High-Fidelity Simulation/Mentoring System for General Officers in High-Stakes Operational Environments

Laura A. Zimmerman, Christopher A. Burns,
Jeff M. Sestokas
Applied Research Associates, Inc.
Klein Associates Division, Fairborn, OH
lzimmerman@ara.com

ABSTRACT

High-level U.S. Armed Forces commanders must often juggle multiple roles while performing in high-stakes, rapidly evolving operational environments. Newly assigned Joint Forces Air Component Commanders (JFACCs) make decisions that affect not only military operations, but also have impact on international political, economic, and social structures. They often have very limited experience making such decisions. As in other domains, complex decision making usually develops with experience. Because these decisions have immediate impact on critical military operations, it is impractical to wait for commanders to learn these decision skills while on the job.

Most existing computer-based instruction for future military leaders focuses on tactical level training. We have created a cognitively authentic, computer-based simulation environment that focuses on the unique demands of commanders in operational environments. This paper will present the simulation and mentoring system we developed for use with the JFACC course at Air University. We used cognitive task analysis to understand the issues encountered, critical tasks performed, and difficult decisions made by high-level military commanders. We then embedded these challenges into complex scenarios involving rapidly evolving international crisis situations. This system allows users to exercise their strategic-operational skills while in the midst of a simulated critical event. Using a structured knowledge base that includes lessons learned, doctrine, and AARs, combined with valuable feedback from mentors, the system challenges users to make complex decisions that impact joint and coalition forces, politics, and social/economic structures. This system creates a unique interactive and asynchronous mentoring program. This program will benefit JFACCs by broadening their experience base prior to dealing with real-life incidents. This system fills the void between formal classroom training and real-world experience by providing high-level decision makers with the opportunity to reshape their experience base in an operational command environment.

ABOUT THE AUTHORS

Laura A. Zimmerman, Ph.D., is a Senior Scientist at Applied Research Associates, Inc., Klein Associates Division, in the Skilled Performance and Expertise Group. Her research interests include domain-specific cognitive skills and expertise development, and decision-centered training. The focus of her work has been on vignette development, knowledge elicitation and web-based decision skills training. Prior to joining Klein Associates, Dr. Zimmerman conducted research on the decision processes of experienced and novice police officers and developed a decision skills training program for patrol officers, with future works in progress for other areas of law enforcement. Dr. Zimmerman holds a B.A. in Psychology from San Francisco State University, an M.A. in Experimental Psychology from University of Texas at El Paso, and a Ph.D. from University of Texas at El Paso in Experimental Psychology with a focus on Legal Psychology.

Chris A. Burns is a Principal Scientist at Applied Research Associates, Inc., Klein Associates Division. He works in the Skilled Performance and Expertise Group and has an extensive background in software development, CBT authoring, graphics and video production. His research activities revolve around instructional design, learning theory, and knowledge management, with an emphasis in multimedia, simulations, and instructional product development. Mr. Burns holds a B.S. in Computer and Information Science from

University of Maryland, a M.S. in Instructional Media and Information Technology from University of Central Arkansas, and a M.S. in Instructional Systems Technology from Indiana University.

Jeff M. Sestokas is a Staff Scientist II at Applied Research Associates, Inc., Klein Associates Division, in the Cognitive Systems Engineering Group. He specializes in the application and diffusion of instructional technologies to military personnel and corporate firms. Mr. Sestokas is currently conducting research for the U.S. Air Force to develop an intelligent mentoring system for future JFACCs. He has also worked on projects using cognitive task analysis to understand the expertise of operators in the oil industry and the submarine world. He holds a B.A. in English specializing in secondary integrated language arts and a M.A. in Education in instructional technology from Baldwin-Wallace College (Berea, Ohio).

High-Fidelity Simulation/Mentoring System for General Officers in High-Stakes Operational Environments

Laura A. Zimmerman, Christopher A. Burns, Jeff M. Sestokas
Applied Research Associates, Inc.
Klein Associates Division, Fairborn, OH
lzimmerman@ara.com

INTRODUCTION

Decision-making training has largely focused on improving tactical or strategic decision-making during critical incidents. Decision makers who must make fast-paced critical decisions at operational levels, such as high-level commanders in emergency response agencies and military organizations, have had less opportunity to engage in high-fidelity hands-on training. Decision-making research has produced computerized simulations to enhance decision making in *group* settings that involve command decisions and planning, such as emergency operation centers and military command centers (Miller, 2001). However, very few computerized simulations exist with the purpose of improving *individual* commanders' decision-making abilities (Pigora, Tamash, & Baxter, 2006).

Decision makers at the operational level usually enter their positions with extensive tactical field experience, and must adjust their focus and priorities when making decisions in operational environments (Leland, 1997). These decision makers often face having to make decisions that affect not only the immediate players in the situation, but also have political, economic, and social consequences. In addition, they need to plan both immediate responses and longer-term responses, must communicate up and down the chain-of-command, and must trust others to make the proper tactical decisions. These factors contribute to the difficulty of creating computerized simulations for these environments.

This paper discusses how we addressed this training need by developing a simulation and mentoring system for high-level leaders in military joint force component commands. The first section of this paper discusses the decision making of high-level military commanders, specifically U.S. Air Force Generals in charge of joint force command centers. The next section discusses our use of cognitive task analysis to develop this system, and presents findings from our interviews with experts. Following this section, we describe the JFACC Mentoring System (JMS), including both a vignette player and simulation player.

As decision-making training gains in acceptance within tactical training environments, those who make decisions at higher levels realize that they too can engage in practical computerized scenario training and advance their decision-making abilities to more expert levels. The U.S. Air Force recognized that this type of training would benefit their Joint Forces Air Component Commanders (JFACCs). However, the Air Force wanted to create more than just another training program. They wanted to incorporate into their existing JFACC mentoring program a high-fidelity simulation that would mentor interactively and provide for enhanced live mentorship from their JFACC Senior Mentors.

JFACCs are general officers who are handpicked to command air force components, joint forces, and coalition forces in command posts throughout the world. They face the task of making complex decisions about military activities and must consider not only the orders and intent from above, but also the needs and desires of host-nation officials, non-government agencies, the media, joint/coalition military partners, and their staff. They enter their role after an in-class training course at Air University, but receive little simulation training and have few opportunities to learn from the experiences of previous JFACCs. A break in training occurs after their training course and prior to receiving their JFACC assignments. During this time, they can practice using their newly acquired knowledge in a simulated JFACC environment and utilize the established mentorship available to them. In this way, they can practice and gain experience prior to assuming command.

The main goal of this work was to create a simulation and mentoring system that enhances the abilities of future JFACCs to make decisions and increase their experience prior to actually performing their official JFACC duties. The objective was to produce a cognitively authentic simulated environment in which they could practice performing complex JFACC duties while in the midst of a critical event. We accomplished this by using cognitive task analysis techniques to uncover the decision processes of experienced JFACCs. By providing future JFACCs with the opportunity to engage in deliberate practice in contextually rich environments, we expect performance to improve. Research demonstrates that deliberate practice, which allows decision makers to practice targeted skills and receive performance feedback, improves the performance of military commanders (Ross, Battaglia, Phillips, Domeshek, & Lussier, 2003).

DECISION MAKING OF HIGH-LEVEL MILITARY COMMANDERS

A JFACC is a functional component commander who controls all air and space forces in a joint force. Specifically, they control theater counterair operations, strategic attack, theater reconnaissance and surveillance, and the overall air interdiction effort. Current joint doctrine and previous studies indicate that JFACCs are responsible for the following duties (Baxter & Lunsford, 2005):

- Determine how to plan for the enemy.
- Determine how to decide which information sources to use.
- Determine how to plan for an ATO cycle.
- Determine how to prioritize tasks.
- Determine how to manage diplomacy within joint forces.
- Determine how to manage diplomacy with coalition partners.
- Determine how to manage diplomacy with the host nation.
- Determine how to decentralize execution.

The JFACC position was created to fill the role of a unified commander responsible for all air assets across services, with the hope that this consolidation of authority might lead to more efficient and effective use of air and space resources. The JFACC is in a unique and demanding position as both a supporting and supported commander, often responsible for joint and coalition forces. Not only must the JFACC be concerned with military operations, they also need to consider, often for the first time in their careers, other factors of PMESII (Political, Military, Economic, Information, Infrastructure) using diplomacy, intelligence, military, economic (DIME) instruments within their coalition partners' countries and as they establish and maintain joint/coalition partner relationships (Davis & Kahan, 2007).

The JFACC needs to consider these factors as conditions are rapidly changing and while under severe time-pressure, and with conflicting goals and ambiguity surrounding the problem. Their work environments are also characterized by uncertainty and risk. During planning phases, military commanders must acknowledge the inevitableness of uncertainty and consider various options. Klein (1998) contends that once the 'inevitableness of uncertainty' is accepted, decision makers can focus on the task of using the information that is available to reach effective decisions. The more experienced the decision maker, the more apt they are to effectively handle decision making under uncertainty. During crisis events, JFACCs must be able to act in the face of high uncertainty, and must have the ability to adapt as information and the situation changes (Davis & Kahan, 2007). This type of decision making environment fits within the Naturalistic Decision Making (NDM) paradigm (Klein, 1998), thus it is possible to use the theories and methodologies created in the NDM field to enhance the performance of JFACCs.

The *Air & Space Commander's Handbook for the JFACC* provides an indication of the uncertainty in the JFACC's job. It also underscores the difference between the theory associated with acting in the JFACC role and the practice. Consider a few examples: The JFACC, in theory, (a) defines air objectives and tasks for subordinates, (b) continually assesses campaign effectiveness, (c) translates JFC guidance into tactical direction, and (d) develops own mission, intent, and end state. On the other hand, the JFACC, in practice, has to (a) train a new staff on procedures and equipment, (b) figure out how to communicate with his boss, (c) build trust and confidence with other components, and (d) deal with a Joint Task Force (JTF) staff that manages JTF business (Department of Defense, 2005, p. 17). In theory, JFACCs handle concrete tasks with reduced uncertainty. In practice, they handle ambiguous tasks with increased uncertainty about what the task requires. In order for JFACCs to maximize performance, they need to learn the *practice* of being a JFACC, not just the theory.

Although JFACCs are promoted from the ranks of high-level commanders, they are often inexperienced in their new, more complex command roles. Currently, ex-JFACCs serve as mentors to future JFACCs, providing opportunity for future JFACCs to acquire practical and procedural knowledge from their more experienced colleagues. Live one-on-one mentoring is a beneficial learning tool. Combining this mentoring with experiential learning and embedded mentoring though simulations and critical thinking questions increases the learning benefits inherent in traditional mentoring. Combining simulations, directed questioning, mentoring, and both automated and live feedback creates a complete mentoring program.

Mentoring involves the passing of wisdom, knowledge, and experience from the mentor to the learner. The mentoring relationship evolves over time, adjusting to the learner's skill level and needs. Mentoring is context-dependent, experience-based, and individualized. It also promotes the learner's professional contacts and connection to relevant knowledge (i.e., literature, procedures, historical data, etc). Mentoring teaches the learner *how* to think, rather than *what* to think. A mentor is usually someone who has vast experience in a given domain. Mentors provide one-on-one guidance to learners and encourage self-learning and reflection (Herman & Mandell 2004). Thus, mentors do not have to be present during learning; instead, they can provide feedback after learners struggle through their exercises, and then reflect, self-assess performance, and formulate questions. In this mentoring system, JFACCs go through simulated scenarios that also provide mentoring by immersing the learner in a realistic environment and allowing them to see the consequences of their actions in real-time. In the simulation, learners develop their own leadership styles and practice interacting with simulated staff members and experiencing reactions. Both they and their mentors review the outcomes and discuss JFACCs' performance.

DEVELOPING SIMULATION/MENTORING CONTEXT

A Cognitive Approach to System Design

Well-crafted cognitively-relevant scenarios provide an effective method that we can use to evaluate command decision making. Scenarios, often refered to as qualitatative foresight exercises, are stories that present a logical and consistent picture of past and future events (Davis & Kahan, 2007). The purpose of this project was to present a cognitively relevant scenario of a complex critical incident in order to create a high-fidelity learning experience for future JFACCs. To create a cognitively complex scenario, we gathered information from domain experts about how they make sense of situations, what tasks they engage in, the types of decisions they face, and the possible action choices available. We used this scenario-based approach for the content of both the vignette and simulation player.

The first step in generating a scenario-based simulation/mentoring system that enhances the decision making of future JFACCs is to understand the demands of this position. To achieve this knowledge we needed to know the physical tasks and procedural demands placed on JFACCs. We also needed to understand the cognitive demands present in high-stakes command environments. JFACCs can only achieve proficient task performance by mastering both the physical and cognitive demands placed on the decision maker. These cognitive demands include activities such as decision making, judgment, planning/replanning, problem solving, and sensemaking. These cognitive demands drive the course of the physical tasks. Decision makers must make sense of emerging situations, identify a feasible course of action, and change plans in response to changing situations in order to accomplish the mission.

For this project, we sought to recognize where JFACCs tend to struggle, and which aspects of the job are likely to lead to sub-optimal levels of performance. We did this by interviewing experienced JFACCs using cognitive task analysis to gain insight into the JFACC environment at both the cognitive and behavioral levels. Cognitive Task Analysis (CTA) is a set of tools and methods used to elicit general and specific knowledge about the cognitive skills and strategies that underlie performance (Crandall, Klein, & Hoffman, 2006). The CTA allows us to go beyond the procedural knowledge and the behavioral aspects of the JFACC position. The purpose is to get inside the JFACC's head, and try to understand the "cognitive map" that guides his/her decision-making processes. To create our simulation/mentoring program we gathered information about how experienced JFACCs view their environments, and what critical cues, expectancies, and goals they require to make a good decision in a specific context. By obtaining this information from experienced JFACCs, it is possible to increase the experience-bases of future JFACCs by transferring to them the knowledge, experiences, lessons learned, and mental models of former JFACCs.

To elicit expertise from former JFACCs, the specific CTA tool we used was the Knowledge Audit. The Knowledge Audit draws directly from the research literature on expert-novice differences (Dreyfus & Dreyfus, 1986; Hoffman, 1992; Klein & Hoffman, 1993; Shanteau, 1985) and Critical Decision Method studies of expert decision making (e.g., Kaempf, Klein, Thordsen, & Wolf, 1996; Klein, Calderwood, & MacGregor, 1989). The Knowledge Audit employs a set of probes designed to elicit domain knowledge and skills, along with relevant examples. This elicitation technique is organized around knowledge categories that characterize expertise such as how decision makers: diagnose and predict events, attain situational awareness, effectively use their perceptual skills, know when to apply tricks of the trade, and recognize anomalies and compensate for system limitations. The goal is to uncover the knowledge and skills present in the task, the nature of these skills, the specific events where they are required, and strategies used to employ these skills. The interviewer asks about the critical cues and decision strategies present in specific examples, followed by a discussion of potential errors that a less-experienced person might have made in this situation.

Data Analysis

CTA provides the tools necessary to analyze and document the cognitive processes revealed in the knowledge audit (Crandall, et al., 2006). By documenting these cognitive processes, we gained an understanding of how JFACCs make decisions, what task elements are challenging, and what support (i.e., assets, information, technology) they need.

We analyzed the data collected from the knowledge audits using decision requirements analysis, a method for capturing the specific details of incidents gathered from domain experts. This analysis utilizes Decision Requirements Tables (DRTs), an organizing framework that categorizes and highlights the key decisions or assessments in a given domain. DRTs classify why decisions are difficult, factors that affect decisions, and strategies for improving decision processes. The decisions as well as the factors and strategies can be used to design the training simulation. Findings from the DRTs revealed eight critical tasks that new JFACCs struggle with while on-the-job (see Table 1).

Table 1: Eight Critical Tasks that future JFACCs tend to struggle with while on the job

Eight Critical Tasks for JFACCs	
1)	Coordinating with joint and coalition partners and NGOs
2)	Building/maintaining relationships and managing communications
3)	Knowing and using assets
4)	Gathering and assessing information and intelligence
5)	Planning and replanning
6)	Maintaining leadership and delegating task
7)	Managing, balancing, and mitigating risk
8)	Applying ROE and legal requirements

Analysis also revealed important areas where mentoring would benefit future JFACCs, areas where experience tends to improve performance, and the characteristics of effective mentoring.

Based on the data obtained from the DRTs, we developed a comprehensive knowledge and learning management portal that incorporated the computerized vignette and simulation players and web-based access to senior mentors and provide documents relevant to performing the duties of a JFACC.

The web-enabled learning environment provides two phases of learning for the user: a vignette player and a simulation player. The *vignette player* presents a text-based scenario that users read in segments. The vignette uses low-fidelity scenarios and focused questions to develop the user's critical thinking skills. The *simulation player* presents the scenario in a format that mimics real-life events. The simulation uses high-fidelity scenario-based exercises to allow the user to practice their skills in time-pressured critical situations and increases their decision making and practical abilities. This mentoring program provides the users with a web-enabled tool they can use to practice their skills prior to assuming command. Besides the computer mentorship, the system provides mentor feedback, after action reviews, and links to reference material to promote reflective practice by the learner and increase learner knowledge.

THE JMS TRAINER

First, we will discuss the content of scenario used in both the vignette and simulation. Then we will discuss the JFACC Mentoring System (JMS).

The scenario

To create the scenario storyline we focused on some of the Eight Critical Tasks identified from the data (see Table 1). The scenario we created focused on "Managing, balancing, and mitigating risk" (task 7). This task overlaps with many of the other tasks in that risk increases or decreases based on how the JFACC attends to the other tasks. Our vignette questions also focus on task involving information management (task #4) and joint/coalition relationships (task #1 and 2). The vignette questions require that JFACCs think critically about the issues raised in the scenario. For example, after the opening scene, JFACCs answer the question: *Analyze this situation and list the three highest potential risks to U.S. national interests. Explain why you consider these the highest risks.* This question focuses on task #7. Another question is:

Describe the type of assistance, including assets, you will request from joint forces. Provide explanations for why your needs take priority over other joint force operational needs. This question focuses mainly on tasks #1 and 2.

The *vignette* is not timed, so the JFACC can reason through their answers and request feedback about their answers from the senior mentors. Allowing JFACCs to make decisions without time-pressure gives them time to explore various action choices, weight the importance of different elements of the situation, formulate plans, address challenges, and analyze their solutions. This exercise increases JFACCs experience bases and skill sets, and provides a cognitive map that JFACCs can use during real and time-pressured incidents.

Unlike the vignette, which has no time limit, the *simulation* presents a time-pressured environment, where risk-management becomes vital to resolving the crisis. As both relevant and irrelevant information pours into the AOC, information and intelligence gathering and assessment also become a high priority. The dynamic situation is filled with uncertainty and ambiguities, requiring the JFACC to exhibit leadership, communicate and coordinate with joint/coalition partners, and delegate tasks to his/her staff.

Our program specifically emphasizes enhancing high-level commanders' ability to decide:

1) How to organize and prioritize his/her time?
2) Who is the right staff member for what job?
3) What decisions he/she should be making?
4) How will the political and economic climate affect his/her actions?
5) Where has he/she seen this situation or problem before?
6) How will the rules of engagement or other context affect his/her options? Some relevant sources of context are:
    a. Politics (international/domestic)
    b. Economics (international/domestic)
    c. Climate/weather
    d. Non-government agencies
    e. Para-military
    f. Morale (friendly & threat)
    g. Joint/Coalition characteristics
7) What constitutes good performance, and what does he/she need (e.g., knowledge, equipment, personnel) to make improvements?
8) What are the most time-sensitive targets, and what are the current high-payoff targets?
9) What information is reliable or relevant?

In addition to creating an exercise scenario that is cognitively relevant, it is important to create a *contextually* relevant simulated environment. Within the scenario, JFACCs receive e-mails and phone calls, intelligence briefings, attend meetings, view CNN-style new breaks, and give orders/receive information from staff. This environment is filled with tasks, information flow, and time demands that are present in real-world JFACC environments. In this simulation, we created a time-pressured environment filled with uncertainty, risk, ambiguity, and conflicting goals.

Feedback

A key component of this system is the feedback learners receive, both from the system and from senior mentors. Feedback is an essential component of efficient decision making and necessary for the development of expertise in a given domain. Research has shown that people who become experts actively seek out feedback and engage in self-feedback after performing tasks (Klein 1998, Shanteau, 1992).

The vignette player provides feedback once users complete an analysis of a scenario and submit their answers to the structured essay-style questions to the JFACC Mentoring System. At that point, a senior mentor receives an email notification that vignette answers are ready for review. The senior mentor can then review the submitted answers to provide valuable feedback and food-for-thought to the future JFACCs. In addition, the system can provide direct feedback by providing examples of how experienced JFACCs and senior mentors might answer the questions. Students are able to discuss and evaluate these answers in a discussion forum to further expand their experience bases and practice critical thinking.

The simulation player provides four levels of feedback during the simulation. We accomplish this by embedding the consequences of the users' decisions, actions, and inactions into the simulation. The system has an automated assessment feature that pauses the action in the simulation to ask the learner questions to discern their grasp of the situation. After completing the simulation, the system provides the user with a robust After Action Report (AAR) that assesses their overall performance during the simulation. Finally, a senior mentor can annotate the AAR to interject comments and further questions about actions taken, decisions made, and diplomacy tips to provide active mentoring to the Future JFACC.

The JMS Program

In determining how best to train and prepare the future JFACC's, we conducted an instructional analysis and determined that the constructivist learning theory would best suit their simulation experience. Constructivist learning theory lends itself well to Immersive Learning Simulations (ILS; Windschitl & Thomas, 1996). Most approaches that have grown from constructivism suggest that learning is accomplished best using a hands-on approach. People learn through experimentation. They are left to make their own inferences, discoveries and conclusions. It also emphasizes that learning is not an "all or nothing" process, but that students learn new information that is presented to them by building upon knowledge that they already possess. Pedagogies based on constructivism require the learner be engaged to support their motivation to use critical thinking to figure things out for themselves.

In order to make the preparation of JFACCs more effective, we designed an ILS system to present a rich scenario-based simulation environment. Some of the key considerations that can fuel a successful ILS design are the theories of immersion and engagement. Many simulations developers are not able to merge learning science, cognitive science, and simulation strategies with the concepts of immersion and engagement. It is crucial to understand the importance of the cognitive, affective, and instructional aspects of ILS design.

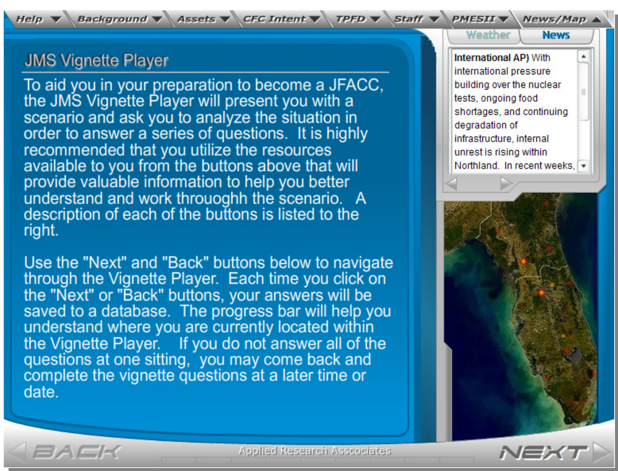

Figure 1. Example of Vignette Player

In order to immerse the learner into to the scenario, it is important that the ILS design take advantage of the three dimensions of immersion:

- Spatial Immersion (Response to Setting): this is the "hook" that relates to the learner's past memories and to help to develop an intimate relationship to the setting.
- Temporal Immersion (Response to Plot): past events cast shadow on the future and restrict the range of what can happen next. This is how we experience suspense. Suspense increases as the range of possibilities decreases and this is when the learner can reach a state of complete temporal immersion.
- Emotional Immersion (Response to Character): this response occurs fundamentally as the attachment that the learner begins to form with the characters participating in the serious game.

We took a two stage approach to the integrating the principles of immersion and engagement. We first place the learner into a vignette that puts them into the role of a JFACC in a fictitious but realistic scenario, complete with a staff, a commander (JFC), ficticious country, and joint/coalition partners. We use ficticious locations and incidents in order to reduce potential biases and preconceived notions that JFACCs may have about how to respond. These ficticious scenarios are based on information provided during the CTA interviews about real incidents, real-world problems and potential threats to the U.S. military.

They immerse themselves into the scenario by finding out about their assignment and situation by reviewing:

- Assets available to them
- CFC Intent Document
- TPFDD (Time Phased Force and Deployment Data)
- PMESII Data
- Local News and Weather
- Maps of the region

The learners must use this data to establish a situational awareness of the scenario and then they answer a series of detailed questions such as: what are the potential risks inherent to the scenario and how will you mitigate them? The tabs at the top of the vignette player screen contain this data (see Figure 1)

In the simulation, we further utilize the scenario immersion that takes place in the vignette. The scenario continues to unfold in the simulation. While in the simulation future JFACCs are presented with realistic environmental stimuli that requires them to properly filter a barrage of information (see Figure 2). They need to properly assess the situation and determine:

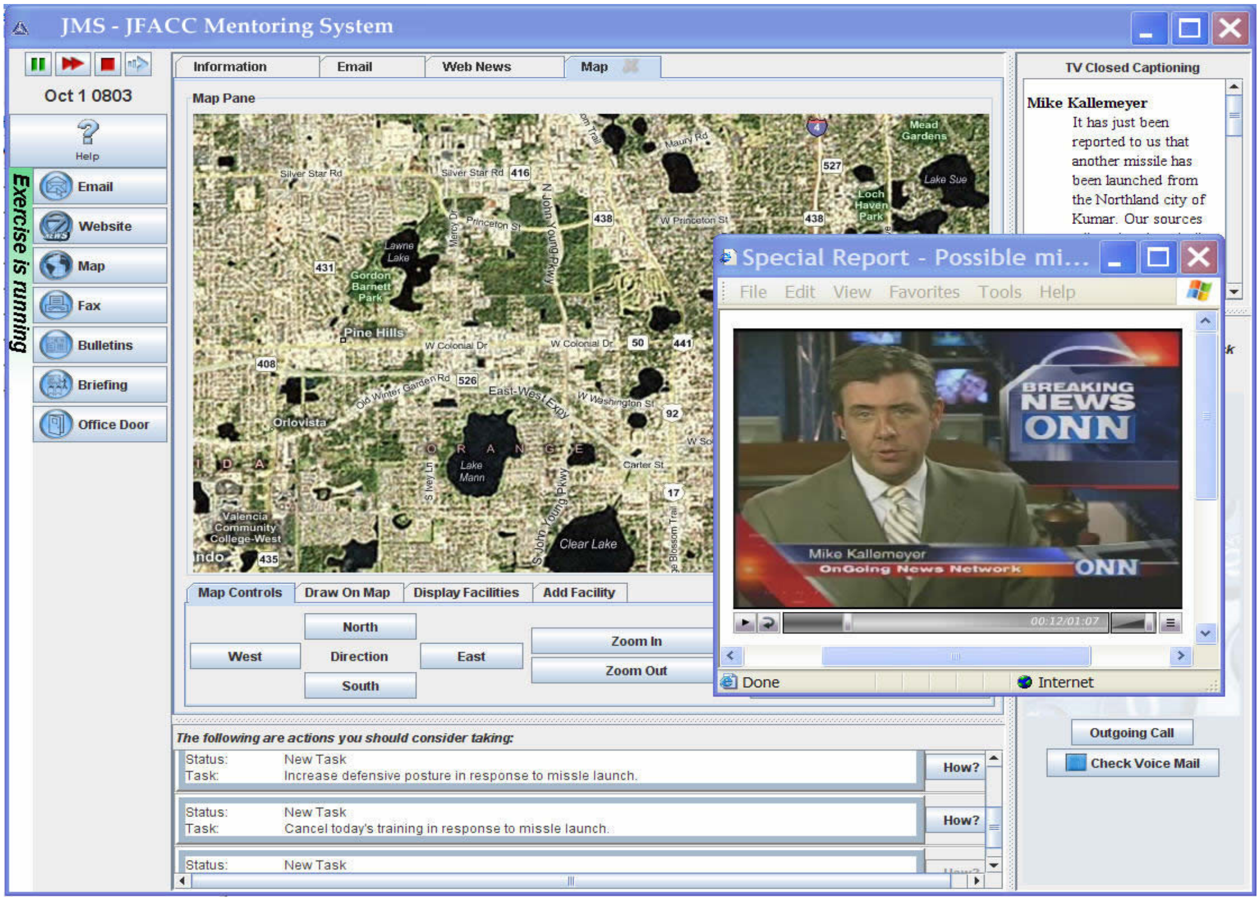

Figure 2. Example of Simulation Player

- What information needs to be acted on
- What decisions should be made
- What coordination must take place
- Who should they involve
- What additional information do they need
- How do the decisions impact:
  - The commanders intent
  - The local community
  - International diplomacy
  - The combined forces
  - NGOs

The simulation presents a very challenging, flexible environment, allowing for any actions that the learner may want to take. As in real life, there are many ways to accomplish a particular task. By allowing for multiple correct actions to any situation, the program gives learners the flexibility to use their own leadership style. As the learner makes decisions and takes actions, simulated staff members provide feedback and input to decisions. The simulation tracks the learner's actions throughout the scenario and presents them with an After Action Report (AAR) at the completion of the simulation.

The Immersive Learning Simulation includes the following features:

- User interface similar to a user's day-to-day desktop
  - Email, phone, fax, and bulletin board
  - Telephone, TV, CNN-style news casts
- Interactive Maps using Google Earth
  - Zoomable
  - Display of terrain and road systems
- Built-in Knowledge Builder - Web Based Training delivery system
- Online news web site
- Access to online reference materials
- Comprehensive assessment modules
- Robust After Action Report
  - Integrated mentoring – annotation of actions in the AAR

An important concept of this system is the ability to provide active and passive mentoring to future JFACCS at a distance. Senior mentors can provide passive mentoring by contributing expert answers to vignette questions, which will be accessible to future JFACCs for self-assessment purposes. Senior mentors can provide active mentoring by providing detailed annotations to future JFACC's vignette answers in order to: point out potential errors in thinking, to commend innovation, or provide food-for-thought. The answers that future JFACCs provide to the vignette questions along with the expert's annotations and mentoring advice can be packaged and published as a mentoring object once it has been sanitized to hide the identity of the individual providing the answer. In this way, future JFACCs can take advantage of mentoring provided to another individual (passive mentoring) to maximize the mentor's ability to reach the masses.

Another way that senior mentors can provide active mentoring is to provide detailed annotations to individual AARs from the simulation. This further provides tailored feedback to the individual regarding the decisions and actions taken within the simulation. The senior mentor can review everything the future JFACC has done in the simulation to include evaluating diplomacy, tone, and effectiveness of all communications. Providing very direct and detailed feedback to the AAR is an excellent tool aid the future JFACC in gaining expertise.

This method of active mentoring provides immense value to the vignette and simulation to help future JFACCs gain valuable experience while under the virtual tutelage of senior mentors.

The vignette and the Immersive Learning Simulation are housed inside a portal system called the JFACC Mentoring System (JMS). The system is completely web-based and scalable to meet the needs of a large online community or user group. The portal also has a large database of searchable content to include related doctrine, articles, video interviews, and other multimedia assets. We designed the JFACC Mentoring System to continue to prepare future JFACCs after their classroom training experience until they receive an assignment as a JFACC/CFACC.

CONCLUSION

The intent of the JFACC Mentoring System is to align theories of cognitive science with the development of enhanced JFACC performance. Mentoring of critical cognitive skills will provide future JFACCs with the information and experiences they need to recognize problems and manage uncertainty in dynamically complex situations. The vignette and simulation presents a complex, multi-faceted, rapidly unfolding, ambiguous situation that forces decision makers to think beyond the tactical level. In addition, the simulation uses a virtual environment that exposes participants to many forms of stimuli and multimedia to include both audio and video-based components to further challenge their decision making skills.

This system discussed in this paper is under development and is near completion (completion date planned for Fall 2007). Future and past JFACCs will test the system for usability, learning potential, and mentoring capabilities. Senior mentors will evaluate the vignette and simulation as well as their vignette expert answers. These expert answers and the AAR annotations will be accessible to future JFACCs. We will use this evaluation feedback to further enhance the system and advance the simulation/mentoring concept.

Recommended future projects include expanding the scenario database to include a diverse set of storylines set in diverse JFACC environments, and creating similar systems for high-level decision makers in other domains. This system is highly applicable to other military applications and other domains where similar complex decisions are made and where mentoring would assist in the transition from practical/tactical thinking to conceptual/operational thinking (ie, upper ranks of law enforcement/fire fighters, corporate executives, state, local, and federal agencies,). Our use of CTA to develop this system provides an added benefit in that this methodology provides an opportunity to elicit and analyze the specialized knowledge and experience of high-level commanders and leaders before they retire or move on to other careers. Rather than losing this unique domain history, these experiences are passed along to newer decision makers to use as part of their own experience bases.

The JFACC Mentoring System performs an invaluable role in bridging the gap between formal classroom training and real-world experience. It also provides high-level decision makers with the opportunity to reshape their already extensive experience bases through an interactive and active/passive mentoring system so they are better prepared to assume command as Joint Force Air Component Commanders.

ACKNOWLEDGEMENTS

We thank the Air Force Research Laboratories for their support through Contracts FA8750-04-C-0077 and AF8750-04-C-0155. And, specifically recognize our TPOC, Carl DeFranco, and our collaborative partners, Charles River Analytics and WBNS/ONN-TV for their support.

Finally, we acknowledge our coworkers for their contributions to this research: Eric Geissler, Dave Malek, Donald Cox, Holly Baxter, Bill Ross, Karol Ross, Will Readinger, and Jennifer Phillips.

REFERENCES

Baxter, H. C. & Lunsford, J. R. (2005). Creating JFACC Aces: Utilizing cognitive requirements to develop effective training simulations. *Proceedings of I/ITSEC 2005.*

Crandall, B., Klein, G., and Hoffman, R. R. (2006). *Working minds: A practitioner's guide to cognitive task analysis*. Cambridge, MA: The MIT Press.

Davis, P. K. & Kahan, J. P. (2007). *Theory and methods for supporting high level military decision making.* (Technical Report prepared under contracts F49642-01-C-0003 and FA7014-06-C-01). Santa Monica, CA: Rand Corporation.

Department of Defense. (2005). *Air & Space Commander's Handbook for the JFACC (17 June Revision)*. Washington, DC: Author.

Dreyfus, H. L. & Dreyfus, S. E. (1986). Mind over machine: The power of human intuition and expertise in the era of the computer. New York, NY: The Free Press.

Herman, L. & Mandell, A. (2004) *From Teaching to Mentoring: Principles and practice, dialogue, and life in adult education*. New York, NY: RoutledgeFalmer.

Hoffman, R. R. (Ed.). (1992). *The psychology of expertise: Cognitive research and empirical AI*. New York: Springer-Verlag.

Kaempf, G. L., Klein, G., Thordsen, M. L., & Wolf, S. (1996). Decision making in complex command-and-control environments. *Human Factors, 38*, 220-231.

Klein, G. (1998). *Sources of power: How people make decisions*. Cambridge, MA: MIT Press.

Klein, G. A., Calderwood, R., & MacGregor, D. (1989). Critical decision method for eliciting knowledge. *IEEE Transactions on Systems, Man, and Cybernetics, 19*(3), 462-472.

Klein, G. A., & Hoffman, R. (1993). Seeing the invisible: Perceptual/cognitive aspects of expertise. In M. Rabinowitz (Ed.), *Cognitive science foundations of instruction* (pp. 203-226). Mahwah, NJ: Lawrence Erlbaum & Associates.

Leland, J. M. (1997). Keeping the JFACC at the operational level. Unpublished manuscript, Naval War College: Newport, RI.

Miller, T. E. (2001). A cognitive approach to developing tools to support planning. In E. Salas & G., Klein (Eds.), *Linking expertise and naturalistic decision making* (pp. 95-111). Mahwah, NJ: Lawrence Erlbaum Associates.

Pigora, M A., Tamash, T., & Baxter, H. C. (2006). Training novices and experts: A common assessment mechanism for knowledge, skills, and abilities. *Proceedings of I/ITSEC 2006*.

Ross, K. G., Battaglia, D. A., Phillips, J. K., Domeshek, E. A., & Lussier, J. W. (2003). Mental models underlying tactical thinking skills. In *Proceedings of the Interservice/Industry Training, Simulation, and Education Conference 2003*.

Shanteau, J. (1985). *Psychological characteristics of expert decision makers* (Vol. 85). Manhattan, KS: Kansas State University.

Windschitl, M. & Thomas, A. (1996, April). *Using computer simulations to enhance conceptual change: The role of constructivist instruction and student epistemological beliefs.* Paper presented at the Annual Conference of the American Educational Research Association, New York, NY