Deployable Simulation Training for Operational Medical Personnel

Roberta Gearhardt
JXT Applications, Inc
Beavercreek, Ohio
rsgearhardt@jxtai.com

William J. Walsh
JXT Applications, Inc.
Fair Oaks Ranch, TX
wwalsh@gvtc.com

Laura Millitello & Andrea Snead
University of Dayton Research
Dayton, Ohio
Militello@udri.udayton.edu
Snead@udri.udayton.edu

ABSTRACT

Current training for deployable medical personnel occurs in the field through on-the- job training and focuses on the acquisition of procedural knowledge. This severely limits the capability of training organizations to rapidly produce "mission ready" personnel for the field, and hinders mission performance for deploying medical forces, both ground based and air evacuation teams. Medical professionals need a means of accelerating the acquisition of expertise in decision-making and team coordination that underlies responses to chemical, biological and radiological (CBR) threats. This paper describes the use of cognitive approaches to determine the training scenarios needed and the content to be included in simulation-based training to address the potential threat environments where ground based medical crews and aerospace medical personnel are expected to operate. The use of simulation based training will provide medical personnel with realistic, high fidelity, mission-oriented training in critical medical skills, decision-making and team coordination for emergency response and rapid deployment. The simulations developed will be hosted in multiple delivery media to facilitate their use at the home duty station, on transport aircraft en-route to deployment, at ground bases and in theater. A conceptual high-level design and demonstration has been developed in this Phase I SBIR effort to prove the concept for the training technologies and simulation.

ABOUT THE AUTHORS

Roberta S. Gearhardt is JXT's Director, Medical Systems, Emergency Medical Services (EMS) Continuing Education Program Administrator, and Principal Investigator (PI) on the Deployable Simulation Training for Operational Medical Personnel & Emergency Responders contract. She is a Registered Nurse, Emergency Medical Technician-Paramedic (EMT-P), Emergency Medical Services Instructor (EMS-I) and Supervisory Nurse with the OH-5 Disaster Medical Assistance Team (DMAT). She is the Immediate Past President of the Ohio Association of Emergency Medical Services. As a member of the Greater Miami Valley Emergency Medical Services (GMVEMS) Council Protocols Committee during 2001-2002 she played a key role in the development, approval and implementation of the first ever set of standardized EMS Protocols for Ohio EMS Region II which covers a 10 county area of Southwest Ohio. Mrs. Gearhardt is a graduate of Community Hospital School of Nursing (RN), Edison State Community College (AS), and College of Mount St. Joseph (BS Nursing).

William J. Walsh has been designing innovative training and education technologies for military customers since 1968. His work in industry has ranged from defining requirements for new ground-based and aviation training systems, designing and developing soldier and aircrew training and intelligent tutors, and developing and delivering train-the-trainer courses. Mr. Walsh has also been active in training systems research with special emphasis on meaningful interaction in distance learning. His participation in I/ITSEC over the years has involved several roles. In addition to authoring and presenting papers, he has served as 2001 Program Chair and 2003 Conference Chair. Mr. Walsh has a BA from the University of Scranton and MA from The Pennsylvania State University.

Laura Militello is a Senior Research Psychologist in the Human Factors group at the University of Dayton Research Institute. She has extensive experience conducting cognitive task analysis across a broad range of domains including critical care nursing, air campaign planning, weapons directing, and consumer decision making. Ms. Militello developed a set of applied cognitive task analysis methods (ACTA) for use by practitioners. She has conducted more than 20 cognitive task analysis workshops for human factors professionals and students. She has experience conducting multinational usability testing for medical devices, refining interface elements of existing products to reduce error and improve customer satisfaction, as well as designing new, first-of-a-kind interface elements for future ultrasound platforms. She received her M.A. in Experiment Psychology and Human Factors from the University of Dayton in 1995.

Andrea Snead is a Research Psychologist in the Human Factors group at the University of Dayton Research Institute. She has been involved in usability testing of mobile and wearable computer technologies, using both qualitative and quantitative methods for data collection. She has been a part of project teams investigating the usability of an array of advanced technologies for use by US Air Force maintainers, including voice-head integrated technologies, the Xybernaut flip down display with stylus and mouse input devices, and an eyeglass-mounted display of digital technical manuals. She recently completed a project to evaluate handheld and mobile tools to help aircraft maintainers diagnose wiring faults in military aircraft. Ms. Snead has broad experience with questionnaire construction and development, as well as field-based usability testing. She received her B.S. in Human Factors Psychology from Embry Riddle Aeronautical University in 2000.

Deployable Simulation Training for Operational Medical Personnel

Roberta Gearhardt
JXT Applications, Inc
Beavercreek, Ohio
rsgearhardt@jxtai.com

William J. Walsh
JXT Applications, Inc.
Fair Oaks Ranch, TX
wwalsh@gvtc.com

Laura Millitello & Andrea Snead
University of Dayton Research Institute
Dayton, Ohio
Militello@udri.udayton.edu
Snead@udri.udayton.edu

INTRODUCTION

Training of medical personnel for decision making and team coordination has traditionally been done in either the classroom setting or not at all. According to discussions with military resources, officers have relevant training programs, but front-line medical first responders are not usually participants in management training. All personnel involved in potential CBR threat environments must have a working knowledge of the critical elements needed to make accurate command decisions. This paper will address the process of developing the medical training component of "Deployable Simulation Training for Operational Medical Personnel",[1] a Phase I Small Business Innovation Research (SBIR) contract being performed for the US Army Medical Research and Materiel Command.[2]

OVERVIEW

Development of a training program for medical first responders involves investigation into current training provided in both military and civilian Emergency Medical Services (EMS) and includes initial, advanced and sustainment training curricula. Knowing what emergency care providers have learned in the past is critical in determining what their future educational needs are. In addition, one must find out what those providers have to do and what they need to know in order to function effectively within their environment of care. Combining these two pieces of information sets the foundation for the determination of user requirements and the ultimate design and content of the scenario to be trained. The target population for this course is emergency responders who are deployed, preparing for deployment, and members of teams who may be deployed in the future. This includes military, civilian and Department of Homeland Security deployable teams.

BACKGROUND

The ability to properly manage all aspects of an event involving the threat of Weapons of Mass Destruction (WMD) is critical to the outcome of the event. Lack of training for those who will be providing the initial medical first response can lead to poor outcomes due to inappropriate use of personnel and resources and an increase in the danger to responders and victims. This project set out to alleviate the identified problem through the development of scenarios that are specific to WMD threat environments and that train the appropriate response from a team coordination and decision-making standpoint. The investigation included conducting a Cognitive Task Analysis (CTA) and an assessment of current training and technology. It was followed by development of a conceptual high level design, a feasibility assessment and concept demonstration. The final steps included an assessment of the benefits of the proposed course and the commercialization potential. The following discussion provides a description of the process used for this effort and details of the critical components.

DETERMINATION OF USER REQUIREMENTS

Determining the user requirements is the first technical objective in the process of developing a training program. To address the cognitive challenges under-represented in current training, one must identify key decisions and coordination issues. These then provide a framework for designing the training delivery methods and content. For this effort, conducting Cognitive Task Analysis (CTA) interviews was the initial step.

---

1 Deployable Simulation Training for Operational Medical Personnel & Emergency Responders (Phase I) U.S. Army Medical Research and Material Command, Telemedicine and Advanced Technology Research Center.

2 The views expressed are those of the authors and do not reflect the official position of the U.S. Army Medical Research and Material Command.

Cognitive Task Analysis

Cognitive Task Analysis (CTA) interviews were conducted with military and civilian subjects who have experience with decision making and team coordination requirements in WMD threat environments. This information provided the foundation of all activities that followed, and was the primary determinant of the topics to be trained (Table 1).

CTA methods are proven tools for investigating complex decision making across a range of domains including critical care nursing (Militello & Lim, 1995), weapons directing (Klinger, et. al., 1993), and command and control (Kaempf, et. al, 1996). CTA findings have driven the design of several strategies for training complex decision making including Decision Skills Training (Pliske, et. al, 2001), and Collaborative Development of Expertise (Stanard, et. al. 2001).

Table 1. Topics to be Trained (Derived from CTA Interviews).

1. Delivery methods
2. Actions/symptoms
3. Timelines for symptoms to develop
4. Antidotes/treatment modalities
5. Transport decisions: method of transport and destination facility
6. Decontamination procedures and indications for decontamination for each type of agent
7. Isolation from others to prevent spread: necessary or not
8. Personal Protective gear utilization: necessary or not in various situations according to agent (levels of MOPP gear)
9. Differential diagnoses
10. Indicated laboratory testing for exposed personnel
11. On scene identification of agent(s) involved
12. Responsibility of in charge person to protect personnel.

Identifying key elements of the environment to be simulated and the critical decisions to be trained is necessary in the design of successful simulation technology. The critical decision method (Klein, Calderwood, & Macgregor, 1989), in particular, lends itself to the investigation of medical decision making in deployed settings. The critical decision method was developed specifically to aid researchers in eliciting information about decision making in high-stakes, time-critical settings.

In this case, the critical decision method was tailored to elicit examples of difficult decisions facing first responders and other members of the health care team. Interviews were conducted with military personnel who have real-world deployment experience and civilian SME's with comparable experience. Interviews focused on the critical decisions, the context in which they took place, key information, goals, and strategies used by experienced health care providers in potential WMD threat environments. Four specific cases were identified through these interviews **(**Table 2) and were used as background information in developing the concept demonstration scenario.

Table 2. CTA Scenarios Elicited

Scenario	Type/Agent
1	White Powder
2	Nerve Agent
3	Bacterial/Viral
4	Cyanide

Qualitative data analysis methods were used to look across interviews to extract themes. These themes fell into four categories: initial assessment, on-scene size-up, ongoing monitoring and assessment, and coordination issues. For each category key decisions were identified as well as challenges, goals and strategies, important variables, coordination issues, and the potential next steps in the given situation. Findings indicate that priorities may vary from civilian to deployed settings. Information seeking strategies, as well as the implications of certain types of information, are often quite different in deployed settings. Further, some health care personnel work with greater autonomy and decision-making authority in deployed settings in contrast to their roles in civilian settings.

Findings from the CTA guided the development of the learning objectives for the simulation training tool, as well as the information to be used in the training scenarios. In addition, CTA data aided in identifying important aspects of the relational structure required for learners to apply the simulated experiences appropriately in real-world settings. Medical first responders, like pilots, must train as they are expected to perform during critical circumstances.

Decision-Making

Within the CTA interview process, interviewees described the decisions that were critical in their specified situation. These were grouped to provide the basis for the learning objectives for the simulations. Although each situation was very different the decisions required fell into a similar pattern.

In addition to determining the user requirements, the steps necessary to perform tasks and decisions had to be analyzed and broken down into the sub steps. The time to perform various tasks had to be estimated and the potential outcomes or repercussions of each potential action identified. This was done to enable the determination of the "expert path" against which student performance is measured. These tasks and subtasks were charted to include as many variables as possible in order to make each scenario flexible and adaptable to the needs of the learner. From this list of topics, the learning objectives (Table 3) were developed. Again, these were simplified to enable greater generalization and variety within the scenarios.

Table 3. Learning Objectives

1. Identify potential WMD agent release
2. Determine the proper PPE for personnel to use to prevent exposure.
3. Determine best utilization of team members medical knowledge and skills
4. Determine the best assessment methods for victims of potential WMD agent exposure
5. Identify appropriate treatment for suspected or confirmed agent used
6. Determine the best transport method and destination for exposed victim(s)
7. Evaluate decisions made for the specific scenario
8. Gain practice in synthesizing information and applying to real-life scenarios.

TECHNOLOGY ASSESSMENT

Assessment of the available technology appropriate for use with this course had to be completed to assure that the final conceptual design was useable and feasible for later detailed design and development and that all Advanced Distance Learning/Shareable Content Object Reference Model (ADL/SCORM) requirements are met. The ADL strategy includes:

- Exploiting existing Internet-based technologies
- Creating re-usable content to lower development costs
- Promoting widespread collaboration to satisfy common needs
- Enhancing performance with next-generation learning technologies
- Developing a common framework that drives COTS product cycle
- Establishing a coordinated implementation process.

Specific tasks included: Identification of potential training technologies and applications, assessment of their usefulness, determination of technology shortfalls, identification of alternative approaches and development of a list of recommended technologies and applications. The technologies and applications investigated included:

- Learning Management System (LMS)
- Internet-Based Training (IBT)
- Multimedia Training
- Computer-Based Training (CBT)
- PDA/Wireless Applications
- Intelligent Tutoring Applications

The initial assessment of the usefulness, shortfalls and alternatives to these to support simulation-based WMD training led to a recommendation to use of the Northrop Grumman Information Technology Virtual Schoolhouse LMS, the JXT Web Training Portal to host the STOMP courseware, Macromedia Flash embedded multimedia, CBT using Macromedia Dreamweaver and integrated Intelligent Tutoring as the best methods for development and delivery for this type training program. These options offer cost-effective delivery and ease in development of the lessons and capitalizes on the success of the current research and development effort for the prototype Global Treatment Protocol Course (GTPC) being developed through an Air Force SBIR Phase II contract.

Develop Conceptual High-level Course Design

In order to prepare medical personnel for deployment, training strategies focus on creating simulated incidents and exercises that require the learner to become actively engaged in solving problems and making decisions in the context of a deployed health care team. Research indicates that presenting learners with analogous situations in simulated settings is not enough to guarantee transfer of knowledge. The training must also facilitate an understanding of the relational structure so that the learner can begin to understand the key features of a specific incident so that he/she will recognize circumstances in which it is appropriate to generalize. In this case, the critical decision method can be tailored to elicit examples of difficult decisions faced by medical first responders and other members of the health care team. Using this approach, an ADL/SCORM compliant conceptual high-level design and a sample simulation depicting a real-life scenario involving CBR threats was developed. Based on a sequence of decisions and their consequences, through these simulations first responders and other medical personnel will gain knowledge of treatment protocols and how to apply them in the field. These decision-tree simulations specify a role for the student and contain a path of decision points and consequences that lead most directly from the initial condition to the end state. Realistic events have been incorporated to add drama and stress to the scenario. If the student makes a critical mistake the scenario will end. As long as students make no critical mistakes, they will be allowed to complete the scenario. The embedded Intelligent Tutor component will provide feedback to students at the completion of the exercise, thus allowing the participants to perform without interference. The design includes lesson content, delivery methods, and performance evaluation tools to determine student mastery of the learning objectives. Optional interactive links will be used to provide more detailed information for the students. In our sample lesson, we used multiple tools for course delivery and incorporated the delivery method which we determined to be the most feasible for use in this application.

DEMONSTRATION OF THE CONCEPT

The Scenario

The specific scenario written for the concept demonstration was that of a medic posted in an embassy when a cluster of illness symptoms began to emerge. Participants are required to get more information using various means and then act on the information given. Some brief information is provided at the beginning of the simulation in a manner similar to what would be available in a real situation. Distracting information is also included from which the participant must sort out the essential information in order to complete the scenario in an acceptable time frame. The participant has the ability to obtain additional information as deemed appropriate, but seeking non-essential information will delay the performance of more critical actions.

Command Decision-Making

Integrating decision-making for those who find themselves in command of a WMD/CBR threat situation was completed using the general decisions elicited through the CTA interviews (Snead, et al 2004) and by applying Crew Resource Management (CRM) principles to the training design (Walsh, et al 2004). Variables which can and should be manipulated were also identified. These included available information, indicators of CBR exposure, patient symptoms, assessment findings, communications methods available, environmental factors, staff resources, transport/ evacuation issues (methods, expediency and destinations), diagnostic facilities available, results of testing, equipment supplies available, and the socio-political situation (combat vs. Non-combat).

Scenario Development

Development of a sample scenario for this effort began by breaking down a realistic situation into tasks. Key decisions were incorporated into the scenarios. This was accomplished through the use of a flowchart. In addition, the overall decision-making process used by medical first responders in the management of all types of critical and non critical situations was evaluated and charted (Figure 1). A variety of elements had to be considered, not the least of which was what the team members qualifications were and how to most effectively coordinate these with the needs of any particular situation. In addition, the many potential environments in which care might be delivered had to be considered. Each environment can involve simple to complex distractors and maintenance of situational awareness and completion of required tasks requires the ability to quickly evaluate and discard these distractors.

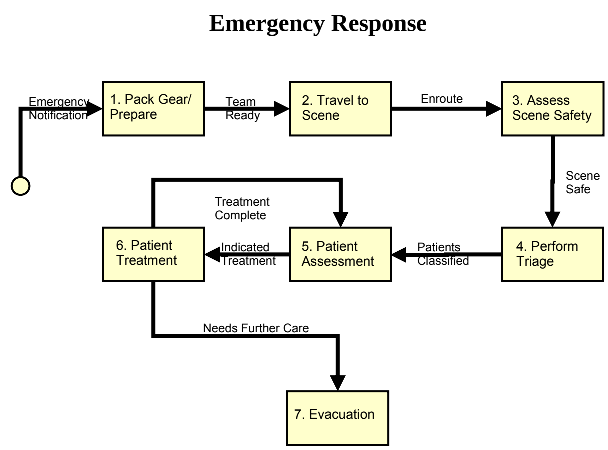

Figure 1. EMT Process

Detailing each of the decisions was completed and integrated into the tutor development and concept demonstration simulation scenario. Completion of an initial database for use in randomization of simulation scenarios was also designed. Development of the application in this manner allows for future completion of a more comprehensive program for training emergency providers in diverse areas of practice. The next step in the process was to determine which protocols are currently in use by the potential user groups of STOMP and how to distill them into one standard protocol for training. The protocols used were civilian (Ohio Region 2) and military (Air Force, Special Operations, US Coast Guard). Other materials that were considered include the Army's 91W program initial and sustainment curricula, and proposed protocols obtained from the US Coast Guard. These were vastly similar, with the primary difference being the environments in which the first responders would utilize these guidelines for care. From this information, the Biological Agent WMD protocol was developed (Table 4). Further refinement of this protocol and development of the remainder of the Chemical, Nuclear, Radiological and Explosive components will be done in the future. The WMD Module of the GTPC, which is also being developed by the authors of this paper, will include all detailed training and resource information. This course will be accessible through the JXT Web Training Portal in addition to the other courses and resources contained therein (Gearhardt, 2003).

Lesson Content Development

Research was conducted regarding the various aspects of WMD knowledge needed for the lessons and simulations. Detailed information was necessary to enable the development team to be assured that the learners could be assumed to have a certain body of knowledge. Resource information and a training module for WMD is included as part of the GTPC as an alternative for those who need it. It is available through the same JXT Web Training Portal in the Medical Education Building. Details of the information to be included in the scenarios were based on this core knowledge. For example, the symptoms and expected care were determined from information obtained through the Centers for Disease Control (CDC) Biological Agent section. Information regarding the scenario location and details was obtained through a team member who has been previously posted in an American Embassy abroad. Development of a preliminary Instructional Design Document (IDD), story-boarding of the scenario and scripting of the various portions of the sample simulation were completed to assure that the lesson meets all SCORM and ADL requirements.

Table 4. Biological Agent Protocol (in part)

Biological Agent Contamination

Background Information

Biological Agents may be disseminated through aerosol release, in foods or liquids, or as dry powders. A high index of suspicion is necessary to prevent overlooking of this cause of clusters of similar symptoms of illness. Because the onset of symptoms is delayed with biological agents, careful investigation of past events is necessary. Similar symptoms in groups of people who were present at a specific event should indicate that a biological release may have occurred. In addition, the severity of symptoms and ages of victims can be an indicator. Young healthy persons with severe symptoms are uncommon with most diseases. Those particularly affected are the extremely young or old and those with pre-existing debilitating conditions under normal circumstances. With biological release, the healthy, robust members of a population contract diseases. The diseases exhibited may be atypical in the geographic location or in a form which is not naturally occurring. (i.e., in the U.S. inhalational Anthrax is atypical, cutaneous Anthrax is not)

Notification:
1. Witnessed release
2. Patients reporting for care in abnormally high numbers, with same or similar symptoms

Scene Safety: Be Aware of possibility of secondary device if recent release

Do not attempt patient care until you have adequately protected yourself.

Call for additional manpower if the number of victims is larger than the amount of personnel or supplies and equipment available to you.

In witnessed release:

1. Protective mask and overgarment
2. Practice Body Substance Isolation
3. Prepare for decontamination (if agent on skin of victims) with soap and water or use of decontamination kit
4. Administer prophylactic antibiotics to all exposed persons

Concept Demonstration

Development of the concept demonstration for proof of concept entailed combining all of the aforementioned elements into a visible, functioning product. Efforts were made to assure that the sample lesson is attractive and stimulating to the user. The demonstration shows that the concept is both useable and feasible for further development. A screen from the sample simulation lesson is shown in Figure 2.

Figure 2. Sample Simulation Lesson Screen

BENEFITS

A primary benefit of STOMP is the cost-effective method of delivering mission rehearsal capability in an attractive and useable format that can be used by military and civilian agencies so that their personnel can repeatedly practice decision-making and team coordination skills in a safe environment. It is educationally and technically sound and can meet the emergency medical technical (EMT) and Paramedic continuing education requirements for recertification following approval of the Continuing Education Coordination Board of Emergency Medical Services (CECBEMS). Being able to practice as expected to perform enables medical first responders to more effectively complete their mission and minimize medical and tactical errors.

COMMERCIALIZATION POTENTIAL

STOMP has widespread application for commercialization since this type of training is not currently available in the civilian emergency medical services (EMS) community. It is suited for use by military, civilian and Department of Homeland Security (DHS) deployable medical teams. It allows for practice in a comfortable, non-threatening environment, and affords the opportunity to repeatedly rehearse decision-making and team coordination skills. In addition, we envision that this course can also include many other types of medical scenarios which could be useful to medical personnel.

CONCLUSIONS

The future of training in all venues lies with the application of constantly evolving technology. Medical training as it relates to decision-making and team coordination skills does not currently exist for medical first responders. Providing a method/vehicle to allow medical personnel to rehearse in a safe environment and make mistakes while learning will improve those skills. Providing feedback allows users to learn from the mistakes made and prevent development of bad habits. The inclusion of Intelligent Tutoring and the CRM principles allows for a more flexible and targeted training program.

LESSONS LEARNED

The most important lesson learned from this effort is that this domain proved to be a rich source of incident information. CTA interviews worked well here as interviewees were able to recall critical incidents in considerable detail, providing valuable input to scenario-based training. Another important lesson learned is that for future efforts, we will need to move beyond our local group of interviewees to sample all the services and obtain a broader range of deployment experiences. Finally, a purely pragmatic issue: obtaining approval from an Institutional Review Board (IRB) for Human Use Protocols requires a substantial amount of time. Future efforts will benefit from building adequate time into the schedule for paperwork, coordination, and approval before interviewing can begin; and identifying useful alternative actions while the approval process works to conclusion.

ACKNOWLEDGEMENTS

This research is funded under the Small Business Innovation Research (SBIR) Program, OSD03DH04, and managed by the Telemedicine and Advanced Technology Research Center (TATRC), an agency of the U.S. Army Medical Research and Materiel Command. The authors would like to express appreciation to Dr. Gerald R. Moses, Chief, Clinical

Applications Division and J. Harvey Magee, Project Officer, Medical Modeling & Simulation & Advanced Medical Technologies (TATRC), and to Dr. Barbara Sorensen, Air Force Research Laboratory, Human Effectiveness Directorate, Warfighter Training Research Division.

REFERENCES

Air Force Research Laboratory. *Cockpit Resource Management Training Research.* Retrieved March 8, 2004, from http://www.mesa.afmc.af.mil/html/cockpitR.htm

Boudourides, M., *Constructivism and Education: A Shopper's Guide.* Retrieved March 8, 2004, from http://www.math.upatras.gr/.

Brown,T. *Constructivism.* Retrieved March 8, 2004, from http://scs.une.edu.au/Units/CurricSt/CSIT513/573/573_5html.

Dodge, B., *Active Learning on the Web.* Retrieved on March 8, 2004, from http://edweb.sdsu.edu/people/bdodge/Active/ActiveLearning.htm

Gagne, R. *Career of Robert Gagne.* Retrieved on March 8, 2004, from http://www.ittheory.com/gagne1.htm

Gagne, R., *Conditions of Learning.* Retrieved March 8, 2004 from http://www.educationau.edu.au/archives/cp/04d.htm

Gagne, R., *Conditions of Learning.* Retrieved March 8, 2004, from http://tip.psychology.org/gagne.html

Gearhardt, R., Wilson-Vinson, R., Sorensen, H.B., (2003). *Global Treatment Protocol Course for Emergency Medicine, Proceedings of I/ITSEC 2003 (December).*

Gorman, P., Meier, A., Krummel, T. (1999). Simulation and Virtual Reality in Surgical Education, *ARCH Surg Vol. 134, Nov. 1999.*

Issenberg, S.B., et al. (1999). Simulation Technology for Health Care Professional Skills Training and Assessment. *JAMA, Vol 282, No. 9* (861-866).

Kaempf, G.L., Klein, G.A., Thordsen, M.L., & Wolf, S. (1996). Decision making in complex command-and-control environments. *Human Factors,* 38, 220-321.

Klein, G.A., Calderwood, R., & MacGregor, D. (1989). Critical decision method for eliciting knowledge. *IEEE Transactions on Systems, Man and Cybernetics*, 19(30, 462-472.

Klinger, D.W., Andriole, S.J., Militello, L.G., Adelman, L., Klein, G., & Gomes, M.E. (1993). *Designing for performance: A cognitive systems engineering approach to modifying an AWACS human-computer interface* (Technical Report AL/CF-TR-1993-0093). Wright Patterson AFB, OH: Department of the Air Force, Armstrong Laboratory, Air Force Materiel Command.

Learning Theory in Practice: Case Studies of Learner-Centered Design. Soloway, E., et. al. Retrieved March 8, 2004, from http://www.acm.org/sigchi/chi96/proceedings/papers/Soloway/es_txt.htm

Lowenstein, J., Thompson, L., Gentner, D., (1999). Analogical encoding facilitates knowledge transfer in negotiation. *Psychonomic Bulletin & Review* 6 (4). 586-597.

Merrill, M., *First Principles of Instruction.* Retrieved on March 8, 2004, from www.id2.usu.edu.

Moses, G. (2001). *Military medical modeling and simulation in the 21st century*. Proceedings of the 12th International Training, Education and Simulation Conference. Lille, France, April 2001.

Pliske, R.M., McCloskey, M.J., & Klein, G. (2001). Decision skills training: Facilitating learning from experience. In E. Salas & G. Klein (Eds.), *Linking expertise and naturalistic decision making* p 37-53. Mahwah, NJ: Lawrence Erlbaum Associates.

Psychology.org—Theory Into Practice (TIP) database. *Cognitive Learning Styles*. Retrieved March 8, 2004, from http://tip.psychology.org/styles.html

Snead, A., Gorman, M., Militello, L. (2004). *Cognitive Task Analysis (CTA) Case Studies*. University of Dayton Research Institute. March 22, 2004.

Snead, A., Gorman, M., Militello, L. (2004). *First Response in Chemical, Biological and Nuclear Scenarios: Key Decisions and Coordination Issues.* University of Dayton Research Institute. June 16, 2004.

Stanard, T., Pliske, R.M., Axambok, C.E., Armstrong, A.A., Green, S., McDonald, D. P., & A., S. - J.K. (2001). *Collaborative development of expertise (CDE): A mentoring-based on-the-job training program*. Prepared for the Naval Air Warfare Center Training Systems Division, under Contract No. N61339-98-C-0026 (Final Report). Fairborn, OH: Klein Associates Inc.

State of Ohio Security Task Force (2003). *Ohio Hazmat & WMD: Awareness for the First Responder.* Retrieved on March 8, 2004, from http://www.homelandsecurity.ohio.gov/images/hazmat%20manual.pdf

Stein, D., *Situated Learning in Adult Education. ERIC Digest No. 195.* Retrieved on March 8, 2004, from http://www.ericfacility.net/databases/ERIC_Digests/ed418250.html.

Torkington, J., Smith, S. G. T., Rees, B. I. and Darzi, A. (2000). The role of simulation in surgical training. *Annals of the Royal College of Surgeons of England*, 82, 88-94.