous to life or health	6

(continued)

	Document learners' performance of objectives	4
	Provide constructive feedback to participants	5
	Perform evolution debrief	4
	Monitor rehab of participants (heat stress, EMS)	6
Perform Duties of Instructor in Charge	Organize acquired structure live burn evolution	5
	Ascertain all required paperwork is completed	5
	Recognize and respond to changes in the fireground	6
	Prepare building for live burn	5
	Ensure all relevant agencies are notified	4
	Ensure all consumables are on scene	4
	Ensure all firefighting apparatus are on scene	4
	Ensure all firefighting equipment are on scene	4
	Ensure rehab and EMS are on scene	4
	Arrange/recruit personnel support (porta-potty, food, shelter)	4
	Arrange staff	5

(continued)

Arrange staff	5
Establish burn sequence	5
Make staff assignments	5
Attest and validate instructors	6
Verify communications	6
Establish and document objectives	6
Create overall plan	6
Demonstrate appropriate incident command	6
Perform after action review	5

See Figure 1 for explanation of rating scale (Adams, Hogan, & Steinke, 2015)

CHAPTER V

Discussion

Research for this study was conducted in order to discover if it is possible to accelerate the process of creating experts in high-risk occupations (e.g., military personnel, first responders, firefighters). Experts are individuals who perform within a particular domain at a very high level of performance. The nature of high risk occupations often means operators within those domains must respond to critical and dynamic situations with appropriate action and often with great urgency. Response to a dangerous or life-threatening emergency involves the operator making one or more decisions that must address what must be accomplished, how it must be performed, and the most expedient method according to the circumstances and the time constraints involved. The ability to make good decisions under extreme conditions is the province of the subject matter expert. Specifically this study sought to identify the competencies and skills needed by instructors. According to Adams, Hogan, and Steinke (2105), in order to instruct others within an occupation, you must have expertise within the skills in that occupation.

Summary

Review of the literature and research revealed two distinct decision making philosophies, traditional decision making and naturalistic decision making. Proponents of the traditional method espouse domain-specific curricula and mastery of one skill before proceeding to the next more complex or difficult skill, thus establishing a foundation where decisions can be made based on experience, training, and abilities.

Scholars advocating the naturalistic decision making method propose that decisions in life-threatening situations do not have to be perfect decisions, only good enough to achieve the desired goal. Operators compelled to make decisions under extenuating circumstances most probably do not have time to consider many options or have adequate information to make the best decisions. Advocates of the naturalistic decision making method subscribe to the concept that the individual acts instinctively, applying mitigating techniques that worked in similar situations in the past.

Regardless of the fundamental differences in decision making philosophies, both the traditional and naturalistic methods require the decision maker to have sufficient expertise within the domain in order to make a decision appropriate to the situation. Expertise becomes the sum total of an operator's accumulated knowledge and skills; how the operator applies each in different circumstances depends "on how well the requirements of the current task match with the resources of the individual" (Salas & Klein, 2009, p. 292). "Experts do not seem to perceive the same world that other people do" (Salas & Klein, 2009, p. 291). The research revealed that in order to perform competently within a high-risk occupation the operator must achieve an expert level of performance in nearly all of the identified skills. Effective decision making is wholly dependent on the domain expertise of the operator. In order to create or improve effective decision making skills it becomes necessary to recognize and employ the following strategies: "(a) engaging in deliberate practice, so that each opportunity for practice has a goal and evaluation criteria; (b) obtaining feedback that is accurate and diagnostic; (c) building mental models; (d) developing metacognitive skills; and (e) becoming more mindful of opportunities for learning" (Salas and Klein, 2009, p. 41).

The DACUM process is particularly well suited to accelerate expertise in high-risk occupations. The panel of subject matter experts identifies the requisite competences and skills within the domain and rates each skill with a minimum performance value each candidate must exhibit in order to prove proficiency. A candidate with prior experience, training, or quality self-instruction can demonstrate he or she can perform the skill to the level of performance noted on the DACUM chart and is immediately given credit for that skill. The candidate can now focus on learning another occupational skill and need not spend time attending a redundant instructional session merely because of a preexisting curriculum requirement.

Overall Themes Identified

Three themes of note emerged from the research: first that the DACUM panel was reluctant to consider any recommendations on their part without referring to their industry's established and recognized standards. Second, the panel was uncomfortable with the idea of presenting ideas that may appear to be contrary to their employer's current curriculum. Lastly, the panel assigned the majority of the individual skills extremely high ratings. Though this consistency may appear to have been intentional and without due consideration the panel members repeatedly assured the co-ordinator that due to the life-or-death nature of the vocation such expertise is warranted.

The first notable theme was that the panel members were reluctant to disregard their industry's long-established standardized material and consider or seek nontraditional or unconventional alternatives to training within their vocation. One panel member in particular frequently attempted to access information directly from his personal library of industry standards. Having additional resources on hand is strongly discouraged (Adams, Hogan & Steinke, 2015, p. 111). The co-ordinator frequently reminded the panel members they were free to create a novel training curriculum with no restrictions or constraints relative to prior occupational pedagogical methods, personnel time-in-service, or previous training.

The second theme was similar to the first in that the panel members were hesitant to deviate from the curriculum and methods currently utilized by their employer, the Midwestern fire service institution. The panel members often questioned whether the occupational skills they identified as part of the DACUM chart development process could or would be taught within the institution's existing instructional programs. The co-ordinator reminded the panel members that they were not bound by preexisting curricula, the fire service institution was directly funding the research project, and the organization was open to novel ideas and approaches.

The third theme was the DACUM panel's widely held consensus that candidates for the occupation of acquired structure live burn instructor must be experienced firefighters and have mastered the basics skills to the point of being considered an expert among his or her peers in those skills. When determining the minimum performance rating to each skill, the panel members assigned a rating of "5" or "6" (i.e., expert) to the majority of the skills. This consistency of assigning high ratings (expert ability) to most skills was due to the opinions of the panel members who strongly felt that to instruct others, especially in a high risk occupation, the instructor must be able to demonstrate performance at the level of expert.

Recommendations

Domain experience is vital in order for operators in high-risk occupations to perform efficiently and make critical decisions especially when confronted with severe time constraints. There are several techniques that may be employed to provide learners with opportunities to gain experience. These include high-fidelity simulations, realistic training scenarios in the actual environments where the learner can expect to operate, and mentoring by expert performers with immediate feedback to the learner.

High-fidelity simulations can include sophisticated machines that replicate operation of complicated machines such as jet aircraft, nuclear submarines, and nuclear powerplants with nearly 100% realism. Simulators are now available within the health care profession to teach surgeons and other medical professionals technical skills without requiring human or animal subjects. The advantage of simulators is that the learner can be exposed to scenarios that would be too dangerous or risky to practice outside the training environment. Another benefit of simulation is that specific tasks can be repeated until the operator has performed the skill to the required level of performance. High-fidelity simulators are often exorbitantly expensive but offer the learner excellent opportunities to gain and master occupationally-related skills and add to their overall occupational experience.

Realistic training scenarios have long been employed by the military in the form of "war games" where opposing forces are pitted against each other in mock battles in natural terrain and exposed to the vagaries of the weather. Commanders can observe the performance of the combatants as they attempt to gain strategic advantage over their foes. The participants gain valuable experience about what they might expect under actual battlefield conditions. Firefighting is another profession that utilizes realistic scenarios when training. Firefighters can practice live burns on structures acquired for that purpose gaining invaluable experience that might otherwise be difficult to obtain. Realistic training scenarios should be included in training curricula as part of the initial educational process as well as maintaining proficiency contributing to the operator's experience base.

Mentoring of learners by expert performers can accelerate expertise in a number of occupations and other settings as diverse as athletics and chess. Factories can utilize workers who are recognized by management and their peers as expert performers (i.e., operators whose work is accomplished efficiently with few errors and little waste). Aspiring gymnasts, golfers, and other athletes benefit from the tutelage of expert mentors who can provide immediate corrective feedback. The mentor can ensure the aspirant performs each skill to the level of performance required prior to moving on to the next level of difficulty or related skill. Personal mentors or trainers can set an accelerated training pace based on the motivation and talent of the learner.

Conclusions

The process of achieving expertise at an accelerated pace can be accomplished if the learner is motivated and expert instruction is available to the learner. The inspired learner can seek an established curriculum within his or her chosen profession to get started on a career path. With sufficient motivation the learner can elect to seek additional learning opportunities through related internships, volunteer work, or entry-level employment to gain occupational experience. Relevant self-instruction, willingness to gain additional skills, and seeking self-improvement builds a solid experience base.

Expert instructors provide the learner with knowledge, guidance, and feedback. Exemplary work and a strong work ethic may bring the learner to the attention of instructors, expert performers, or management who may be able to provide the learner with additional opportunities within the occupation that will facilitate the accumulation of experience.

The DACUM process lends itself quite suitably to the acceleration of occupational expertise. The versatile nature of the DACUM system identifies core competencies and related skills. Each skill is rated as to the level of performance that must be achieved by the learner. If the learner has previous experience or training in a particular skill he may demonstrate his proficiency of that skill to a qualified instructor. If the performance matches or exceeds the rating assigned the learner is given credit for that skill and moves on to another. This feature of the DACUM system enables learners to master skills at their own pace; motivated learners can seek out learning and occupational opportunities to proceed through the DACUM chart at a rapid pace and achieve occupational competency sooner than a less inspired or proficient peer. The sooner the learner gets into the occupation the sooner he or she begins to acquire domain experience and ultimately a more effective decision maker.

Recommendations for Further Study

One interesting aspect of decision making that has not been researched in depth is how important the attitude of the individual operator is to becoming expert in his or her chosen occupation. Attitude being the third tenant in the knowledge, skill, and attitude triad. What can make an individual intrinsically motivated to improve their performance within the profession through self-study, deliberate practice, or opportunities to train or serve with industry-recognized experts? Are there practices that can be employed to encourage operators to continuously seek improvement to broaden their expertise? Curricula can be created to teach skills, can a program be created that would inspire an individual to want to master those skills as soon as practical, to ultimately achieve domain expertise?

References

Adams, R. E., Hogan, R. L., Steinke, L. J. (2015). *DACUM the seminal book.* Wilmington, DE: Edwin & Associates, LLC

Baker, E. L., The influence of learning research on the design and use of assessment. In K. Ericsson, (Ed.) *Development of professional expertise*, 333-355. New York: Cambridge University Press.

Bransford, J. D., & Schwartz, D. L., It takes expertise to make expertise: Some thoughts about why and how and reflections on the themes in chapters 15-18. In K. Ericsson, (Ed.) *Development of professional expertise*, 432-448. New York: Cambridge University Press.

Bryant, D. J., Webb, D. G., & McCann, C. (2003, Spring). Synthesizing two approaches to Decision making in command and control. *Canadian Military Journal*, 29-34

Crandall, B. Klein, G., Hoffman (2006). *Working minds.* Cambridge, Massachusetts: The MIT Press.

Elliott, T., (2005). *Expert decision-making in naturalistic environment summary of research.* Edinburgh South Australia 5111 Australia: DSTO Systems Sciences Laboratory. Retrieved from www.dtic.mil/get-tr-doc/pdf?AD=ADA434061

Ericsson, K. A., (2008). Deliberate practice and acquisition of expert performance: A general overview. *Academic Emergency Medicine, 15*(11), 988-994. doi: 10.1111/j1553-2712.2008.00227.x Retrieved from:http://www.mockingbirdeducation.net/uploads/5/4/0/7/5407628/ericsson_1993.pdf

Ericsson, K. A., (2009). Enhancing the development of professional performance: Implication from the study of deliberate practice. In K. Ericsson, (Ed.) *Development of professional expertise*, 405-432. New York: Cambridge University Press.

Ericsson, K. A., (2006). The influence of experience and deliberate practice on the development of superior expert performance. In K. Ericsson, N. Charness, P. Feltovich, & R. Hoffman (Eds.) *The Cambridge handbook of expertise and expert performance*, 685-705. Retrieved from http://www.skillteam.se/wp-content/uploads/2011/12/ Ericsson_delib_pract.pdf

Ericsson, K. A., Prietula, M. J., & Cokely, E. T., (2007, July-August). The making of an expert. *Harvard Business Review* (pp. 1-8). Retrieved from www.hbrreprints.org

Fadde, P. J., (2007). Instructional design for advanced learners: Training recognition skills to hasten expertise. *Association for Educational Communications and Technology*, 359-376. doi: 10.1007/s11423-007-9046-5

Fadde, P. J. & Klein, G. A., (2010, October). Deliberate performance: Accelerating expertise in natural settings. *Performance Improvement, 49*(9), 5-14. doi: 10.1002/pfi.20175

Fallensen, J. J., Michel, R. R., Lussier, J. W., & Pounds, J. (1996). *Practical thinking: Innovation in battle command instruction.* Alexandria, Virginia: U.S. Army Research Institute for the Behavioral and Social Sciences.

Fiore, S. M., Jentsch, F. J., Oser, R. L., Cannon-Bowers, J. A. (2000). Perceptual and conceptual processing in expert/novice cue pattern recognition. *Cognitive Technology 5*(2), 17-26.

Fletcher, J. D., (2009). The value of expertise and expert performance: A review of evidence from the military. In K. Ericsson, (Ed.) *Development of professional expertise*, 449-469. New York: Cambridge University Press.

Gasaway, R. B., (2011). *Understanding fireground command: Making decisions under stress.* Retrieved from http://www.fireengineeringuniversity.com /courses/42/PDF/FEUgasaway.pdf

Gonzales, C., Lerch, J. F., Lebiere, C., (2003). Instance-based learning in dynamic decision making. *Cognitive Science 27*, 591-635. doi: 10.1016/S0364-0213(03)00031-4

Horton, J.N., (1980). Nominal group technique. *Anaesthesia, 35*, 811-814. Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2044.1980.tb03924.x/pdf

Kahneman, D. & Klein, G. (2009, September). Conditions for intuitive expertise: A failure to disagree. *American Psychologist, 64*(6), 515-526. doi: 10.1037/a0016755

Kirshenbaum, S. S., McInnis, S. L., & Correll, K. P. (2009). Contrasting submarine specialty Training: Sonar and fire control. In K. Ericsson, (Ed.) *Development of professional expertise*, 271-285. New York: Cambridge University Press.

Klein, G. (1998). *Sources of power.* Cambridge, Massachusetts: The MIT Press.

Klein, G. (1998). *Wildland Firefighter Safety Awareness Study,* Appendix C. Arlington, VA: TriData Corporation.

Kowalski-Trakofler, K. M., Vaught, C., & Scharf, T. (2003). Judgment and decision making under stress: An overview for emergency managers.Retrieved from http://cdc.gov/niosh/mining/pubs/pdfs/jadmu.pdf

Lajoie, S. P., (2009). Developing professional expertise with a cognitive Apprenticeship model: Examples from avionics and medicine. In K. Ericsson, (Ed.) *Development of professional expertise*, 61-83. New York: Cambridge University Press.

Lambert, K. C., (2010, August). *Critical thought for the fire service.* Retrieved from http://www.fireengineeringuniversity.com/articles/print/volume-163/issue-8/Features/critical-thought-for-the-fire-service.html

Leland, F., (2008, December). *Critical decision making under pressure.* Retrieved from www.lesc.net

Lipshitz, R., Strauss, O., (1997, February). Coping with uncertainty: A naturalistic decision-making analysis. Organizational Behavior and Human Decision Processes, *69*(2), 149-163.

Orasanu, J. M., (2005). Crew collaboration in space: A naturalistic decision-making perspective. *Aviation, Space, and Environmental Medicine, 76*(6), B154-B163. Retrieved from: http://docserver.ingentaconnect.com/deliver/connect/asma/00956562/v76n6x1/s21.pdf?expires=1288128076&id=59

Prochnau, W., Parker, L. (2009). *Miracle on the Hudson: The survivors of flight 1549.* New York: Ballantine Books.

Pliske, R. M., McCloskey, M. J., Klein, G., Decision skills training: Facilitating learning from experience. In E. Salas, & G. Klein, (Eds.) *Linking expertise and naturalistic decision making*, 37-53. New York: Psychology Press.

Salas, E. & Klein, G. (2001). *Linking expertise and naturalistic decision making*. New York: Psychology Press.

Schraagen, J. M. (2009). Designing training for professionals based on subject matter experts and cognitive task analysis. In K. Ericsson, (Ed.) *Development of professional expertise*, 157-179. New York: Cambridge University Press.

Shadrick, S. B., & Lussier, J. W. (2009). Training complex cognitive skills: A theme-based approach to the development of battlefield skills. In K. Ericsson, (Ed.) *Development of professional expertise*, 286-311. New York: Cambridge University Press.

Shattuck, L. G. & Miller, N. L. (2006). *Extending naturalistic decision making to complex organizations: A dynamic model of situated cognition*. London, Thousand Oaks, CA & New Delhi: SAGE Publications.

Simpson, P. A., (2001). *Naturalistic decision making in aviation environments.* Fisherman's Bend, Vic 3207 Australia: DSTO Aeronautical and Maritime Research Laboratory. Retrieved from http://hdl.handle.net/1947/3813

Smith, E. M., Ford, J. K., & Kozlowski, W. J. (1997). *Building adaptive expertise: Implications for training design strategies.* In M. Quiñones & A. Ehrenstein (Eds.), Training for a rapidly changing workplace: Applications of psychological research. (pp. 89-118). Washington, DC, US: American Psychological Association, xii, 345 pp. 93-118

Vandergriff, D. E. (2006). *Raising the bar. Creating and nurturing adaptability to deal with the changing face of war.* Washington, D.C.: Center for Defense Information.

Vandergriff, D. E. (2010). When do we teach the basics? *Joint Force Quarterly, 58*, 69-74. Retrieved from www.ndupress.ndu

van Merrienboer, J. J. G., & Boot, E. W. (2009). Research on past and current training in professional domains: The emerging need for a paradigm shift. In K. Ericsson, (Ed.) *Development of professional expertise*, 131-156. New York: Cambridge University Press.

Yates, J. F. (2001) "Outsider": Impressions of naturalistic decision making. *Linking expertise and naturalistic decision making.* New York: Psychology Press, 9-33

APPENDIX A

IRB Certification of Exemption - Kuchenbrod, #16-065

April 28, 2016

Ralph Kuchenbrod
School of Technology

Thank you for submitting the research protocol titled, "Accelerating Expertise to Facilitate Decision Making in High-Risk Professions" for review by the Eastern Illinois University Institutional Review Board (IRB). The IRB has reviewed this research protocol and effective 4/27/2016, has certified this protocol meets the federal regulations exemption criteria for human subjects research. The protocol has been given the IRB number 16-065. You are approved to proceed with your study.

The classification of this protocol as exempt is valid only for the research activities and subjects described in the above named protocol. IRB policy requires that any proposed changes to this protocol must be reported to, and approved by, the IRB before being implemented. You are also required to inform the IRB immediately of any problems encountered that could adversely affect the health or welfare of the subjects in this study. Please contact me, or the Compliance Coordinator at 581-8576, in the event of an emergency. All correspondence should be sent to:

Institutional Review Board
c/o Office of Research and Sponsored Programs
Telephone: 217-581-8576
Fax: 217-581-7181
Email: eiuirb@www.eiu.edu

Thank you for your cooperation, and the best of success with your research.

Richard Cavanaugh, Chairperson
Institutional Review Board
Telephone: 217-581-6205
Email: recavanaugh@eiu.edu