Hydrogen Fuels Training and Education Research and Outreach Demonstration

Report on the Research and Initial System Analysis for Phase One

Submitted to:
The Department of Transportation Pipeline and Hazardous Materials Safety Administration and the Research and Innovative Technology Administration

By the:
International Association of Fire Chiefs

May 31, 2010

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I. Executive Summary

This white paper was written as a conclusion to the first phase of the Hydrogen Fuels Training and Education Research and Outreach Project per the Cooperative Agreement between the U.S. Department of Transportation's (DOT) Pipeline and Hazardous Materials Safety Administration and the International Association of Fire Chiefs (IAFC), as funded by the DOT's Research and Innovative Technology Administration (RITA). The goal of the ongoing partnership between IAFC and DOT is to expand awareness of critical information and issues related to hazardous materials, and enhance/improve preparedness for hazardous materials response for firefighters and other emergency responders.

Problem & Needs Statement

There are about 800,000 underserved responders in the first response community who staff over 90% of America's fire departments (Stittleburg 2002). Hydrogen is an alternative fuel gaining momentum in the economy just as ethanol was several years ago. However, hydrogen training is competing with a variety of other trainings. In order to compete with these other trainings, hydrogen training needs to be robust to cover various learning styles to keep users engaged. It is imperative to get ahead of the curve to comply with federal law mandates.

Project Goal Statement

The underlying goal of this project is to train the first responder community on hydrogen and hydrogen fuel cell incidents with a special focus on the hard-to-reach volunteer responders.

Purpose Statement

The purpose of Phase One of the project is to prove the concept of a distance learning approach for training the volunteer first responder community by utilizing the topic of hydrogen and hydrogen fuel cell technologies as the subject matter for training. Hydrogen generators have experienced a steady increase in use, due in large part to this emerging energy's ability to lower emissions and improve fuel economy. The rapid growth in hydrogen use is only expected to increase given the current economic state. Initially, content developed for the learning system will focus on hydrogen and hydrogen fuel cell technologies. However, the system will be scalable. The system will grow in capacity as the need to include training on more topics arises. Likewise, it will grow in feature and function as technologies mature and newer technologies are developed. While the training will be targeted to the volunteer first responder community, all persons in the first responder community would have this training available to them.

Defining Audience

The key audience for this report are the volunteer and combination departments across the United States who need training, taking into account four different training environments (home, station with informal group, formal class with a remote facilitator, formal class with on-site facilitator). They have a range of time constraints to consider, as these first responders balance full-time jobs, fulfill their volunteer hours, and need to complete various trainings on top of this.

Objectives

The objectives of this report are to identify the needs and requirements of an online distance training system, identify techniques that will keep the audience engaged and to report on hydrogen fuels training that is currently available. The report will also provide recommendations on the most effective platform(s) and distance learning system(s) capable of delivering hazardous materials training throughout the nation, as well as give a recommendation on knowledge methodology to enhance responders' hazardous materials

skills. These recommendations will be supplemented with analysis on how the chosen knowledge methodology will help support compliance to the National Fire Protection Association's (NFPA®) 472 standard and fill gaps, both current and future, in alternative energy hazmat education and training. This paper summarizes requirements and proposes an approach for hydrogen training, along with making general recommendations that are based on the research, but does not suggest any particular brand or vendor for any future development efforts.

Approach

To conduct due diligence for this project's research phase, a qualitative research approach was taken. The process began with problem identification, and subsequent development of a purpose statement and creation of research questions. A variety of methods were used to collect information: a literature review was conducted; meetings with the state training directors and hazmat team leaders were held; meetings with other organizations representing various industries were held; a request for information was sent out to the industry; and data was collected, analyzed and interpreted. At the conclusion of this approach was the construction of this report of the findings and recommendations.

Findings

There are about 800,000 underserved responders in the first response community with various and diverse needs regarding culture, education, standards and funding.

A younger and more tech-savvy group is filtering into the nation's workforce, bringing an eagerness to use online tools to aid professional growth and development. Technology-based methods now account for 30 percent of all learning hours nationwide, which is a significant jump from 11.5 percent in 2001.

Web-based courses actually increased student confidence with the computer, introducing them to skills and opportunities they would not have had in the classroom.

No difference was found in the student achievement measures of online versus on-campus students.

The use of online education can in many cases eliminate the need for employees to attend out-of-town training, or at least greatly reduce the frequency of that necessity and provide even greater savings of training resources.

Volunteer first responders currently have some exposure and access to hands-on and web-based hydrogen training. However, that exposure and access is random at best.

State training directors maintain hope and a positive outlook for the future of online training for the volunteer and combination first responder community. The directors agreed that the instructional technology and methodologies chosen for the existing online systems and courses merely scratch the surface of what is now possible.

Discussions from the regional meetings did not reveal any state-based hydrogen specific training or courses; however, several states indicated that hydrogen was a piece, or addressed in some way as a part of, a larger training course. In terms of training produced by federal agencies or industry, hydrogen-specific courses were recognized, but none of the training programs identified were designed specifically to be NFPA® 472 compliant.

The eSUCCESS framework, which represents a fusion of theory and practice of a select group of e-Learning leaders, is an appropriate theoretical framework for the development of the distance learning training system for volunteer first responders

A learning management system (LMS) is a software application that provides the platform for the proposed distance learning training system. The LMS enables the management, delivery, and tracking of learning activities. Some of the important issues when evaluating an LMS are high availability, scalability, usability, interoperability, stability and security. Effective LMSs and tools should be able to reproduce and facilitate the teaching and learning experience of the typical classroom course. Any system must be easily adaptable to the style of the individual user, without a long learning curve on the part of either instructors or students.

In developing and delivering instructional content, e-Learning research discusses the need to use multiple learning strategies that accommodate individual differences and learning styles. The instructional features deemed to be the most important are:

- Expectations of adults for personal relevance in what they learn
- Participation in setting their learning outcomes based on their real-world needs
- Self-direction of their learning resources and pathways
- Establishment of an active learning community

The flexibility of time, place, and programs offered via web-based training is appealing to learners who are trying to balance training and education with work and home responsibilities.

A mature and successful online learning system to model for the proposed distance learning training systems is located at the Defense Acquisition University (DAU).

Gaps exist between the actual state of affairs regarding hazardous materials training for the first responder community and what the stakeholders consider to be the optimal state of affairs.

Recommendations

The findings of this research led to the recommendation to build a training system that utilizes the resources of online distance learning to deliver hydrogen fuel curriculum, with the acknowledgement that this system should be scalable so it can be later used to encompass and deliver other alternative fuels and hazmat training. Using hydrogen curriculum as a model, a scalable system should be built that will be expandable to encompass other hazmat training, such as alternative fuels.

- Put into practice a framework of eSUCCESS around the project to ensure victory throughout development by making sure that key players are involved, the content is strong, it is built with the intended users in mind, and it creates a stimulating learning environment.
- Leverage critical partnerships with federal, state, local and industry stakeholders on the development of the training system and training curriculum.
- Implement a spiral model development philosophy to allow the system to grow over time as needs and resources increase.
- View future development as two distinct tasks: distance learning training system development and hydrogen courseware development.
- Consider the Open Source market for a new LMS solution.
- Set high standards for courseware design that support learner engagement, asynchronous and synchronous collaboration, interactivity, multi-media and adult learning principles based on the findings in the Phase One research.
- Set high standards for system design that support tools, collaboration, tracking and scalable technology infrastructure based on the findings in the Phase One research.
- Adhere to federal standards for development of information technology (SCORM, Section 508).

Conclusion – Benefits of the project

It is becoming increasingly clear that volunteer and combination departments throughout the United States need more timely hazardous materials training that is not only cost effective, but easy to implement and that provides valuable knowledge in hazardous materials incident response. To enhance the potential for success, other organizations such as the Department of Energy, the National Fire Academy, etc., and other disciplines such as law enforcement, health, public works, industry and targeted university partners were incorporated into the research. This online training system will give volunteer and combination fire departments a viable training option to ensure they are able to keep current on trends and issues relating to hazardous materials response and help them meet the competencies in NFPA® 472. It will also provide others in the hazmat community, such as law enforcement, health and industry, with the knowledge to keep their communities safe.

- Findings point out that the baseline responder knowledge of hydrogen and hydrogen fuel cell technologies throughout all five Pipeline and Hazardous Materials Safety Administration (PHMSA) regions is minimal at best. In rural areas particularly, volunteer first responders are underserved in this type of training.

- Findings confirm that the few first responders who currently have access to training on hydrogen and hydrogen fuel cell technology receive it in an online or blended learning format.

- Findings establish that gaps exist between actual and optimal responder knowledge of, and access to, hydrogen and hydrogen technologies needed to keep communities safe.

- Findings substantiate that available online and distance learning strategies and systems have a positive effect on adult learning by way of improved learning outcomes, reduction in cost to train and convenient time to participate in training activities.

- Findings prove that a hazardous materials distance learning program should not piggyback on an existing system. Though some resources exist, none support the feature and function of what a quality distance learning training system should have.

II. Introduction

DOT's PHMSA and the IAFC entered into a cooperative agreement for the Hydrogen Fuels Training and Education Research and Outreach Demonstration Project funded by DOT's RITA. The goal of the partnership between the IAFC, PHMSA and RITA is to expand awareness of critical information and issues related to hazardous materials preparedness and response by firefighters and other emergency responders. The short-term objective of the partnership is to prove the concept of a distance learning approach to provide hydrogen and hydrogen fuel cell technology awareness training to the volunteer first responder community in the fire service. The project calls for a two-phased effort spanning a 16-month period to support this objective. The purpose of this paper is to fulfill the requirement of the cooperative agreement to report on Phase One: Research and Initial System Analysis, for a proposed distance learning training system for the volunteer first responder community in the fire service.

Background

With the increase in development and usage of various alternative energy sources, it is now more important than ever to conduct research on these emerging energy sources so that the entire emergency response community, including fire and law enforcement, can be trained properly to deal with incidents involving these hazardous materials. Unless departments adopt an innovative approach to hazardous materials training, the fire service community will not be able to adequately train its members over the next five to ten years.

The origin of hazardous materials training came about in 1989 with the promulgated standard under the U.S. Occupational Safety and Health Administration (OSHA) Standard 1910.120 "Hazardous Waste Operations and Emergency Response" (HAZWOPER). The section on training refers to five types of hazardous waste operations conducted in the United States. The standard contains the safety requirements employers must meet in order to conduct these operations. The volunteer and combination fire departments currently do not have enough accessible training to fulfill state training requirements such as the HAZWOPER. These departments are also lacking the next evolution of hazardous materials training found in the NFPA® 472 - Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents (See Appendices G, H, and I for more NFPA® 472 Information and impact). This lack of baseline training jeopardizes the health and safety of first responders.

Eight hundred thousand volunteers who staff about 90 percent of America's fire departments lack the time and resources for adequate training on current trends and issues relating to hazardous materials. Most of the volunteer firefighters serving in rural communities are involved in structural firefighting without having sufficient or formal training in that capacity. The National Volunteer Fire Counsel (2010) reported that 40 percent of fire department personnel responding to a hazardous materials incident in rural areas lack formal training.

Purpose and Scope

The purpose of Phase One of the project is to prove the concept of a distance learning approach for training the volunteer first responder community by utilizing the topic of hydrogen and hydrogen fuel cell technologies as the subject matter for training. Hydrogen generators have experienced a steady increase in use, due in large part to this emerging energy's ability to lower emissions and improve fuel economy. The rapid growth in hydrogen use is only expected to increase given the current economic state. Initially, content developed for the learning system will focus on hydrogen and hydrogen fuel cell technologies. However, the system will be scalable. The system will grow in capacity as the need to include training on more topics arises. Likewise, it will grow in feature and function as technologies mature and newer technologies are developed. While the training will be targeted to the volunteer first responder community, all persons in the first responder community would have this training available to them.

The scope of Phase One research is focused by the following questions:

- What is the baseline responder knowledge of hydrogen and hydrogen fuel cell technologies throughout all five PHMSA regions?
- How are first responders currently trained on hydrogen and hydrogen fuel cell technology?
- What gaps exist between actual and optimum responder knowledge of hydrogen technologies needed to keep communities safe?
- What is the effect of available online and distance learning strategies and systems?
- If feasible, how might a hazmat distance learning program piggyback on an existing system?

Aligning Values and Objectives

The goal of the partnership between the IAFC, PHMSA and RITA to expand timely hazardous materials response training for first responders is closely aligned with aspects of the PHMSA Strategic Plan (2007), which states:

- *"Incidents involving these materials pose the greatest challenges for the emergency management community and the state transportation and highway officials who must understand the risks and respond appropriately. The emergency response community needs to be prepared to address these new technologies (e.g. hydrogen or lithium battery-powered vehicles and equipment) through the development of emergency response plans, training and outreach materials."*

- *"PHMSA and the emergency response community are assessing the needs of emergency responders for training to respond safely to new and changing hazardous materials products in transportation. We are refocusing existing programs, modifying training curricula, developing cooperative agreements with emergency responder organizations and sponsoring cooperative research to build the capability of emergency responders to respond to transportation incidents involving hazardous materials."*

(Pipeline and Hazardous Materials Safety Administration, 2007)

It also very closely aligns with aspects of RITA's primary objective, which states:

- *RITA was created by Congress with the primary objective of serving as the Department's focal point for coordination of crosscutting research and clearing the pathway to technology deployment. To fulfill its role as Department of Transportation's lead agency in support of the Administration's Hydrogen Fuels Initiative, RITA will continue to coordinate, manage and execute key components of the Department's hydrogen activities. Many of these activities will be conducted in collaboration with DOT, Federal, State, academic, and industry partners.*

(Research and Innovative Technology Administration, 2008)

Overview of Content

Components of the report following this **Introduction** are:

- **Key Terms** containing a brief description of key terms relating to learning systems
- **Research Approach** containing a brief overview of the research methodology
- **Findings** containing the summary and interpretation of findings

- **Conclusions and recommendations** containing the summary of conclusions to the original research questions, and recommendations on how to address the conclusions in subsequent development efforts
- **Appendices** containing the supplemental materials

III. Key Terms

a. **Distance Learning Training System**: generic language used in the cooperative agreement to describe a proposed learning system for volunteer first responders delivered over the Internet.

b. **Learning Management System (LMS)**: a software application for the administration, documentation, tracking and reporting of training programs, classroom and online events, and training content.

c. **Distance Learning**: a field of education that focuses on the pedagogy, technology and instructional system designs that aim to deliver education to students who are not physically "onsite" in a traditional classroom or campus.

d. **Electronic Learning (e-learning)**: computer and network enabled transfer of skills and knowledge.

e. **Online Learning**: e-Learning that occurs over the Internet; also known as web-based training (WBT).

f. **Mobile Learning (m-learning)**: e-Learning that occurs over mobile communications devices.

g. **Web 2.0**: web applications that facilitate interactive information sharing, interoperability, user-centered design, and collaboration on the World Wide Web. A Web 2.0 site allows its users to interact with each other as contributors to the website's content, in contrast to websites where users are limited to the passive viewing of information that is provided to them. Examples of Web 2.0 include web-based communities, web applications, social-networking sites, video-sharing sites, wikis and blogs.

IV. Research Approach

The research process for Phase One of the project consisted primarily of the following steps:

Problem Identification

There are about 800,000 underserved responders in the first response community who staff over 90% of America's fire departments (Stittleburg 2002). Hydrogen is an alternative fuel gaining momentum in the economy just as ethanol was several years ago. However, hydrogen training is competing with a variety of other trainings. In order to compete with these other trainings, hydrogen training needs to be robust to cover various learning styles to keep users engaged. It is imperative to get ahead of the curve to comply with federal law mandates.

Literature Review

The George Mason University Academic Libraries were used to search literature for the project. Primary sources included research studies and books, while secondary sources included indexed publications (conference papers, dissertations, university publications, professional association papers) and journal articles (refereed, non-refereed, international, national). The sources identified were used and referenced throughout the report, as well as guiding a literature review to identify and assess ways to keep learners engaged in an online distance learning system.

A short list of sources referenced:

- *Acts of Meaning*
- *Adult Education Quarterly*
- *Contemporary Issues in Technology and Teacher Education*
- *Current Development in Technology-Assisted Education*
- *Ed-Media 2001 World Conference on Educational Multimedia, Hypermedia & Telecommunications*
- *Educational Media International*
- *e-Learning in the 21st Century: A Framework for Research and Practice*
- *First Things Fast. A Handbook for Performance Analysis*
- *Handbook of Computer Game Studies*
- *Information & Management*
- *Journal of Nursing Education*
- *Journal of Distance Education*
- *National Dissemination Center for Career and Technical Education. The Ohio State University*
- *Paper presented at the Academy of Human Resource Development International Research Conference in the Americas*
- *Performance Improvement Quarterly*
- *Performance and Instruction*
- *Proceedings of World Conference on E-learning in Corporate, Government, Healthcare, and Higher Education 2002*
- *Psychology of Learning for Instruction*
- *Theory and Practice of Online Learning*
- *The Quarterly Review of Distance Education*
- *The Journal of Experimental Education*

Data Collection

Data for Phase One research was collected using purposeful sampling where resources were targeted specifically for the value known to exist in the resource.

Purposeful Sample	Collection Method	Value to Project
State Training Directors	Conducted meeting in each of the 5 PHMSA regions (Baltimore, Salt Lake City, Kansas City, Arkansas, and Charlotte) Facilitated 2 virtual meetings	Opportunity to talk to officials directly involved with first responder training and to consider regional differences.
Universities	Visited Texas Engineering Extension Service (TEEX) of Texas A&M Consulted with University of Wisconsin	Examine opportunities for online training that could utilize the resources and systems for online learning at different Universities.
Industry/Federal	Assessed 41 responses to the IAFC-issued Request For Information Held meetings with representatives from several federal organizations (DOE, USFA, DOT) and held discussions with other organizations (CaFCP, NAFSM, IACP)	Collect information from wide range of sources on capabilities that exist for online learning. Better determine what is currently available in hydrogen training for first responders to avoid duplication of existing programs and look into potential for pooling resources.
NFPA® 472 Standard	Conduct mapping of minimum competencies for a hydrogen training course. Mapping based on 2008 edition of NFPA® 472 Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents - Chapters 4, 5, 6, and 8.	Provide template for developing hydrogen training that will be NFPA® 472 compliant and allow first responders credit toward recertification hours.

PHMSA region field notes available at: http://www.hazmatfc.com/Pages/Resources.aspx

Data Analysis and Interpretation

Rather than computer analysis of the data with software tools, hand analysis was used to analyze the data collected. Tasks in the hand analysis included:

1) Organize data
   a) Use color-coded flip charts
   b) Record individual field notes
   c) Transfer flip charts and field notes to computer files
   d) Store in computer folders (e.g. meetings, system literature, design literature)
2) Read the data
3) Mark the data
4) Divide the data into parts

Following analysis were steps to interpret the data:

1) Review of major findings
2) Confirm that research questions were answered
3) Reflect on the meaning of the data
4) Compare and contrast data with the literature
5) Identify limitations of the research
6) Recommend next steps

Research Evaluation

To strengthen the report, multiple reviewers were contracted to scrutinize the report and its appendices. Providing review and general edits of the first draft of the report was Holly Stearns, who has a background in editing publications in the fire service field. Also reviewing the first draft was Dr. Larry Dooley whose expertise in distance learning and adult education allowed him to assess the distance and online learning material and provide supplemental information for both the report and appendices. The final draft was reviewed for content, thoroughness in responding to the draft comments, and grammar by Ed Kirtley and Cathy Cruise. The multiple reviews were part of an effort to overall strengthen the report structure and validity.

Subject Matter Experts (SMEs)

The research during Phase One and the resulting report were produced out of a multi-prong effort that utilized the expertise of a group of individuals. The subject matter experts (SMEs) contracted to work on the project come from a range of backgrounds and disciplines to provide the expertise and experience necessary to strengthen the perspective of the report.

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Shelton Jewette

Mr. Jewette has an extensive history of working in the field of distance and online learning. He has assisted in the development and design of both large learning management systems as well as individual courses. Mr. Jewette has also worked on the analysis for business needs or problem statements, users' needs, project requirements, task analysis and media analysis. In addition, Mr. Jewette has served as an educator in the classroom through his time as an Adjunct Professor and Graduate Research Assistant of Instructional Technology at George Mason University.

Mr. Jewette assisted in the research and data collection by working on data collection and analysis from state training director meetings as well as evaluating the RFI responses. He served as a key writer for the report, utilizing his expertise in online distance learning.

Dr. Larry Dooley

Dr. Larry M. Dooley is an Associate Professor in the Department of Educational Administrations and Human Resources Development (EAHRD) at Texas A&M University. Dr. Dooley serves as the Chair of the Human Resource Development (HRD) Program, which specializes in the areas of distance learning, training and development, career development, organizational development and workforce development.

With his background and expertise in distance learning, Dr. Dooley was contracted to review the first draft of the report as well as the literature review in Appendix A. His input was used to edit and supplement the content of the literature review as his comments were directly incorporated into Appendix A.

Kirk Rosenhan

A.K. Rosenhan currently serves as the fire services coordinator for Oktibbeha County, Mississippi, and is also a professor of engineering at Mississippi State University. His work in the fire service along with his engineering background provides Mr. Rosenhan with first-hand experience and extensive knowledge with alternative fuels. He has provided insight into the role of hydrogen and other alternative fuels considerations for first responders and had his work published in a number of publications, including *Fire Risk Management*. Respected not only for his work in the fire service, but also expertise in engineering, Rosenhan serves as a consultant in fire protection engineering for the U.S. Navy, Air Force and Coast Guard.

Mr. Rosenhan provided an overview of the importance of hydrogen as an emerging energy source to convey the need for hydrogen and hydrogen fuel cell training. He also reviewed the list of current hydrogen training to include any that may have been omitted.

Pete West

Mr. West has been in the fire service for over 40 years. He holds a bachelor's degree in mathematics and English as well as a master's degree in computer science. Mr. West has been a member of the Philomont Volunteer Fire Department for thirteen years and is currently an Assistant Chief in that department. Prior to serving with Philomont Volunteer Fire Department, Mr. West was Chief of the Fair Oaks Vol. Fire & Rescue Co., Fairfax County, Virginia from1975 until 1996. He was also the President of the Fairfax County Volunteer Fire Chiefs Association and has held that position for 11 years. His current qualifications include hazardous materials certification.

Mr. West also has over thirty five years of experience related to the design, development, integration, and testing of IT based command centers and support software.

Mr. West served as an IT and volunteer fire chief SME throughout Phase One of the project.

Tony Mussorfiti

Tony Mussorfiti has served as a Lieutenant for over 20 years for the Fire Department of New York (FDNY), and 17 years as a Hazmat Technician Specialist. Additionally, he serves as a Hazmat Tech and Team Leader for a Federal Emergency Management Agency (FEMA) National Urban Search and Rescue (US&R) Response task force. Mussorfiti has also served as an instructor and course developer in hazmat courses for the FDNY and the Federal Bureau of Investigation (FBI).

As a veteran hazmat responder and instructor, Mr. Mussorfiti was part of the team developing the competency mapping of the NFPA® 472 as it relates to hydrogen.

Charlie Wright

Charlie Wright is an original member of the NFPA® 472 Technical Committee and has been responsible for the development of a number of training programs that have been adopted by fire service and emergency-response agencies throughout North America. He has worked in the hazmat training field for over 30 years and recently has served as manager of hazmat training for the Union Pacific Railroad.

Given his experience in hazmat training and in-depth knowledge of NFPA® 472, Mr. Wright was contracted to work on the team tasked with the competency mapping of the NFPA® 472 as it relates to hydrogen.

Holly Stearns

Ms. Stearns graduated with a Juris Doctor from the George Washington University School of Law. She has been working in the fire industry since 2004 as a consultant, editor, and government relations manager.

She has edited guides for IAFC's Volunteer and Combination Officers' Section as well as written numerous articles and guides for the fire service.

Ed Kirtley

IFSTA & Curriculum Projects Coordinator at Oklahoma State University Fire Protection Publications. He spent over 25 years in the career fire service and is a retired fire chief. He has a background in hazardous materials operations and an extensive background in fire service training at the department, state, national and university level. He is the former chair of the NFPA® 1035 professional qualifications standard. Mr. Kirtley served as one of the reviewers for the final draft of this report, also providing edits for the appendices.

Cathy Cruise

A former editor of IAFC's *On Scene* newsletter, Cathy Cruise currently works as a freelance writer and editor, and produces several other newsletters and publications for IAFC and various organizations.

Ms. Cruise served as one of the reviewers for the final draft of this report, also providing edits for the appendices.

V. Findings

> *Information technologies are more like clothes than like fire. Fire is a wonderful technology because, without knowing anything about how it operates, you can get warm just standing close by. People sometimes find computers, televisions, and telecommunications frustrating because they expect these devices to radiate knowledge. But all information technologies are more like clothes; to get a benefit, you must make them a part of your personal space, tailored to your needs. New media complement existing approaches to widen our repertoire of communication; properly designed, they do not eliminate choices or force us into high tech, low touch situations.* (Dede, 1995)

Audience and Needs

Vision of the New Millennium First Responder:

There are about 800,000 underserved responders in the first response community who staff about 90 percent of America's fire departments (Stittleburg 2002). Hydrogen is an alternative fuel gaining momentum in the economy just as ethanol was several years ago.

During the regional meetings with the state training directors and state hazmat leaders (See Appendix E for Regional Meeting Notes), facilitators prompted the participants to discuss the first responder of 2015 and 2020. Considering the current changes in society, personal experience, and attempts to predict future trends, the directors envisioned the needs of the first responder five-to-ten years into the future. Research findings uncover four topical areas from these discussions: culture, education, standards and funding.

The directors recognized the importance of meeting the needs of people of various cultures, backgrounds, geographical differences, skills and learning styles. They also discussed generational concerns as the workforce transitions from Baby Boomers to Generations X and Y.

They predicted that the future volunteer first responder's ability to obtain education and training will be better than in past decades, due primarily to advancements in information technology (IT). The directors agreed that volunteer first responders will require quick access to less fractured, seamless and centralized IT systems. **Recommendation - Training opportunities for volunteer first responders will need to be available in any of the following situations:**

- **learner working at home on a personal computer**
- **learner working at a fire station with an informal group of six or seven other volunteers, all working on different parts of a self-paced awareness class**
- **learner working in a formal hazardous materials class with a remote facilitator**
- **learner working in a formal hazardous materials class with an on-site facilitator**

They agreed also that training standards and certification requirements remain uneven. The directors suggested creating one certification body working from a single set of standard competencies and training requirements. While this is an overarching recommendation for the state of the standards and training within the fire responder community, this scope is too large as a recommendation for Phase Two of this particular project.

Finally, the issue of how to initially fund and sustain training for the future volunteer first responder challenged the group. The directors talked about methods that currently work for their states, such as grants, tax programs and partnerships with law enforcement agencies and private industry. Other directors

reported having no funding for training. They all concur that the best way to sustain training in the future remains open to debate, but at present they are critically in need of training aid.

Distance Learning Works for Adults

The American Society for Training & Development reports that as older, book-bound workers edge closer to retirement, a younger and more tech-savvy group is filtering into the nation's workforce, bringing an eagerness to use online tools to aid professional growth and development. Technology-based methods now account for 30 percent of all learning hours nationwide, which is a significant jump from 11.5 percent in 2001. Increased deployment of e-Learning improves flexibility, but likely contributes to rising overhead for infrastructure and content development. One of every three hours of training is now being delivered via some form of technology, due in part to higher fees being charged for instructor-led classes, coupled with organizations' growing reluctance to have employees miss work to attend training sessions. (Kranz, 2008)

The state training directors wondered how the type of training required of volunteer first responders could be mastered over the Internet. After all, a huge driver reported by the directors in the use of online learning was computer literacy and the existence of a digital divide.

A study of senior-level undergraduate nursing students, some of whom took a web-based course and some of whom took the traditional classroom version of the same course, is particularly illuminating. (Leasure, 2000) Students without the requisite level of computer literacy were disadvantaged as they struggled to master the course content and the technology simultaneously. However, the web-based courses actually increased student confidence with the computer, introducing them to skills and opportunities that they would not have had in the classroom. The students seemed to immerse themselves more in the web-based course section than the traditional classroom students did. The traditional students came to class once weekly and focused on course content for that limited period of time. They then left the academic setting and most reported completing class preparation one or two days before the next class. In contrast, the web-based students used the internet throughout the week to talk to group members, post questions on the bulletin board, and read information posted by faculty and students.

Researchers at Ohio State University compared the effectiveness of an online career and technical education (CTE) course to equivalent campus-based courses to determine which adult students achieved the desired learning outcomes. (Benson, 2004) CTE is comparable to the operational training offered to the first responder community. CTE students performed equally well in online and on-campus courses. The study found no difference in the student achievement measures of the online and on-campus students. Also, this study found no difference in the student motivation measures of the online and on-campus students. The results also suggest that the persistence of students in the online programs is comparable to their on-campus counterparts. CTE students in the online and on-campus courses also experienced comparable feelings of closeness to their instructors. Overall, the courses and programs assessed in this study met the learning needs of both campus and online students.

A study of police officers (Donavant, 2009) corroborates the findings mentioned above. As with the firefighting community, the law enforcement community has questioned the efficacy of online training for real-life work. However, the study found that officers demonstrated improvement in learning, and that the two delivery methods were equally effective. The study showed that many types of training could be readily complemented through the use of online education, such as legal updates, management skills, and critical incident command, among others. The research found that the use of online education can in many cases eliminate the need for employees to attend out-of-town training, or at least greatly reduce the frequency of that necessity and provide even greater savings of training resources.

Online Training Available to First Responders

Research findings reveal that volunteer first responders currently have some exposure and access to hands-on and web-based hydrogen training. However, that exposure and access is random at best. Of the

29 states that responded to a recent survey of states that provide learning opportunities to its volunteer first responders, just 15 of those states reported offering some form of online learning. (For specific course offerings, please refer to Table 1, page 18. Appendix B also has further information on current hydrogen training as researched). To supplement that survey, the regional state training directors named other online opportunities not already captured:

- New Jersey developed timely, new and recurring short courses and programs online for all emergency responders in the state.
- Alabama, Hawaii, North Carolina and South Carolina offer generalized online training to volunteer firefighters.
- The state of Washington developed an online program for volunteer firefighters specifically on hazardous materials awareness.
- Oklahoma's most successful training program on hazardous materials response blends both online and traditional classroom components (in other words, the state uses a "blended format").
- The National Fire Academy has a portal for online courses for volunteer firefighters that is available to all 50 states.
- Texas Engineering Extension Service (TEEX) makes some online programs for volunteer first responders.

Training directors from the state of Missouri reported more than 1500 completions of its online courses for volunteer first responders. Those self-paced courses have been recognized and awarded by the training industry (University Continuation Education Association and the American Association for Collegiate Independent Study).

Findings show further that the state training directors maintain hope and a positive outlook for the future of online training for the volunteer and combination first responder community. In Maryland, online programs started out slowly, but have grown as people have become more aware of them. In Oregon, since converting training from CD-ROM to online courses, the training completion rates have been "doing well," according to the state training director. Training staff in Oregon have administrative rights that allow them to monitor student progress and motivate them as they go through the course. Similarly, in West Virginia, trainers use a blended learning approach. Online instructors are able to monitor student progress and tailor the learning experience to benefit the students, resulting in satisfied students and very high pass rates. Illinois is finding online training to be more cost-effective than classroom learning. As mentioned earlier, Missouri's online courses, converted from instructor-led courses, have received training industry awards of excellence.

The directors agreed that the instructional technology and methodologies chosen for the existing online systems and courses merely scratch the surface of what is now possible. However, faced with the drivers presented earlier in this paper, the state fire services should be applauded for what they have already done, particularly in a volunteer and combination first responder culture that is deeply rooted in face-to-face interaction and hands-on experience. After all, the very essence of firefighting is hands-on work.

Table 1. Online Training by States

The table below describes which online training courses are offered in the various states.

SUMMARY BY COURSES				
Course Title	States Reporting Individual Course	States or Province	States with Complete Courses On-line	States with Blended Courses
Firefighter 1	LA, MA,MN,NY,WV,WY	6		6
Firefighter 1 - Texbook Neutral	LA	1[1]		
Firefighter 2	IL, MA, MN, NY, WV	5		5
Haz Mat Awareness	IL, LA, MD,MO,MT, OR, TX, VA, WY	9	6	3
Haz Mat Operations	IL, LA, MD	3[2]	1	1
Haz Mat Technician	(none reported)			
Fire Instructor 1	IL, MA, OR, WY	4[3]		3
Fire Instructor 2	MA	1		1
Fire Instructor 3	TX	1	1	
Fire Officer 1	IL, BC, MA, MN, VA, WV, WY	7[2]		5
Fire Officer 2	BC, MA, MN, WV	4[4]		3
Fire Officer 3	BC (British Columbia), MN	2[2]		
Fire Inspector 1	MN	1[4]		
Fire Inspector 2	MN	1[4]		
Acting Officer in Charge	GA	1		1
Technical Rescue Awareness	IL	1		1
Rope Rescue Awareness	TX	1	1	
Fire Origin & Cause	IL	1		1
Life Safety Educator II/III	BC	UD		
Grant Writing	IL	1	1	
Intro to Emerg. Mgt. for Fire Svc.	MO	1	1	
Building Const.: Combustible	MO	1	1	
Building Const: Non-Combustible	MO	1	1	

1. Two states reported they are using another state's program; therefore, counted as in-house.
2. One course under development, counted in total states - not counted in complete/blended or in-house/commercial categories.
3. One course under development, counted in total states - not counted in complete/blended or in-house/commercial categories.
4. Incomplete data see Data by State sheet.

Current Hydrogen Training

A listing and explanation of the current hydrogen training programs identified can be found in Appendix B.

The combination of the regional meetings with state training directors and hazmat team leaders, along with the staff research of available hydrogen training, revealed several programs or courses. Discussions from the regional meetings did not reveal any state-based hydrogen specific training or courses; however, several states indicated that hydrogen was a piece of, or was addressed in some way as a part of, a larger training course.

In terms of training produced by federal agencies or industry, hydrogen-specific courses were recognized. The U.S. Department of Energy (DOE) has produced an online course, Introduction to Hydrogen Safety for First Responders Online, but the rest of the courses are hands-on training, or found in traditional classroom settings. West Virginia University's National Alternative Fuels Training Consortiums (NAFTC), DOT's Transportation Safety Institute (TSI), and Hazardous Materials Management and Emergency Response (HAMMER) all offer hands-on hydrogen courses for first responders. None of the training programs identified were designed specifically to be NFPA® 472 compliant. Discussions with representatives from the different organizations indicated interest in pooling resources for future hydrogen training programs. These programs offer a starting point and curriculum for hydrogen training and have components that can

be helpful in developing an online hydrogen training system that can reach a wide audience and maintains compliance with NFPA® 472. Identifying existing training systems allows for a better understanding of available resources for moving forward in reaching first responders across the country. **Recommendation – Work with organizations with existing training systems for resources and to avoid duplication of efforts. But need to include the NFPA® 472 minimum competencies that were identified from the competency mapping part of the research (More information on the competency mapping are available in Appendix G as well as the competency matrix in Appendix H).**

Theoretical Framework

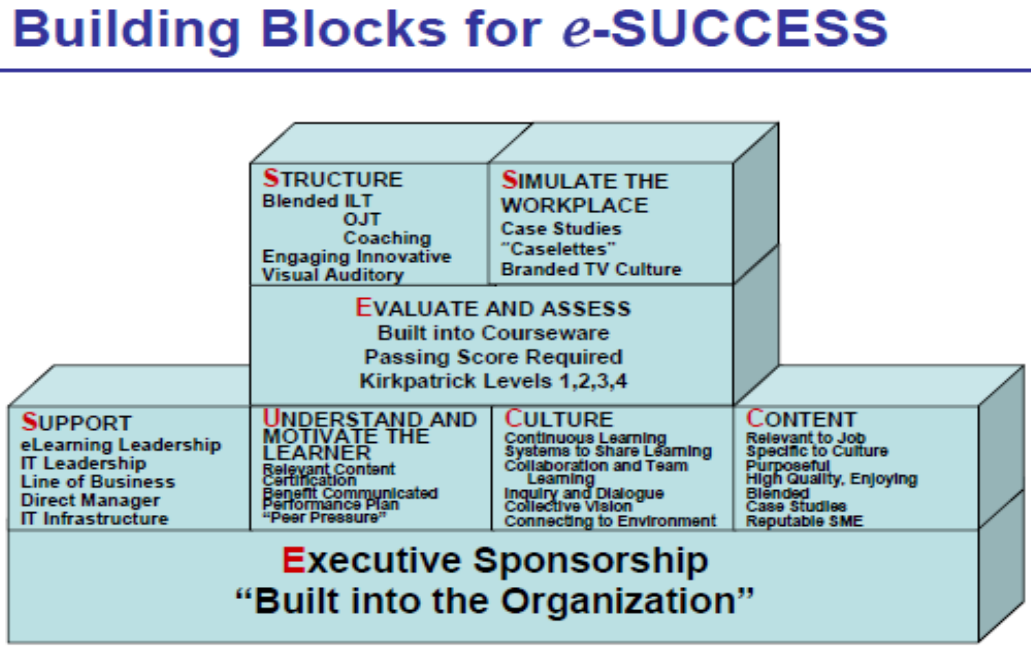
In first focusing on the system as a whole, what emerged from the research findings was a theoretical framework appropriate for the development of the distance learning training system for volunteer first responders. The eSUCCESS framework (Armstrong, 2008) represents a fusion of theory and practice by transforming the experiences and knowledge of a select group of e-Learning leaders into eight tenets. These tenets may be extrapolated to the theoretical framework discussed in Figure 1.

The eight tenets are:

- **E**xecutive Sponsorship
- **S**upport from the Organization
- **U**nderstand and Motivate the Learner
- **C**ulture Fosters Learning
- **C**ontent is Relevant to Learner & Organization
- **E**valuate and Assess
- **S**tructure of Program is Engaging, Interactive and Blended
- **S**imulate the Work Environment and Work Tasks

Figure 1. Theoretical Framework for e-SUCCESS

The figure below shows a visual of the eight tenets for a successful e-Learning framework.



Garnering executive sponsorship in the form of time, money and communications is a key factor in driving successful e-Learning initiatives. Executive sponsorship, executive e-Learning leadership, information

technology leadership and executive line of business leadership also received high rankings from the group of e-Learning leaders.

Fostering an environment that supports and encourages learning is a key factor in driving successful e-Learning initiatives. The respondents in this study identified the core patterns needed for a learning organization, which include: creating continuous learning opportunities; promoting inquiry and dialogue; encouraging collaboration and team learning; developing systems to capture and share knowledge; creating a collective vision and empowering individuals toward that vision; connecting the organization to its environment; and developing leaders who model and sponsor learning.

Learner motivations – and strategies to ignite them – are keys to success for e-Learning programs. The most successful motivators were programs that led to career advancement opportunities, such as certifications, accreditations, and internal designations. Designers must create programs so that learners understand how the content is relevant to them personally and to their current or future jobs.

Also important is program design that is culture-specific (i.e., specific to volunteer first responders), purposeful to the job, engaging, high quality, interactive, incorporates a case study, is blended with more traditional educational methods, and is based on real-life experience. This study revealed that blending the e-Learning with more traditional methods is likely to lead to a successful program. All of the participants in the study of the e-Learning leaders cited some form of a blended solution when describing their most successful e-Learning event. **Recommendation – use e-SUCCESS as a framework when building the system as well as project goals to ensure a successful training.**

Learning Systems

A learning management system (LMS) is a software application that provides the platform for the proposed distance learning training system. The LMS enables the management, delivery, and tracking of learning activities. Some of the important issues when evaluating an LMS are high availability, scalability, usability, interoperability, stability and security. (Hall, 2003)

In a pilot study on LMS (Cavus, 2005) the researcher reported that a good LMS should be 100 percent web-deployable, requiring no additional client applications. The LMS should support various sources from different manufacturers and should be based on open industry standards for web deployments. Finally, it should support the various learning standards, such as those listed below:

Instructional Management System (IMS): standards for the development and adoption of technologies that enable high-quality, accessible, and affordable learning experiences; The scope for IMS specifications, broadly defined as "distributed learning," includes both online and off-line settings, taking place synchronously (real-time) or asynchronously.

Institute of Electrical and Electronics Engineers (IEEE): largest professional association dedicated to advancing technological innovation and excellence; promotes the engineering process by creating, developing, integrating, sharing and applying knowledge about electro- and information technologies and sciences.

Sharable Content Object Reference Model (SCORM): integrates a set of related technical standards, specifications, and guidelines designed to meet SCORM's high-level requirements—accessible, interoperable, durable and reusable content and systems.

Some of the best-known commercially available LMSs are Blackboard™, WebCT™, Learn eXact® and Desire2Learn©. A study evaluating more than 70 open source LMSs listed some of the best performing systems: Moodle™, Segue, Interact, CourseWork©, Atutor, KEWL, LRN, Bazaar, Bodington, Claroline, OnPoint Course Manager©, ILIAS and Sakia. (Uzunboylu, 2006)

Effective LMSs and tools should be able to reproduce and facilitate the teaching and learning experience of the typical classroom course. Thus it is vital to keep in mind the criteria of effective teaching and learning when considering new LMSs and tools (Cooke-Plagwitz, 2001).

Table 2. Distance Learning System Criteria

Table 4 details research findings of LMS criteria that can supplement, extend, and emulate the activities of classroom teaching and learning.

Activities	Effective Teaching	Effective Learning	Optimizing LMS Features
Reading/ Research	Instructors need to recognize and recommend adequate, if not excellent, course literature and resources.	Students need to be directed to adequate course literature and resources.	Systems with hypermedia-enabled library, database, annotation, categorization, and search features aid reading and research. Systems that display hypermedia clearly and make content easy to save and print are particularly effective.
Discussion	Instructors need to initiate and moderate class discussions.	Students need to discuss what they have learned with other students as well as their instructors.	Systems with asynchronous discussion forums, real-time AV and/or text chat, shared whiteboards, listservs, built-in e-mail or e-mail interfaces enhance, extend and capture discussion.
Lecture	Instructors need to disseminate their expertise on course subject matter in a timely, efficient manner.	Students need to access or avail themselves to expertise on course subject matter in a timely, efficient manner.	Systems accommodating hypermedia and streamed media can dispense video/audio lectures asynchronously or in real-time. Also web documents allow for immediate dissemination of and access to lecture notes and transcripts.
Assignments	Instructors need to announce, distribute and acquire a variety of course assignments – to and from individuals and groups.	Students need to know about, access and submit course assignments.	Systems with hypermedia-enabled pages allow for immediate dissemination of and access to assignments; systems that simplify announcing assignments with features such as calendars, bulletin boards and e-mail alerts are particularly useful – as are systems that simplify or automate the assignment submission and review process. Also advantageous are systems that facilitate and track group work or group-produced assignments.
Examinations	Instructors need to assess student knowledge and abilities; they need to announce, distribute, and acquire course examinations – to and from individuals and groups.	Students need to know about access and submit course examinations.	Systems with hypermedia-enabled test, survey and test bank features allow for a wide range of test types; one that allows for restriction (such as time limits) and programmable actions (such as randomized testing, automated grading, alternate coursework based on score) can optimize the use of exams in teaching and learning.
Labs/ Practicums	Instructors need to supervise or gauge student skills or techniques in certain	Students need to practice and demonstrate skills or techniques they have	Systems that offer real-time functions, such as AV or text chat, and interactive simulations, such Flash media, can enhance or extend traditional course

	contexts at specific times.	learned in certain contexts at specific times.	features that are generally face-to-face or physical activities requiring interactivity. Some developments in virtual reality programming look especially promising.
Relevance/ Timeliness	Instructors need to demonstrate the significance or relevance of concepts and theories.	Students need real-world examples; they need to appreciate the relevance of concepts and theories.	Systems that support a means of listing, displaying, linking to, or categorizing (by chronology, subject, author, etc.) relevant and timely events and news in a variety of media formats underscore the importance of course concepts and theories.
Consultation	Instructors need to meet with students privately to discuss individual concerns.	Students need the opportunity to meet with instructors privately to discuss their concerns.	Systems with an e-mail interface or built-in e-mail system, AV or text chat, or discussion forum allow for public, private and group consultation.
Feedback/ Grading	Instructors need to acquire feedback on their teaching from students, as well as disseminate feedback to the appropriate parties regarding assignments, examination, labs and courses.	Students need prompt, clear feedback on assignments, examinations, labs and courses.	System that include tests and systems that automatically grade quizzes or organize survey data are particularly helpful, as are tools that include online grade books that store, calculate and display grades for instructors and students. File transfer systems, e-mail interfaces or built-in e-mail systems also enhance the ease by which content can be assessed and returned.
Record/ Review	Instructors need to keep careful records of their work and their student's work.	Students need the opportunity/facility for recording, studying and reviewing course content.	Tools that keep and display careful records and can graphically represent, extrapolate, export, archive and/or recycle contents are advantageous. Also advantageous is the ease with which web content can be excerpted, downloaded, copied, and printed.

Online learning tends to be more self-directed than classroom learning. Thus, any system must be easily adaptable to the style of the individual user, without a long learning curve on the part of either instructors or students.

Table 3. Learning Management System Tools

Table 3 research findings provide tools for a new LMS such as the one proposed for the delivery of hydrogen training to the first responder community.

Course Tools	Collaboration Tools	Assessment Tools	Student/Management Tools
Content hub **Announcement** **Index/Homepage** **Calendar** **Syllabus generator** **Built-in HTML editor** **Auto-linking (text)** **Auto-embedding**	**Discussion Forum** **--better optimized by search, compile, time/date stamp, attachment, archive, moderator, and anonymous post features.**	**Multiple question types** **Hypermedia support** **Automated grading** **Automated and pre-programmable feedback** **Test bank creation**	**Grade viewing** **Student websites** **Content bookmarking** **Enrollment functions, including batch and individual uploads** **Student tracking** **Webpage tracking**

(media) **Context-sensitive help** **Content search** **Content upload**	**E-mail** **--built-in or e-mail interface systems** **Real-time chat** **--better optimized by archive, multiple room, private messaging, AV, browsers, and whiteboard features.**	**Randomized testing** **Surveying and statistical extrapolation** **Offline testing** **Grade changes** **Restrictions (timed, password protected, multiple attempts, availability)** **Online grade book**	**Read and unread message or submission alerts** **Annotation capability** **Change profile** **Link to offline content or CD-ROM**

Design of Course

Courseware Development Requirements
(Refer to Appendix A for further information)

The contract agreement between IAFC and PHMSA states that the initial course offerings in the proposed distance learning training system will focus on hydrogen and hydrogen fuel cell technologies. Competency within the hydrogen subject matter will be based on The NFPA®'s *Standard 472: Professional Competence of Responders to Hazardous Materials Incidents*. Course content will support hydrogen training at the awareness level and provide an interactive, engaging learning environment based on adult learning principles for the first responder community.

Table 4. Critical Principles for the Design of Web-based Training

Findings from a qualitative study (Williams, 2002) of national adult education experts to determine what adult learning principles are critical for the effective design of web-based training and instruction.

	Constructivist Web-based Training Design Principles
1	The adult educator must access the learner's objective for learning before beginning to design a web-based course.
2	Training/instructional objectives must be based on the goals or a desired competency output of the learner.
3	Training/instructional modules should be designed based on the background, such as demographics and learning styles, of the learners.
4	Training/instructional modules should be designed based on the participants' personal or professional goals for training.
5	Training/instructional modules should be designed based on content for web-based training so that it is meaningful and relevant to the learner.
6	Learners should be allowed to participate in the development of criteria for evaluating their performance.
7	Learners' current knowledge and understanding of the content should be tested before they begin the web-based course.
8	Learners should be allowed to customize the web-based training/instructional material based on their current knowledge and understanding of the subject.
9	The web-based training/instruction should be adapted to the learner's current level of experience and skill.
10	The learner's current expectations, needs, and previous experience should be assessed as it relates to the current training/instructional material.
11	The learners should be allowed to diagnose the gaps between their goals and their present level of performance.
12	Learning activities should be designed for web-based training/instruction based on the prior experiences of the learners.
13	The content of the web-based training/instruction should be related to the concerns of the organization.
14	Web-based training/instruction should be designed so that learners can share work or personal experiences.
15	Aids should be included in the web-based training/instruction that help the learner relate new material to current knowledge and prior experiences.
16	During the design of the web-based training, potential problems the learner may have with the material

	should be anticipated and include activities to help with these anticipated problems.
17	The instructional designer should provide relevant examples and activities to help the learner understand the material.
18	Web-based training/instructional activities should be designed that are directly associated to and relevant to content.
19	Web-based training/instructional activities should be designed that allow learners to be self-directed.
20	Web-based training/instructional activities should be designed that are accompanied by resources and guides.
21	Graphics, examples, cases, and analogies should be included in the web-based training/instruction to make ideas easier to understand.
22	Graphics, examples, cases, and analogies used in web-based training/instruction must be relevant and realistic to the learner.
23	Activities and experiences must be designed such that the learner has the opportunity to explore goals and expectations.
24	Feedback, both positive and negative, must be integrated into the learning activities.
25	Feedback on objectives must be provided to the learners as a part of the training/instruction.
26	Web-based training/instruction should be designed to include checkpoints with questions, problems or activities to ensure that the learner was able to follow and understand the content.
27	Web-based training/instruction should be designed using a variety of methods to provide a way for learners to comprehend what has been taught; if it was not initially clear.
28	Web-based training/instruction should be designed so that one idea is presented at a time in order to aid comprehension.
29	Web-based training/instruction should be designed so that there are frequent summaries to facilitate retention and recall of information.
30	The life stages of adults should be taken into account when designing web-based training/instruction for adults.
31	Web-based training/instruction should be designed to allow for viewpoints from people in different life stages with different values.
32	Web-based training/instruction should be designed to allow for sharing of interpretation of information.
33	The content in web-based training/instruction should be designed to appeal to more than one developmental life stage.
34	Web-based training/instruction should be designed to include on the job post-testing.
35	Web-based training/instruction should be designed to allow for interactions, both learner with learners, as well as instructor with learners, during training/instruction that focuses on using the new knowledge or skills back on the job.
36	Web-based training/instruction should be designed to include instructional strategies, such as simulations and role play that reflect the real world work environment.

In developing and delivering instructional content, e-Learning research discusses the need to use multiple learning strategies that accommodate individual differences and learning styles (Anderson, 2008; Cassidy, 2004; Tallent-Runnels, et. al, 2006). The term “style” has different connotations in different contexts, but the concept is always associated with individuality and individual activity or behavior (Rayner & Riding, 1997).

A notable number of studies have linked learning styles and e-Learning. Gee (1990) studied the impact of students’ preferred learning style on learning and attitude towards distance education. The study showed distance education students preferred an independent learning environment. According to a study by Simpson & Du (2004), learning styles had effects on student’s online participation and enjoyment levels of online courses. Similarly, Lu, et. al (2007) found that the Kolb learning style had significant effect on online learning behaviors and outcomes. They recommend designing course modules that accommodate different learning styles.

Given the range of learning styles, choosing the right model and its associated measure remains a challenge for online course developers. As Cassidy (2004) notes, these theories or models are simplifications of a complex learning process. But there is also a risk of oversimplifying the learning activity by compartmentalizing learners within certain parameters of personality types or styles. In addition, the contextual, cultural and other learner heterogeneity can make these models volatile. Web tools such as blogs, wikis, podcasts and forums are some of the adaptive techniques that can used to reduce these complexities. These activities are also examples of application of learning spaces principle in an e-Learning

environment. Finally, in addition to considering learner differences while developing courses, we need to be aware of teacher's philosophical orientation.

As we move into selecting web tools during the design phase, there is consideration for how to develop the levels of interaction within a course. There are four levels identified: Learner to Learner, Learner to Content, Learner to Instructor and Learner to Technology (Hillman, Willis, & Gunawardena (1994); Moore (1989)). All of these levels need to be addressed during the course design and there are a number of different e-Learning choices for establishing interactivity. Two distinct types of interaction are asynchronous and synchronous. Brown (2000) defines asynchronous as interaction in which students and teachers "engage in collaborative learning" without being online at the same time. On the other hand, synchronous entails a "real-time electronic interchange" by utilizing internet technology with a live instructor and moderator who facilitates the live presentation of information and the interaction of learners who are remotely located.

In terms of selecting which interactive tools to use for learner-learner and learner-instructor, striking a balance is the best approach. Both chat rooms/conferencing and discussion boards/e-mails have appeals and can engage different learners. Asynchronous interactive methods allow flexibility for the learner, but also require a reasonable timeframe in which the interaction must be conducted. Synchronous chats can allow for real-time exchange, but the time for deeper reflection may be missed without additional forms of interaction. Having the capabilities and measures to include both asynchronous and synchronous interaction can reach an audience as large as volunteer firefighters. Giving them flexibility to complete a large portion of the course can accommodate their time-strapped schedules and make them more willing to participate. On the other hand, also having opportunities to interact live with instructors and peers can increase learner connectivity and can be an engaging feature that supplements the course content. **Recommendation – A blended learning approach will accommodate both important types of interaction: synchronous and asynchronous.**

Instructional Goals for Adults in Online Learning

Research findings show that the focus of any future online learning endeavors, as pointed out in discussions with the directors, is the volunteer first responder, or the learner. The flexibility of time, place, and programs offered via web-based training is appealing to learners who are trying to balance training and education with work and home responsibilities. (Brown, 2000)

A researcher from Oklahoma State University (Ausburn, 2004) convened a group of adult students from diverse workplaces, aged from early-30s to mid-50s. The students were enrolled in blended courses that combined periodic class meetings with teacher-facilitated, self-directed study and collaborative work through a web-based course platform. Ausburn studied the group as they completed the courses and identified the instructional features they deemed to be the most important:

- Expectations of adults for personal relevance in what they learn
- Participation in setting their learning outcomes based on their real-world needs
- Self-direction of their learning resources and pathways
- Establishment of an active learning community

Ausburn presented the students with a list of 15 instructional goals. He asked them to choose the five they viewed as most important to them personally and to rank their selections according to how critical they were to the students' success in a distance-learning environment.

Table 5. Instructional Goals in Online Learning

The 15 instructional goals in order of the students' deemed importance.

Rank	Course Instructional Goal

1	Provide options for individualization/customization of learning
2	Facilitate self-directed learning
3	Provide variety in learning activities and assignments
4	Encourage and enable active communication and interaction among learners
5	Provide effective 2-way communication between learners and instructor
6	Provide opportunities for learners to expand their technology skills
7	Provide an introduction to the course and establish clear expectations
8	Provide worthwhile learning experiences in “live” meetings
9	Provide an anchor or “home base” for the course
10	Provide access to sufficient and relevant course content
11	Give learners a sense of “belonging” and involvement
12	Encourage and facilitate active and participatory learning
13	Give learners fast and effective technology and content assistance when requested
14	Give learners adequate feedback to enable them to evaluate and track performance
15	Provide adequate guidance and structure to keep learners focused and on-task

In other findings, a researcher studied a similar group of workers, and found that participants frequently returned to the courses after their official completion date to refresh their memories or answer questions that arose as part of their work responsibilities. (Dobrovolny, 2006) In other words, their learning continued after they completed the official training. Any online learning program should facilitate this kind of continuing education. One way is to allow the participants to print individual sections or an entire course to be used as personalized job aids. Other strategies to help adults continue learning after they finish their official training include providing the names and contact information of mentors or experts, a list of frequently asked questions and answers, and browsing and comprehensive search capabilities within the online training materials.

Model System

A recent study of e-Learning executives (e.g., chief learning officers, senior vice presidents, and vice presidents of learning whose responsibilities include the design and delivery of online training programs) found that the lack of a “strong,” “robust,” “reliable” platform was the reason for an e-Learning program to either fail or have significant problems during roll-out. (Armstrong 2008) The meetings with the state training directors revealed that no training system currently exists that is capable of the robust features and functions explained in this paper.

Findings from research of existing distance learning training systems point to the Defense Acquisition University (DAU) as a mature and successful online learning system to model. The DAU (2009) touches nearly every member of the DOD Acquisition, Technology, and Logistics workforce at all professional levels. Findings show the following benefits of the DAU model:

- It provides a full range of basic, intermediate and advanced certification training that goes beyond minimal requirements for certification; mission assistance; job-relevant applied research; and continuous learning opportunities.
- It is designed to give the user an affordable and flexible system while instituting role-based logic.
- In 2008, the DAU LMS supported more than 7.6 million hours of learning.
- The system has a filtering and security system to maintain data integrity for both administrators and end users. The design is based on the Unified Modeling Language design structure.
- It provides a vocabulary and rules for better communication at the design and maintenance phases of the project.

- This design is heavily laden with documentation and tools that provide designers, maintainers, administrators, and users with information to assist them in communicating and understanding the system and its functionality.
- It uses the latest techniques and technologies available. This system is designed using a J2EE architecture that includes using Java, JSP, EJB, and XML.

The system is designed to be modular, meaning it is based on functional modules that can be interchanged. This interchangeability allows organizations to tailor training to their unique requirements. These modules include user management, enrollment, course handler (SCORM and OSS), course management, test management, report management, collaboration tools, help desk, external interfaces, mobile course launching, security, system utilities and financial management. This modular approach provides a "plug-and-play" mentality and makes the integration of commercial-off-the-shelf products easier and less costly for clients. The biggest strength of this methodology is easy replacement of components as technology and requirements change.

The DAU approach is to design a highly flexible system. This flexibility is illustrated by open architecture that makes it easily deployable on any type of production environment, in terms of both hardware and application/web server software.

The functionality of this LMS highlights flexibility, ease of use, and a cost effective solution to deploy and manage training for any organization.

Barriers *- Drivers to Success*

The findings explain that causes, barriers, and obstacles are all synonymous with performance drivers, which are the factors that now block or aid performance, or may do so in the future. Rossett (1999) names the typical drivers of skills (knowledge and information), motivation, incentives, tools (environment) and work processes. During the meetings, the state training directors discussed candidly the drivers to distance learning opportunities in the first responder community, particularly for hydrogen.

Table 6. Drivers to Distance Learning Success

Highlights of the discussions with the state training directors and hazmat team leaders on drivers.

Type of Driver	Examples of drivers Provided by State Training Directors
Skills	**Computer literacy**
Knowledge	**Digital divide**
Information	**Change management is needed for using new technologies and Internet**
	See a lot of hydrogen commercially used in annealing of metals, working with plants. However there is limited knowledge. Would benefit from awareness on the topic of hydrogen.
	Still need to learn more about the topic to be prepared for responding to hydrogen incidents. Whether it's a problem today or five years from now is hard to say, but it is something to be knowledgeable about and prepared for.
	A disconnect exists between online training and the hands-on skill requirements of the job (for example, responders who are certified in a number of levels but have never run a call).

Motivation	**The chief does not stay chief for long – transition often occurs and a department needs to have buy-in from the top; otherwise, it won't be a priority.** **Common agreement exists that the hands-on component of training cannot be lost.** **Need to identify incentives within members departments – what does the student get in return for his/her investment of time?** **Sending out instructors can be cheaper than paying for online courses.** **Volunteer first responders have not much, if any, exposure to hydrogen.** **The cost of systems, hardware and maintenance can be problematic.** **Often training is defensive (reactive rather than proactive).** **Responders seek hydrogen training on their own. (It is a new and interesting topic for them.)**
Incentives	**Certification is not universal among the states.** **The Hazardous Materials Emergency Preparedness grant program provides financial and technical assistance to enhance State, Territorial, Tribal, and local hazardous materials emergency planning and training.** **The user determines the speed and modules to go through; otherwise, he or she does not feel appreciated.** **Design the course, and they will use it. State training staff is more time-constrained and bare-bones than ever and will be accepting of any help. Current state budget restrictions are not allowing any new curriculum development.**
Tools and Environment	**Internet bandwidth is required.** **Access to the internet can be problematic, especially in rural areas. The training should also be made available in other formats.** **Some states' online systems have restrictions on usage, such as only being available to state employees, which can cut off volunteer responders. Departments need a training system that is secure yet accessible to all the people who would need to use the information.** **Generational differences exist.** **High turnover and attrition rates can be problematic.** **The organizational culture may be rooted in traditional learning methods.** **Integrity and accuracy are required. Departments must be able to ensure that students getting or earning credit for taking the course are actually the students doing the online work.** **No centralized training system or comprehensive curriculum for online hazmat training exists.**
Work Processes	**Curriculum standards and competencies are not defined.** **No time exists for volunteer first responders to participate in online learning.** **The availability of firefighters is a concern. Volunteers have limited availability: evening hours during the week and on the weekends.** **Departments will need to supplement online training with hands-on training (skills) for operations-level and incident command hazmat learning.**

Drivers, as described earlier, block or aid performance. To provide direction and set the course for a new effort, Rossett (1999) suggests a study of the optimals. Actuals determine the current state and optimals determine what could be, and what needs to be done to get there. Optimals are features that bring to light the specifics of what is to be learned and done and the conditions under which it all takes place.

Table 7. Optimal Training System and Design Features

The state training directors' optimals for training system features, as well as optimals for training design features.

Optimal System Features Proposed by State Training Directors	
Allow students to complete the course around their schedule	Bookmarking
Accessible to all who need it	Support 24/7 that can help students*

Let the student choose the module	One vendor for maintenance
Ability to preview or browse courses	Verification of identity
Contemporary system	Large testing bank
Keep it simple	Sharable Content Object Reference Model (SCORM)
Instructor has ability to access the system and monitor the students	Require account with a password
Web 2.0*	Mobile learning*
Reliability	Complement existing training systems that are out there
Optimal Design Features Proposed by State Training Directors	
Contain embedded videos	Built around certification
Current, topical and engaging	Serve different learning styles
Assessment	Universal branding
Performance-based	Blended approach
Passion from instructor	Authentic
Human element	Engage the user
Up-to-date courseware	Free training
Aligned with continuing education	No long videos
Awareness-level content	Standardize training terms
IT skills training	Link to national training
Create lesson plans and instructor notes	Develop as an online and instructor-led training
Interaction with instructor	Involve hazmat experts
Section 508	Learner control
Interactive games and activities	Podcasts*
Stories, cases and experiences to relate to the subject matter	Interactive scenarios
3-4 hours max duration	Feedback for students
Prerequisites	Offer reward for completion
Change management	

* Represents features to be considered in spirals after initial pilot.

VI. Conclusions and Recommendations

A look back at the original questions to focus this research; conclusions can be made based on the findings.

- Findings point out that the baseline responder knowledge of hydrogen and hydrogen fuel cell technologies throughout all five PHMSA regions is minimal at best. In rural areas particularly, volunteer first responders are underserved in this type of training.

- Findings confirm that the few first responders who currently have access to training on hydrogen and hydrogen fuel cell technology receive it in an online or blended learning format.

- Findings establish that gaps exist between actual and optimal responder knowledge of and access to hydrogen and hydrogen technologies needed to keep communities safe.

- Findings substantiate that available online and distance learning strategies and systems have a positive effect on adult learning by way of improved learning outcomes, reduction in cost to train, and convenient time to participate in training activities.

- Findings prove that a hazardous materials distance learning program should not piggyback on an existing system. Though some resources exist, none support the feature and function of what a robust distance learning training system as described should have.

Therefore, the following tasks are recommendations for subsequent development of a distance learning training system for the volunteer first responder community in the fire service:

- Put into practice a framework of eSUCCESS around the project to ensure victory throughout development.
- Leverage critical partnerships with federal, state, local and industry stakeholders on the development of the training system and training curriculum.

- Implement a spiral model development philosophy to allow the system to grow over time as needs and resources increase.
- View future development as two distinct tasks: distance learning training system development and hydrogen courseware development.
- Consider the Open Source market for a new learning management system (LMS) solution.
- Set high standards for courseware design that support learner engagement, asynchronous and synchronous collaboration, interactivity, multi-media and adult learning principles based on the findings in the Phase One research.
- Set high standards for system design that support tools, collaboration, tracking and scalable technology infrastructure based on the findings in the Phase One research.
- Adhere to federal standards for development of information technology (SCORM, Section 508).

Through IAFC's Volunteer and Combination Officer Section (VCOS) and IAFC's National Hazardous Materials Fusion Center, along with partnering with other important organizations, IAFC will be able to reach the targeted population to provide this much needed training.

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Appendices List

Appendix A – Literature Review: Engaging Resource-Strapped Volunteers in Training

This journal review focuses on literature that provides guidance on how to keep learners engaged in an online training system, with a focus within the context of training for volunteer firefighters. The review covers the different approaches and techniques that can be used within online learning so that a variety of learning preferences are taken into account. Reviewing literature on training and learning can help when determining a framework for a system and can be considered along with research findings in the report.

Appendix B – Analytic Report on Hydrogen Fuels Training Available

Part of Phase I for this project called for the available hydrogen training to be identified, which is the purpose of this report. An introduction from subject matter expert, Kirk Rosenhan explains the significance of hydrogen and a summary of current available hydrogen training programs follows. This outlines part of the research effort in Phase I that seeks to identify available resources so as not to duplicate efforts.

Appendix C – RFI Response Table

This table outlines the 41 responses to the IAFC's Request for Information (RFI) in terms of the RFI criteria. It is a brief summary of the responses so that they can be compared, and a comment section is made available to provide additional information.

Appendix D - Regional Meetings Instrument

Identifies the questions used at the Regional Meetings in an effort to engage the state training directors and hazmat team leaders in conversation about current and future training.

Appendix E – Regional Meeting Notes

These are a compilation of notes taken at the five Regional Meetings and the two WebEx Seminars. The notes document comments and discussions from state hazmat team leaders and state training directors as both online training and hydrogen training were addressed. The meetings followed discussion points that had been sent out to attendees earlier, and these notes are also available on the National Hazardous Materials Fusion Center website (www.hazmatfc.com) under the Resources section.

Appendix F – A Concept for a Comprehensive First Responder Training System

Northrop Grumman prepared this white paper for the IAFC prior to an October 14, 2009 meeting between Northrop Grumman and project staff. The white paper provides information on available training systems through a company like Northrop Grumman, with particular attention to online training.

Appendix G - NFPA 472 for Hydrogen Competency Mapping

This is important for understanding the direction of the project and what would need to be included in a training. As indicated throughout the report, the NFPA 472 standard is critical to the success and acceptance of any hazmat training.

Appendix H – Final Competency Matrix

This is a summary of findings in Appendix G

Appendix I – NFPA 472 Impact on H2 Project

From the beginning of the research it was apparent that any hydrogen training would need to follow the NFPA 472 standard. This was our first analysis on NFPA 472 to understand the impact on the project.

Appendix A

Literature Review: Engaging Resource-Strapped Volunteers in Training

Literature Review: Engaging Resource-Strapped Volunteers in Training

Prepared By Jennifer Dietz and Dr. Larry Dooley

Training is an integral part of preparing firefighters for the scenarios they will encounter as first responders. One particular population in the fire service--volunteer firefighters--faces time constraints and a lack of available funding that drastically limits access to training. To address the schedule limitations for volunteer firefighters, distance learning is often explored. Within the realm of distance learning, a web-based training system that utilizes e-Learning can create an opportunity to reach volunteer firefighters dispersed across the country who face an array of time constraints.

It is not enough to present web-based training as a solution to the training barriers facing volunteer firefighters, because extensive planning and thought must go into building a training system that works. During the design phase, it is imperative that the appropriate methods and tools are selected with the intention of keeping students active and engaged in the training. This requires a thorough design that assigns meaningful purpose to the training itself. The opportunities available in e-Learning offer a number of ways to engage the diverse range of learning styles that can be found in a group as large as the nation's volunteer firefighters.

I. Volunteer Firefighters

Volunteer firefighters are a significant portion of the fire service, as volunteers make up a majority of the firefighters in the country. In 2008, there were 1,148,850 firefighters in the United States, of which 827,150, or 72%, were volunteers (Karter & Stein, 2009). Career and volunteer firefighters can work together and form combination departments. Of the estimated 30,170 fire departments in the United States in 2008, 2,315 departments were all career, 6,620 were combination, and the remaining 21,235 were all volunteer (Karter & Stein, 2009). This indicates a considerable number of volunteers working in this country, and underscores the potential danger in not providing ample training opportunities for this population.

While career firefighters are differentiated by salary and benefits, this does not minimize the importance of thousands of volunteer firefighters serving as first responders across the country. Most (94%) of volunteer departments serve fewer than 25,000 people (Karter & Stein, 2009).

Furthermore, there is a potential danger in not providing ample training opportunities to this population. According to the National Fire Protection Association (NFPA), an estimated 233,000 firefighters, with most being volunteers serving rural communities, are involved in firefighting without having sufficient or formal training in that capacity (National Volunteer Fire Council, 2010). Training is vital to the first responder, as it helps to reinforce proper techniques and practices, and leads to better decision making on the job (NVFC, 2010). Firefighters not only require initial training, but refresher courses to ensure that training is current and to introduce any updates or trends that members of the fire service may require. There are numerous potential dangers in not providing ample training opportunities to firefighters, whether they are volunteer or career.

A number of potential obstacles can complicate volunteer firefighter training. They often must balance their career and family life, creating a strained schedule. Most volunteer firefighters also have full-time jobs outside of the fire service, leaving inopportune times for

training, such as nights and weekends (NVFC, 2010). The cost of training is another barrier for volunteer firefighters, but the economic downturn has applied additional restraints on career departments as well, which is reducing funding budgets associated with training (travel, tuition or instructor fees). In a time of downsizing or a depressed economy, training budgets are usually the first to be affected.

II. Distance Learning

Distance learning has historically been a way to accommodate individuals who cannot physically attend face-to-face (f2f) classroom instruction. The literature is mixed on the use of the terms "distance education" and "distance learning," so the terms will be used interchangeably. A broad definition of distance education is a learning approach where the student and instructor are physically separated (Guri-Rosenblit, 2005). The methods used to deliver distance education have evolved over time, but the basic goal of providing effective learning opportunities to "specific clienteles" who cannot attend f2f meetings has remained constant (Garrison & Anderson, 2002). Most learners enrolled in distance education courses have occupational, social or family commitments that impede their ability to physically attend traditional classes. (Dabbagh, 2007). These characteristics are consistent with the schedule constraints facing volunteer firefighters. It is therefore important to better understand the different methods distance education has used to reach this "specific clientele."

Distance learning is credited with a long history that dates back to the early nineteenth century. The pioneering days of this learning approach involved handwritten correspondence through the mail, proving that distance is no recent phenomenon (Guri-Rosenblit, 2009). The inventions of the radio and television presented new opportunities in distance education and brought along the "Modern Era" (Moore, 2003) of technological advancements, a precursor for later developments.

Utilizing the Internet as a medium to deliver distance learning emerged in the 1990s, but as this medium continues to grow and expand, so does its role in distance learning. Online "Virtual Universities" now offer higher education courses, allowing traditional universities to reach out to groups who would not be able to enroll in on-campus courses (Moore, 2003). This profitable opportunity has also evolved in the corporate sector as a means to meet training needs for workers (Brown, 2000).

An early definition by Michael Moore put it this way: "Distance learning is any learning situation where learners are separated by distance and technology is used to bridge the gap". For the sake of this analysis, the focus will be on online distance learning, yet even within this medium a range of capabilities are available. The tools to keep learners engaged through an online distance education program will be considered in regard to providing training to volunteer firefighters.

It is important to note that the very existence of the first response community is to respond to incidents with a hands-on approach. As such, web-based distance learning is not intended to completely replace the hands-on training, but to enhance it.

III. Web Based Training

A great deal of literature focuses on online distance learning in educational settings, whether it be individual online courses offered at a university, or an actual "Virtual University" like the University of Phoenix Online (Moore, 2003). However, web-based distance learning can be utilized outside the educational realm, as the corporate sector has discovered online learning

features applicable for training purposes. Web-based training (WBT) has been utilized by private businesses, like MCI WorldCom, which cited it as a way to achieve greater efficiency by saving training costs (travel, labor) as well as reaching a higher operational capacity, in turn creating an economy of scale (Greengard, 1999). WBT provides an online distance learning option for a wider audience than the academic world, and can be used to reach populations like volunteer firefighters.

Not only does WBT present a potential to generate economies of scale, but it can help cater to the niche of volunteer firefighters by providing flexibility in completing the training, not only in terms of when the training occurs, but also where.

> *Online learning, as a subset of all distance education, has always been concerned with providing access to educational experience that is at least more flexible in time and in space than campus based education.*
>
> (Anderson, 2004, p 41)

To achieve this flexibility, online training allows users to access courses from personal computers, and has an accommodating timeframe for completing the training. WBT that is designed to be regularly updated also enhances the training experience. Continually updated WBT creates an opportunity for an individual to learn and relearn important training materials according to the terms of his or her own schedule (Brown, 2000).

The National Volunteer Fire Council's (NVFC) 2010 "*White Paper on Volunteer Firefighter Training*" indicates that online learning presents an opportunity for training volunteers.

> *Over the past decade, distance learning tools in the form of online course offerings have become important mechanisms for delivering training to volunteer fire departments. Through online courses, a large portion of the material that in the past was only disseminated in a classroom setting can be accessed by volunteer firefighters at their departments or even in the comfort of their homes. Online courses allow volunteer firefighters to train in their spare time and reduce the need for travel.*
>
> *(National Volunteer Fire Council, 2010, p 4)*

However, no matter how efficient and flexible a WBT system is, its success will largely depend on its instructional design, making the design phase a critical determinant of the outcomes of this training. Within a training system are a number of elements that must be included during the design phase to ensure that this system is not only accessible to its target audience of volunteer firefighters, but that it engages its audience so the training is useful.

IV. Instructional Design: The Constructivist Learning Approach

In any instructional initiative, the quality of the program design is the primary factor in determining the educational outcomes (Johnson & Aragon, 2002). A key component of the design phase lies in selecting an appropriate learning approach, which should be determined by the intended purpose of the training and the desired outcomes.

Considering that first responders encounter taxing and straining (physically and mentally) tasks in the field, the preparation provided in training is critical. Given the job demands, it is imperative the training be active and engaging so that information is understood rather than simply retained. If students have a deeper understanding of material, they are better

prepared for hands-on components of training and the situations that will be encountered in the field. Since a successful training system requires active learning, what approach is most suitable for WBT for the first responder community? Two commonly discussed learning approaches are constructivism and behaviorism, as well as didacticism as an instructional style.

> *Constructivism is a philosophy of learning founded on the premise that, by reflecting on our experiences, we construct our own understanding of the world we live in. Each of us generates our own "rules" and "mental models," which we use to make sense of our experiences. Learning, therefore, is simply the process of adjusting our mental models to accommodate new experiences. We use constructivism widely in training adults whether it be f2f or in an online training*
>
> *(Linger, Fisher, Wojtkowski, et al, 2004, p. 382).*

Behaviorism on the other hand, essentially says that for every action, there is really only one reaction that is correct. This type of instruction is usually taught in the early years of school where there is only one answer and we were taught to not "draw outside the lines". It also does not want us to "think" of the answer but to "respond" with the correct answer. This is particularly the type of training for technical training such as training electricians.

Didacticism as an instructional style emphasizes learning through direct instruction, and courses relying on this approach are predominantly lecture based, with the instructor taking the active role (Veenman, Denessen, Van De Oord, & Naafs, 2003). On the other hand, the constructivist perspective believes learning occurs largely along the lines of personal beliefs, motivations and conceptions that the learner attaches to the subject matter (Holmes & Leitzel, 1993). Thus, the constructivist approach advocates learners being active in the process, and the instructor shifts to more of a facilitator role.

These approaches are drastically different, with constructivism being widely advocated due to the fact that through it students will actively build knowledge and skills as part of their cognitive development rather than recognizing information in an external environment (Bruner, 1990). Within the realm of Web-based learning, it is better to require students to "construct" meaning rather than simply regurgitate or repeat information (Brown, 2000). The hands-on and life-or-death nature of firefighter duties truly indicate that learning by being active and drawing upon personal experiences is a necessity, and therefore point to the constructivist approach as the model learning method for this particular group as well.

To best incorporate the constructivist learning approach, a course or training system must be designed along the target audience's existing knowledge (Pang, 2009). This requires not only an understanding of the baseline level of knowledge from which a student can build, but also designing the course so the constructs are relevant and relatable for the learner. The course content is designed so the knowledge is linked to both the subject matter being studied as well as the experiences learners associate with the content (Williams, 2002). This provides flexibility to fit a range of personal or cultural values, and can suit varying learning styles (Bellefeuille, Martin, & Buck, 2005).

Even though the literature heavily promotes the constructivist approach, there are arguments for including some behaviorist and didactic elements. Many adults who have become accustomed to the instructional, heavily didactic teaching approaches in turn become "passive" learners (Akerlind & Trevitt, 1995). To avoid this potential problem, it is best for the constructivist approach to be explained and incrementally introduced throughout the course, while didactic activities are phased out. This allows adult learners to become more comfortable with constructive learning (Macdonald, Bullen & Kozak, 2007).

Following the constructivist approach creates an active environment for learners and can create a more meaningful learning experience so learners feel engaged in the training. For first

responders, being able to connect study materials to experiences makes the content more relatable and enhances the ability to remember and reconnect the lesson back to experiences in the field. Yet it is also important to accommodate those accustomed to other instructional approaches so that didactic learners are eased into the training and more likely to be engaged, rather than had they been completely immersed into a new learning approach. Thus there needs to be balance in the design of the course so a WBT that utilizes constructivism also has didactic elements.

V. Pedagogy versus Andragogy: Nature of Adults in Online Learning

Pedagogy is derived from the Greek words paid, meaning "child", and agogus, meaning "leader of." Thus, pedagogy literally means the art and science of teaching children. This is really nothing more than a set of assumptions about teaching and learning, but it was based in the schools and it was all we had. Therefore, until recently, even adults were taught as if they were children. The pedagogical model assigns the teacher the full responsibility for making all decisions on what is to be learned, how it is to be learned, when it will be learned and IF it is learned. It is teacher directed, or as I like to say, it is in the model of "show and tell; sit and get!"

Malcolm Knowles (1913-1997) developed Andragogy to be the model for adult learning, and created the following set of assumptions:

1. *The need to know*. Adults need to know why they need to learn something before undertaking to learn it. Tough (1979) found that when adults undertake to learn something on their own, they will invest considerable time and energy in probing the benefits they will gain from learning it.
2. *The learners' self-concept*. Adults have a self-concept of being responsible for their own decisions. They want to be seen as being capable of self-direction and resent and resist situations in which they feel others are imposing their wills on them. As adult educators become aware of this, they make
3. *The role of the learners' experiences*. Adults come into an educational activity with both a greater volume and a different quality of experience than that of youths. Any situation in which the trainees' experiences are ignored or devalued will cause the adult student to perceive this as rejecting not only their experience, but rejecting them as a person.
4. *Readiness to learn*. Adults become ready to learn those things they need to know and do to effectively cope with their real-life situations.
5. *Orientation to learnin*g. In contrast to children's and youths' subject-centered orientation to learning, adults are life-centered (or task- or problem-centered). Adults are motivated to learn to the extent they perceive that

learning will help them perform tasks or deal with problems they confront in their life situations.

6. *Motivation*. While adults are responsive to some external motivators, the most potent motivators are internal forces.

(Knowles, Holton & Swanson, 1998, p 64-65)

As you can see, although some have referred to andragogy as the adult learning theory, it is not a theory but a set of assumptions similar to pedagogy, which is also a set of assumptions related to the education of children. It is critical, however, as we develop any training program for adults, that the principles of andragogy are considered.

VI. Learning Styles

In developing and delivering instructional content, e-Learning research discusses the need to use multiple learning strategies that accommodate individual differences and learning styles (Anderson, 2004; Cassidy, 2004; Tallent-Runnels, et. al, 2006). The term "style" has different connotations in different contexts, but the concept is always associated with individuality and individual activity or behavior (Rayner & Riding, 1997). There are a lot of learning style theories, models and instruments, many of which have not been tested for reliability and validity (Cassidy, 2004; Curry, 1987). In e-Learning literature, commonly used learning style theories can be broadly categorized into process-based learning styles (for e.g., Kolb, 1984 and Honey & Mumford, 1992), and personality-based learning styles (for e.g., Myers, 1978 and Keirsey & Bates, 1984). Kolb's (1984) widely acclaimed learning style model is based on experiential learning theory that defines learning as a process of knowledge creation (perceiving) through transformation of experiences (processing). Kolb theorizes it as a four-stage process that includes concrete experience, reflective observation, abstract conceptualization, and active experimentation. Theoretical and empirical explorations have further enhanced the experiential learning theory and the original four learning styles – assimilating, converging, accommodating and diverging, into nine distinct styles (Hunt 1987). Recently Kolb and Kolb (2005) added the concept of learning spaces to this theory, which emphasizes that "learning is not one universal process but a map of learning territories, a frame of reference within which many different ways of learning can flourish and interrelate" (p. 200). Use of these learning style theories in educational practices and research is debated, but widely accepted and applied. In general, theoretical formulations are important for educators because they facilitate coherent frameworks and provide broader perspectives (Anderson, 2004; Cassidy, 2004; Freedman & Stumpf, 1980).

A notable number of studies have linked learning styles and e-Learning. Gee (1990) studied the impact of students' preferred learning styles on learning and attitude towards distance education. The study showed distance education students preferred an independent learning environment. According to a study by Simpson & Du (2004), learning styles had effects on students' online participation and enjoyment levels of online courses. Similarly, Lu, et. al (2007) found that the Kolb learning style had a significant effect on online learning behaviors and outcomes. They recommend designing course modules that accommodate different learning styles. Despite these proven links between learning styles and e-Learning, there have also been few studies that showed no effect or no significant impact of learning styles on e-Learning. For example, Bernner's (1997) study of community college students showed learning styles had no impact on student's success in online education. Diaz and Cartnal (1999) also

noted that activities used in f2f classes can be equally effective in online courses if the learning styles are not significantly different between these two groups. Other studies have shown a similar lack of links between learning styles and learning outcomes, learning effectiveness or student grades (Aragon, Johnson, & Shaik, 2000; Neuhauser, 2002; Rovai & Grooms, 2004).

Critique of learning styles also includes difficulties in the implementation and application of learning styles to learning strategies (Cassidy, 2004; Rayner & Riding, 1997). Many instruments have been developed based on learning style theories and models that help identify individual learning styles. The two widely distributed instruments are Learning Style Inventory (LSI) (Kolb, 1987) and Myers-Briggs Type Indicator (MBTI) (Myers, 1978) which are process-based and personality-based learning styles, respectively. Other learning style instruments include Learning Modality Preference Inventory and Keirsey Temperament Inventory (Keirsey & Bates, 1984).

Given the range of learning style theories, models and instruments, and mixed research results on their effectiveness in learning process, choosing the right model and its associated measure remains a challenge for online course developers. As Cassidy (2004) notes, these theories or models are simplifications of a complex learning process. But there is also a risk of over simplifying the learning activity by compartmentalizing learners within certain parameters of personality types or styles. In addition, the contextual, cultural and other learner heterogeneity can make these models volatile. Use of web tools such as blogs, wikis, podcast and forums are some of the adaptive techniques that can used to reduce these complexities. These activities are also examples of application of learning spaces principles in an e-Learning environment. Finally, in addition to considering learner differences while developing courses, we need to be aware of teachers' philosophical orientations.

VII. Applying Constructivism to WBT: e-Learning

Simply selecting a constructivist approach for WBT does not ensure active or engaged learners; rather it is how this theory is applied that determines whether or not the target population is drawn into the training. Constructivism provides an overarching theme and goals of creating active learners who draw upon personal experiences, but how that is achieved is largely determined by the tools and methods selected for a particular training course. The features available in WBT are made possible largely through e-Learning.

E-Learning refers to the use of electronic media for learning purposes, whether it be students in a traditional classroom setting who use computers along with face-to-face instruction, or students who are enrolled in web-based courses. Since e-Learning can occur regardless of any physical separation between a facilitator/instructor and learner, it cannot be used interchangeably with distance learning (Guri-Rosenblit, 2009). The two terms can overlap, however, since a WBT system needs to utilize the resources available in electronic media, making WBT a distance learning approach that employs e-Learning. Analyzing what e-Learning has to offer will allow us to determine the features and methods that can contribute to keeping learners engaged in WBT.

Information Delivery Methods

A key focus of course design lies in the information delivery method. It is not enough to simply state that WBT will use the Internet to deliver training, given that there are a realm of possibilities online. E-Learning presents a variety of approaches for information delivery that range from PowerPoint© slides to game-based simulation. It is recommended that information be presented in a variety of different modes to accommodate individual differences that may occur in learning styles and preferences (Ally, 2004). This follows the dual-coding theory, which

claims that information delivered in different modes is processed better than that offered in a single mode (Paivio, 1986). But what are the different modes available in WBT?

In an effort to mirror the utilization of textbooks in traditional coursework, a WBT system can operate on text-based delivery mode. A major text-based resource, PowerPoint©, allows for the incorporation of the didactic (visual) strategy as it has an instructional focus and follows a lecture-based approach. Other text-based resources can be found in HTML formats or PDF. A text-based approach can help address the dilemma discussed earlier, as some adult learners are accustomed to didactic instruction, and thus need didactic elements to ease them into WBT. A way to enhance engagement in a PowerPoint© format or other text-based learning is to create hyperlinks to additional and supporting outlets of information (Joliffe, Ritter, & Stevens, 2001).

Another way to deliver lecture-based material is with streaming audio, which is available in online distance learning. Audio was one of the earlier modes used in online learning, but it has reverted to more of a supplementary role (McGreal & Elliot, 2004). Audio can take a number of forms in a WBT, whether it is prerecorded lectures, interviews with subject matter experts (SMEs) or other guests, sound bites or clips related to the course subject. The option to include audio as part of the course increases the number of modes used to deliver information, and extends the reach through a medium that may better reinforce the material than if it had been provided simply through text. Another advantage of audio is that it requires a smaller bandwidth to deliver. Sometimes we forget the simpler means of course delivery, as more robust means are more popular (Dooley, Lindner & Dooley, 2005).

Video is another mode of information delivery. The visual stimulation that can come from incorporating video in an online course can alleviate boredom that often results from 'page-turning' in text based courses (McGreal & Elliot, 2004). Prepared lectures, video illustrating hands-on activities or clips of incidents/training simulations can all be presented in video format. Using video can enhance the WBT as long as these materials are all relevant to the course subject matter. Providing learners with visual resources allows them to actually see the material and create connections to personal experiences. This can especially help visual learners to better understand the material. It is important to keep in mind that video requires additional bandwidth, and the user may not have the same stream as the designer. Videos provided on a supplemental CD along with other course material can ensure accessibility to all users.

Graphics, whether still photos or diagrams, can also be used to emphasize critical details that are relevant to the course (McGreal & Elliot, 2004). Graphics in a course should have only one purpose: to deliver complex information in a way that is easier to visualize than words alone. Never use graphics to simply "dress up" a presentation (Dooley, Lindner & Dooley 2005). Animation can be used to create visuals of scenarios or simulations that may not be captured on video (train derailments and other incidents that first responders can encounter). Another use for animation can be supplementing technical explanations for topics like chemical properties and reactions. While both graphics and animation can drive a critical point home if used correctly, difficulties arise when they are used too often or simply for show, creating more of a distraction than a learning opportunity (McGreal & Elliot, 2004).

One information delivery mode that combines elements of both lecture and discussion is web whiteboarding. This is a form of graphic conferencing that simulates writing or drawing on a blackboard. Both the instructor and learner are active, as they can contribute by manipulating, reviewing and updating the graphical information found on this electronic whiteboard (McGreal & Elliot, 2004). Using this collaborative approach allows for real-time interaction as well as information delivery from instructors, creating an opportunity for brainstorming among participants. Other options include Smartboards® as well as software similar to gotomymeeting.com where instructors and students can share a document and make corrections in real time. Wikis and blogs are also used in this manner. This is an informative, interactive option in e-Learning, and its importance in WBT will be discussed at length.

A more recent development in e-Learning is the use of gaming as a tool to deliver training. Video games have become a popular activity for younger generations, and their widespread use has resulted in this younger demographic having a learning style that has been programmed to the speed and interactivity found in computer and video games (Prensky, 2005). The engaging nature of gaming and the familiarity younger age groups have with this approach offer a learning tool that contains "motivating elements not found together in any other medium" (Prensky, 2005).

Gaming options for first responders can allow for simulating incidents or scenarios, which can be video or animation based. Video creates a more realistic simulation, but animation allows the designer to have more flexibility and can create scenarios that may be difficult to capture in video, such as major incidents with mass casualties (Prensky, 2005). Another consideration in gaming is whether a game is based in real time, or has the capacity to pause and allow for reflection. Both have value in learning, but a game application that does not allow pausing is more realistic, as there is no pause button out in the field.

To engage as many potential learners as possible, it is imperative to consider all information delivery modes. Given the wide variety available, it may not be feasible to include every mode that has been mentioned, but consideration should be given to each, since they can work together to enhance the overall experience for the learner. By incorporating resources in different formats—including text, graphics, video, audio, simulations, and games—a WBT can reach out to a wide range of learning objectives and styles (Johnson, Trabelsi & Tin, 2004).

Interaction: Levels & Approaches

Interaction is a major component of learning and deserves extensive consideration when designing a WBT. Within an online distance learning system there are different levels of interaction. Moore (1989) developed a model for describing interactions used to engage learners in a distance education course. His model includes three types of interaction: 1) learner to learner, 2) learner to content and 3) learner to instructor. Hillman, Willis and Gunawardena (1994) expanded this model to include an additional type of interaction, learner to technology (the interface used). Moore (1989) stated that, "Educators need to organize programs to ensure maximum effectiveness of each type of interaction." (p.5). Fulford and Zhang (1993) stated that, "The critical predictor of satisfaction is the perception of overall or vicarious interaction." (p.17). Although each level has value that enhances the overall interactivity of a course, we will discuss two in this paper—learner to content, and learner to learner.

Learner to content refers to how the individual learner engages with the course material. In this level of interaction learners should be encouraged to apply, assess, analyze, synthesize, evaluate and reflect on what they learn from the course content (Berge, 2002). During learner-content interaction, the individual processes the information to transform it from short-term to long-term memory, therefore the higher the level of processing, the more associations are made in long-term memory, and higher-level learning is achieved (Ally, 2004). Utilizing text, audio, video and animation allows the information to be absorbed and understood in a variety of contexts that learners can use to draw upon personal experiences.

Learner to learner interaction pertains to the communication that can occur amongst peers enrolled in the same course. Learner-learner interaction is cited as an important component of constructivist learning, as working with others allows for personal experiences to be shared and learners to benefit from each other's strengths (Ally, 2004).

A third level arises from learner to instructor, or student to teacher, which is just as important as the first two types of interaction. This level of interaction allows the instructor to provide feedback to the learner and therefore enhance understanding by responding to the learner's application of the knowledge (Moore, 1993).

Learner to technology refers to how the learner interacts with the information delivery method of a course. Familiarity with technologies will impact the learner's ability to absorb and

understand how the course content presented. This level of interaction varies depending on the type of technology utilized in a course and how accustomed an individual learner is to the respective technology.

These levels of interaction are not independent of each other, and all add up to impact the overall degree of interactivity within a learning experience. Figure 1 illustrates the different levels of interaction and how they can overlap or coincide. Developing and considering all levels of interaction is vital to ensure that learners are given the best chance to not only absorb and understand the material, but develop connections with the material, peers, instructors and even the technologies so that the relevance of the subject matter is enhanced.

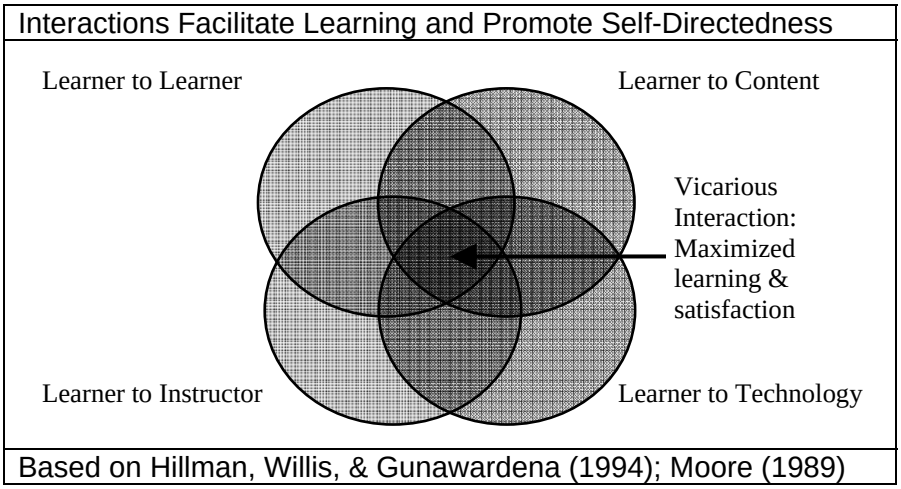

Figure 1. Depiction of vicarious interaction and maximized learning and satisfaction resulting from four learner relationships.

In addition to the different levels of interaction are two distinct types of interaction that can be provided in an online distance learning course: asynchronous and synchronous. Asynchronous refers to the interaction in which students and teachers "engage in collaborative learning" without being online at the same time (Brown, 2000). On the other, hand synchronous entails a "real-time electronic interchange" by utilizing Internet technology with a live instructor and moderator who facilitates the live presentation of information and the interaction of learners who are remotely located (Murugiah, 2005).

Neither asynchronous nor synchronous interactions are optimal for all WBT. Rather, the interactive approach should be complimentary to the course objectives and specific considerations of the target audience. Synchronous interaction is more like a traditional classroom, given the interaction between students and instructor, which can be ideal for a training system trying to mirror an in-class approach (Brown, 2000). However, asynchronous can better serve learners who need flexibility in the course schedule and are utilizing WBT as an alternative to traditional classroom settings. Asynchronous communication can also allow more time for thoughtful analysis and evaluation, which may compliment the needs of a learner-instructor relationship (Brown, 2000). The needs of the learner can determine the best approach to interaction in WBT, and a designer should try to accomodate these needs (Murugiah, 2005).

There is no set path to follow in terms of what communication or interactive features to include in a WBT. It is imperative that the goal of the training be considered, with attention paid to the particular dynamics of the target audience and resources available. Incorporating interaction at all levels can enhance the learning experience, and keep learners engaged in the training.

Technological advancements continue to create more options for interactive online learning. Live chat rooms allow for synchronous communication, as learners and instructors can interact with each other over this real-time exchange. Chat rooms can be text-based, or can utilize audio/video web conferencing (Murugiah, 2005). The web whiteboarding method is

another synchronous tool, due to its graphic conferencing. Having the ability to communicate in real time with fellow learners and instructors increases the speed in which experiences are shared and feedback is received. In terms of engaging learners, the quick turnaround of synchronous exchange can create a greater sense of connection to the course, but also requires learners to be active in the discussion within the timeframe provided.

Asynchronous discussions can also occur in WBT. Discussion or bulletin boards and e-mails present interactive tools that do not require instructors or learners to be participating in an exchange simultaneously. Rather, these exchanges are done on the learner's own time, creating an opportunity to still have interaction with peers and instructors, while maintaining flexibility for individual schedules. These tools can engage time-strapped individuals, like volunteer firefighters, as there is still a sense of community without requiring adherence to a strict course schedule (Piccoli, Ahmad & Ives, 2001). Since asynchronous exchanges can allow more time for reflection, evaluation and potentially reviewing literature and other source documents, the quality of shared learning experiences and instructor provided feedback can be lengthened and enhanced (Brown, 2000). Learners provided with higher quality interaction can further engage in a course and improve their level of learning.

When selecting which interactive tools for learner-learner and learner-instructor, striking a balance is the best approach. Both chat rooms/conferencing and discussion boards/e-mails can engage different learners. Providing both asynchronous and synchronous interaction can give volunteer firefighters the flexibility to complete a large portion of a course within their time-strapped schedules, and make them more willing to participate, while offering opportunities to interact live with instructors and peers can be an engaging feature that supplements the course content.

Ensuring that learners are provided with multiple opportunities to interact with course materials, peers and instructors will promote learning. The different options available in course delivery and interactive capabilities will reach across personal preferences and learning styles so that a wider audience is reached. Given the diverse and large number of volunteer firefighters it is vital that a WBT be able to appeal to learners across preferences and generations. Having a WBT system with a host of interactive features and range of course formats will increase the appeal, but the course must also maintain a level of flexibility that can adapt to volunteer firefighter schedules.

VIII. Challenges to Engaging Learners

Motivation is a major factor in learning or training of any kind. Two distinct, yet intertwined, types of motivation are extrinsic and intrinsic, and both play a key role in learning. Extrinsic motivation refers to behaviors that arise out of a response from something outside an individual, as in a perceived reward or recognition. Intrinsic motivation comes from within an individual's own perception of an activity being engaging or interesting (Lee, Cheung & Chen, 2005). A training system can incorporate a number of extrinsic factors to motivate members of the fire service. Rewards can be offered in the form of promotions or an increase in rank, but given that volunteers are not on a career path in the fire service, this tool is limited. Recognition can also be given in the form of certificates for course completion. Or training can simply be required, so that all firefighters are obliged to complete it.

A number of strategies can make learning more interesting or engaging. Incorporating gaming, including guests or featured speakers, and utilizing multimedia are all strategies to increase motivation by creating a more entertaining and engaging learning environment (Johnson & Aragon, 2002). The idea of creating entertainment is reiterated throughout the literature, as is the importance of establishing interactivity and utilizing varying formats for

course content (Lee, Cheung & Chen, 2005). The very nature of volunteerism in the fire service shows a high level of intrinsic motivation to perform a job without pay. This motivation can be tapped into with regard to training. The attachment and dedication volunteers demonstrate simply through sacrificing time and money to be part of the fire service with few extrinsic rewards is promising. Therefore, presenting training to volunteer firefighters in a way that doesn't interfere with their career or family commitments can prove to be a major motivator.

The tools to increase intrinsic motivation reemphasize the importance of a multi-faceted learning approach that can reach a wider audience. However, no learning system can be engaging or fun for all individuals, due to the varying factors that go into an individual's intrinsic motivation. A training system should do its best to account for a range of learners, while realizing there is a degree of motivation that is always left up to the individual.

When discussing motivation in terms instructional design and theory there are four major dimensions identified: interest, relevance, expectancy and satisfaction. To better understand the four dimensions of motivation we will need to explore each individually.

> *Interest can be described as stimulating the learner's curiosity. Relevance is determined by whether the instruction satisfies the learner's personal needs or goals. Expectancy determines the learner's perceived likelihood of success and feeling of control. Satisfaction is determined by how well the learner enjoyed the learning experience.*
> (K.E. Dooley, Lindner, & L.M. Dooley, 2005, p 142)

There is also an important distinction between types of motivation as there is intrinsic and extrinsic motivation. External forces perceived as tangible rewards serving as extrinsic motivation while internal factors like personal satisfaction and feelings of self determination constitute as intrinsic motivation. An instructor can incorporate both types of motivation into a given course. An instructor hoping to motivate learners should be aware of the great variations in academic abilities, interests and attitudes. Because extrinsic motivators are powerful and widespread, learners are influenced by rewards such as grades. (K.E. Dooley, Lindner, & L.M. Dooley, 2005).

Not only are there four dimensions for motivation, there are four different components as well. The four components identified by Driscoll (1994) have corresponding strategies to enhance motivation. These components are gaining and sustaining attention, enhancing relevance, building confidence and generating satisfaction. To sustain attention the instructor can attempt to intrigue learners with various tools like problem solving exercises, invoking 'mystery' or simply varying the instructional presentation of material (K.E. Dooley, Lindner, & L.M. Dooley, 2005). In terms of enhancing relevance the material should be related back to personal and professional goals so that learners can draw connections with the subject matter.

When it comes to building confidence for learners, it is best for the instructional goals and objectives of a course to be clear. This allows learners an opportunity to understand course expectations and improves the likelihood of successfully achieving goals (K.E. Dooley, Lindner, & L.M. Dooley, 2005). Successful achievement of goals plays into the fourth component of motivation, generating satisfaction, which can utilize the strategy of positive reinforcement. Considering these components helps maintain a learner-centered instructional design. Learners who are motivated can learn regardless of the delivery strategy or medium used (Heinich, Molenda, Russell, & Smaldino, 1996). Table 1 provides a summary of the components and the corresponding strategies.

Table 1
Instructional Strategies for Stimulating Motivation

Component of Motivation	Corresponding Strategies
Gaining & Sustaining ATTENTION	• Capture students' attention by using novel or unexpected approaches to instruction • Stimulate lasting curiosity with problems that invoke mystery • Maintain students' attention by varying the instructional presentation
Enhancing RELEVANCE	• Increase the perception of utility by stating (or having learners determine) how instruction relates to personal goals • Provide opportunities for matching learners' motives and values with occasions for self-study, leadership, and cooperation • Increase familiarity by building on learner's prior knowledge
Building CONFIDENCE	• Create a positive expectation for success by making clear instructional goals and objectives • Provide opportunities for students to successfully attain challenging goals • Provide learners with a reasonable degree of control over their own learning
Generating SATISFACTION	• Create natural consequences by providing learners with opportunities to use newly acquired skills • In the absence of natural consequences, use positive consequences such as verbal praise, real or symbolic rewards • Ensure equity by maintaining consistent standards and matching outcomes to expectations

Source: Driscoll, M. P., 1994, p. 319.

IX. Blended Learning

A range of options within WBT have been discussed, which creates an array of choice when designing a system to serve as a niche to groups like volunteer firefighters who cannot access traditional classroom style training. Developing a WBT can create training opportunities for a wide group of first responders, yet we cannot overlook the potential drawbacks of relying solely on web-based learning.

Even if the instructional design is solid and all of the right approaches have been taken to avoid potential online learning pitfalls, it is dangerous to ignore the value of f2f interaction. Research has indicated that f2f interaction is a strong supplement to online learning activities, signifying that e-Learning can be more effective when combined with other methods of educational delivery (Macdonald, Bullen & Kozak, 2007). In the first responder arena, f2f and hands-on training fits perfectly with the hands-on nature of the job. An argument that there is "no replacement for practical on the job experience" provides justification for including f2f learning exchanges so that the learner is better prepared (Stephenson, 2003).

"Blended learning" utilizes both traditional, f2f elements of training and the technological resources found in web-based systems. f2fAt times, blended learning has been referred to as a "hybrid model" for learning, as it combines e-Learning with f2f sessions in classrooms or labs. This hybrid model can be a well-rounded approach for learning, if the approach is well thought out, so that the two components fit together (Greenagel, 2002). When Toshiba's telecommunications division utilized a hybrid model for training, it managed to cut down on lab sessions while still increasing competencies, as its e-Learning component well prepared learners for lab sessions. (Greenagel, 2002). This same concept can be used for first responders. E-Learning can lay the foundation and even provide simulations for scenarios that are difficult to demonstrate, while hands-on training can follow, to strengthen the acquisition of knowledge.

Earlier we discussed assessment or evaluation processes available in e-Learning, but the introduction of a blended learning option brings a new dimension to training assessment measures. Including a f2f component of training not only allows for balance in the learning experience, but creates a new opportunity to test the retention and understanding of the materials. In-classroom testing or assessments can be conducted in blended learning programs and add a hands-on approach to the learning and testing components of the training.

X. Conclusion

The time and financial constraints facing volunteer firefighters complicate their ability to access training. The issue is not whether to provide them with training resources, but what approach is best to take so that these first responders are prepared for the demands they will face in the field. Given their time constraints and the fact that these volunteers are dispersed across the nation, having a flexible and far reaching training system creates an opportunity to increase the scope of training. The features and capabilities in WBT make it an ideal system for volunteer firefighters, as it combines the history of distance education with the resources and tools of e-Learning.

Following a constructivist approach, WBT can seek to develop active learners who can attach experiences and add meaning to the subject matter, thereby attaining a better understanding. Utilizing multiple e-Learning tools and formats (text, audio, video, graphics, and games) will allow WBT to reach across different individual learning preferences and styles. This multi-faceted approach enhances information delivery and helps create an interactive learning environment. If a range of information delivery formats and interactive features (chat,

discussion board, whiteboarding, conferencing, e-mail, and bulletin boards) are appropriately including into a training system, the environment can be more engaging and even fun for the learner. This sense of fun can be a major aid in addressing the challenge presented by intrinsic motivation, which often poses as a daunting obstacle for engaging learners in an online or f2f setting.

Web-based training is not the be all, end all. Its numerous possibilities create an opportunity to reach a wide audience, yet the hands-on nature of first response means that f2f training cannot be eliminated. In any WBT for first responders, the value of a hands-on component should be considered. A blended learning approach can be the balance that gives learners flexibility and still prepares them for working in the field.

XI. References

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Appendix B

Analytic Report on Hydrogen Fuels Training Available

Analytic Report on Hydrogen Fuels Training Available

I. Overview of Hydrogen

Prepared by A.K. Rosenhan

A.K. Rosenhan currently serves as the fire services coordinator for Oktibbeha County, Mississippi, and is also a professor in engineering at Mississippi State University. Respected not only for his work in the fire service, but also expertise in engineering, Rosenhan serves as a consultant in fire protection engineering for the U.S. Navy, Air Force and Coast Guard.

While hydrogen fuel has been in use for a number of years, the fire service has had little interface with it. Numerous rules and laws pertain to hydrogen fuel transportation, storage and use that have been enacted by the Occupational Safety and Health Administration (OSHA), National Fire Protection Association (NFPA)[1] and members of the hydrogen fuel industry. The fire service should be trained on these rules and laws.

Any significant amount of hydrogen, regardless of end use and storage type, must be stored either at a high pressure (thousands of psi) or a very low temperature (-423˚ F). Further, hydrogen has a very wide explosive range (4-75%) and burns at a very hot temperature (3700˚ F). All of these properties pose great hazards to firefighters.

The typical fire department is aware of the hazards of hydrogen only as they relate to storage (for welding operations) and use in some chemical labs, power plants, and in various industrial processes (mostly in chemical factories). Perhaps the most common thought and application for a fire department would be gases from batteries. All of this is covered in basic hazardous materials training, which may vary from very rudimentary to technician-level.

No significant incident involving fire departments and hydrogen has occurred to "catch the eye" of the fire service in general. No doubt incidents have occurred, but they are normally in industrial settings where a fire department may not be involved. OSHA and National Institute for Occupational Safety and Health (NIOSH) reports are sources for such incident data.

OSHA standards relate to industrial uses and are well publicized. NIOSH reports are available but the typical fire department does not review them.

[1] Representative National Fire Code (NFPA®) contents include:

- NFPA® 497 Classification of Flammable Liquids, Gases, or Vapors and of Hazardous Locations for Electrical Installations in Chemical Process Areas
- NFPA® 55 Compressed and Liquefied Gasses in Portable Cylinders
- NFPA®51 Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes
- NFPA® 50A Gaseous Hydrogen Systems at Consumer Sites
- NFPA® 329 Handling Releases of Flammable and Combustible Liquids and Gases
- NFPA® 50B Liquefied Hydrogen Systems at Consumer Sites
- NFPA® 472 Professional Competence of Responders to Hazardous Materials Incidents
- NFPA® 471 Responding to Hazardous Materials Incidents
- NFPA® 853 Stationary Fuel Cell Power Plants (various gaseous fuels, including hydrogen)
- Numerous other standards that relate to personal protective gear and firefighter operations

Appropriate training for fire department response to hydrogen fuel emergencies is lacking. Funding and time limits tend to restrict training, especially in smaller, mostly volunteer departments, which comprise most of the 30,000-plus departments in the United States. Adding training, even at a simple awareness level, requires resources that may not always be available (much less the philosophy to ensure its delivery).

The development of hydrogen-powered cars, hydrogen filling/recharging stations and the more common use of hydrogen in general pose significant hazards to the public and the fire service. In most cases, hydrogen-powered vehicles also are equipped with significant electrical voltage and amperage, both of which pose hazards in and of themselves. In addition, any such hardware is relatively expensive, and even in emergency situations the fire service must be careful not to cause unnecessary damage.

A review of state training programs shows a lack of consistency in the area of hydrogen fuel, except that a very small portion is devoted to automotive applications. The fixed installation aspects are covered in the basic hazardous materials work, but only the very basic chemistry of hydrogen is normally discussed, and only in conjunction with other gaseous materials.

While myriad private companies market various hazardous materials course work – sometimes for rather significant prices – no cohesive content or curriculum exists. Some of the packages offer a decent amount of content, along with elaborate graphics, but others are not very useful.

The means of delivery of any hydrogen-related education will vary a great deal among the states. Much emphasis is put on delivery via online training or CD-ROM; however, considering the differences among U.S. fire departments, no one method or medium will suffice. Urban area career departments are more likely to have the resources and training philosophy, as well as the immediate need, to have specific hydrogen training. The smaller and more typical departments need quite different levels of awareness, training, and operational data. Ironically, the smaller departments would be more apt to respond to emergencies involving transportation (for example, railroad or truck accidents) than large cities (which deal mostly with filling stations, larger fixed storage and more prevalent users).

As hydrogen fuel use becomes increasingly common, fire departments will have a growing need to know its potential problems, how to handle them, and how to mitigate their effects.

II. Current Hydrogen Training

Prepared by Jennifer Dietz, IAFC Staff

Hydrogen is an emerging alternative fuel. Part of the research phase of the Hydrogen Fuels Training and Education Research and Outreach Project was to identify and evaluate the current hydrogen fuel response training available to first responders. To achieve this objective, project staff conducted online research, held discussions at regional meetings with state training directors, and conducted other meetings with various organizations.

After extensive research and seven regional meetings (two of which were conducted via WebEx) a number of different hydrogen training systems emerged. Further information on each training program is provided below. Several training courses specifically target hydrogen as their core subject, while some states include just a component or section of training on hydrogen. None of the training programs identified were designed specifically to be NFPA 472 compliant, and only one (provided by the Department of Energy) is online. These programs offer a starting point and curriculum for hydrogen training and have components that can be helpful in developing an online hydrogen training system that can reach a wide audience and maintains compliance with NFPA 472. Identifying existing training systems allows for a better understanding of available resources for moving forward in reaching first responders across the country.

Federal/Industry

Introduction to Hydrogen Safety for First Responders
Online Course
U.S. Department of Energy (DOE)

The DOE's Hydrogen Program includes an online course on hydrogen safety that is intended to better prepare its target audience of "fire, law enforcement, emergency medical personnel, or individuals who may witness or discover a hydrogen release and must initiate an emergency response sequence".[2] DOE created this course with the Pacific Northwest National Laboratory and the Volpentest Hazardous Materials Management and Emergency Response (HAMMER) Training and Education Center. The course is designed to provide an awareness level overview of hydrogen.[3]

The primary delivery method is an online course delivered via interactive slideshow through Adobe® Flash®. The course is accessible online and in an abridged format on CD-ROM. A student must register with a valid e-mail address to take the web-based course.

The course content is divided into eight modules. In order, they are: *Hydrogen Basics, Transport & Storage, Hydrogen Vehicles, Hydrogen Dispensing, Stationary Facilities, Codes & Standards, Emergency Response* and *Summary*. Within each module, a variety of features – videos (with scripts to accompany any narration), pictures, labeled diagrams and an animation of fuel cells – deliver the relevant information.

[2] DOE Hydrogen Program overview available at: http://www.hydrogen.energy.gov/index.html
[3] DOE Hydrogen Program: Hydrogen Safety for First Responders available at: http://www.hydrogen.energy.gov/firstresponders.html

Students may follow the given module sequence or skip ahead. The *Summary* offers a brief bulleted summary and quiz. The web-based version of the course has a 24 question quiz that tells the student at each step whether his or her answer is correct, and gives a corresponding explanation. The CD-ROM quiz has the same format, but offers only 13 questions. The quiz is available without completing or clicking through all of the slides or modules. Upon completion of the online quiz, students receive their percentage score and can opt to print a certificate to indicate course completion. Students may choose to take the quiz again.

Bandwidth options exist for various Internet connection speeds and capabilities. Students may leave comments by clicking on a designated box in the lower right corner of the screen.

Alternate versions of the web-based and CD-ROM course are available to individuals with special hearing, visual or mobility needs. The course also is available in HTML format with different visuals but the same content. A printer-friendly PDF version also is available.

Hands-on Course
HAMMER (Hazardous Materials Management and Emergency Response) and Pacific Northwest National Laboratory

The Volpentest HAMMER Training & Education Center offers a range of training in the field of hazardous materials for hazardous materials workers, emergency responders and firefighters.[4] HAMMER has partnered with the Pacific Northwest National Laboratory to develop and deliver its hydrogen training. Another partner in this training is the California Fuel Cell Partnership (CaFCP), which provided portions of the course curriculum and Emergency Response Guides.[5] The Hydrogen course is part of the HAMMER First Responder Training program. It is different from the online DOE's *Introduction to Hydrogen Safety for First Responders* in that HAMMER provides a hands-on course at its facility in Richland, Washington. However, material from the HAMMER hydrogen course was used as a resource to create the DOE online course.

The course lasts approximately eight hours and includes classroom instruction, group exercises involving incident scenarios, a quiz, and a hands-on, live-fire exercise using a fuel cell vehicle (FCV) burn prop.[6] Within this course are six modules of basic information to help raise awareness among fire, law enforcement, and emergency medical personnel and provide access to resources for more detailed information.

Workshop for Hydrogen and Fuel Cell Vehicles
California Fuel Cell Partnership (CaFCP)

The workshop covers the following topics.

- Basic hydrogen properties and handling
- How a fuel cell and fuel cell vehicle works
- Fuel cell vehicle and bus safety systems
- Awareness information for responding to several Fuel Cell Vehicles (FCV) incidents

[4] HAMMER Training available at: http://www.HAMMERtraining.com/?page=108&parent=0&hparent=108
[5] Kinzey, B. (2005). HAMMER Emergency Response Training for the Hydrogen Economy available at : http://www.hydrogen.energy.gov/pdfs/review05/sa5_kinzey.pdf
[6] New Hydrogen Training Opportunity Brochure, from Department of Energy Hydrogen Program available at: http://www.icsfire.com/utcfs/ws-385/Assets/Hydrogen%20Training%20Opportunity.pdf

Training is currently in-person, not online. CaFCP works together with HAMMER to deliver the *Hydrogen Emergency Response Training for First Responders* course. Jennifer Hamilton, CaFCP Safety Officer, is the lead instructor for the course which was developed and delivered by Pacific Northwest National Laboratory and HAMMER. James Bryan and Scott Jones of HAMMER lead the emergency response training modules, group scenarios, etc. CaFCP has worked very closely with the DOE on their emergency responder curriculum for hydrogen and fuel cells. Jennifer Hamilton is one of the instructors for their operations-level prop course and supplied them with some of CaFCP's material for the fuel cell vehicle portion of that curriculum (with the approval of CaFCP members). Additionally, CaFCP's material has been included in California State Fire Training curriculum for alternative fueled vehicles. That course made its debut at the California Fire Trainers Symposium in November of 2009 and will be a course at the Continuing Challenge Haz-Mat Workshop in September of this year in Sacramento. In the meantime, the material is delivered to emergency responders in California communities where fuel cell vehicles and stations are deployed. [7],[8]

National Fire Academy (NFA)

The NFA does not currently have hydrogen training. It currently offers some basic online training. NFA has found that there are several challenges to the delivery of training on a nation-wide basis: many firefighters are undertrained and not prepared to take the course being offered; the fire fighters cannot attend training; the fire fighters or department are not properly connected to the internet; and some fire fighters have difficulty using online training. NFA has started an experimental new approach designed to address the problems called the EZ Pilot Program, which is still in development. Features of the program are listed below.

- EZ online access for all responders through EZ buttons located on local department websites.
    - Local departments can use the EZ Wizard to download the EZ button with all connections through states onto the local website
    - Students will click the EZ button on their local website and go straight to state-specific EZ training site
    - Three easy clicks and a student is in
- Brief introductory interactive training on various topics
- Portal channeling of students into state training systems and topic-specific federal and association curricula.
- Provide local department training officer with curricula to blend online training with local instructor training.
- Local department training officer and state training office would get automatic reports of student completions and other information
- Lesson plans provided for local department training sessions

Experimental Pilot will be taking place in the next year. There will be 10 training areas for the pilot, including hazardous materials where the initial micro-unit example would be "Using the ERG."[9]

[7] California Fuel Cell Partnership – First Responder Education Workshops
http://www.fuelcellpartnership.org/outreach/emergency-responders/first-responder-education-workshops
[8] Further information gathered through e-mail correspondence between CaFCP and IAFC staff.
[9] Information gathered from a PowerPoint presentation titled "EZ Training" given during a meeting between NFA & IAFC.

First Responder Safety Training – Hydrogen
Transportation Safety Institute (TSI) (Department of Transportation (DOT))

TSI offers a range of hazardous materials courses, but only one specific hydrogen course: First Responder Safety Training—Hydrogen (available under the heading of Special Programs). The course will educate and prepare first responders at the awareness level for the potential risks related to hydrogen incidents, identify the advantages of hydrogen use, identify proper ways to handle hydrogen, and identify and initiate proper procedures when dealing with a hydrogen hazard and/or incident.

This one day, eight-hour course is traditional classroom style and seeks to provide first responders with an awareness level of training for hydrogen related incidents.[10] It is divided into two, four-hour phases, with the first focusing on introduction to hydrogen. The second phase deals with emergency situations such as extraction, uses case studies, and utilizes a hands-on approach when possible. The training does not cover hydrogen home-built or after-market hydrogen canister boosters that people are installing on their vehicles, but it does become part of the conversation during classroom discussions. The current hydrogen course is listed with a fee of $420. [11]

The target audience listed includes the following groups.Fire service personnel (volunteers, full-time, and airport)

- Law enforcement (police, state highway officers, and sheriff)
- EMT
- EMS
- Transportation system professionals
- Towing operators
- Collision repair professionals
- Service personnel
- Safety officers
- Refueling station attendants
- Community members

Through meetings with TSI, the background of the hydrogen course was explained. The University of Montana received funding to develop the hydrogen course, but had no funding to maintain and administer the course. The search for funding resulted in a partnership with TSI.

TSI reached out to a broad range of groups to promote or raise awareness for the hydrogen course, but have not received many requests for enrollment. The hydrogen safety course is not currently offered online.

It was noted that hybrid technology has captured the interest of emergency professionals and that during hydrogen safety training there is a need to incorporate information about hybrid vehicles to fully meet the needs and interest of the participants. New hydrogen technologies dealing with distributed generation and home hydrogen refuelers also need to be considered in emergency response training scenarios. So far the training is not going past the eight hour awareness level, but this can be easily done. TSI has found that there are complications with

[10]TSI Course Descriptions available at: https://www.tsi.dot.gov/tsilms/classes.aspx
[11] TSI First Responder Safety Training - Hydrogen https://www.tsi.dot.gov/tsilms/classlisting.aspx?CourseID=126

determining who needs to be trained for what and how it is classified (hazardous material versus fueling).[12]

Hydrogen First Responder Safety Training
West Virginia University's National Alternative Fuels Training Consortiums (NAFTC)

The National Alternative Fuels Training Consortium (NAFTC), founded in 1992, is headquartered at West Virginia University and currently has 39 training centers around the country. The NAFTC mission is to "provide training infrastructure for implementing the widespread use of the alternative fuel vehicles and advanced technology vehicles."[13]

To address the specific topic of hydrogen, NAFTC offers workshops as part of the *Hydrogen First Responder Safety Training*, including *Hydrogen Fuel Cell Engines and Related Technologies* and *First Responder Safety Training: Hydrogen and Hydrogen Vehicles*.[14] The workshops are conducted as face-to-face meetings led by NAFTC instructors and vary in size and length, with the typical number of students falling in the range of 12-15 per workshop. Workshop scheduling depends on the demand for a particular course. The cost of each training session depends on the location and length of the workshop. None of the NAFTC courses are cited as utilizing or following NFPA 472 as a curriculum standard.

- For the *Hydrogen Fuel Cell Engines and Related Technologies* course, each student receives a learner's guide as well as a program certificate upon workshop completion. The workshop utilizes classroom instruction and claims to provide students with "hands on experience."[15] A smaller introductory workshop, *An Introduction to Hydrogen-Powered Vehicles*, is led by an instructor, and provides students with a reference booklet.[16]

- *First Responder Safety Training: Hydrogen* is available as either a four- or eight-hour workshop. The four-hour option includes a booklet with important information, while the eight-hour workshop has an instructional manual to provide students with an awareness level of hydrogen fuel response. Cost for a manual in this workshop is listed as $109.95; the cost of training is not included in this price. In addition, the NAFTC provides a two-day instructor training course that provides a "more in-depth look into hydrogen technologies."[17]

Also working on hydrogen training with the NAFTC is the University of Montana's Alternative Energy Technologies (AET). The two collaborate on *Hydrogen Safety for Emergency Responders*, which is a four-to-eight hour workshop that has a target audience of fire fighters, emergency management technicians, law enforcement officers and emergency administrators. This workshop has two modules. Module One provides an overview of hydrogen (properties,

[12] Information gathered during a meeting between TSI and IAFC
[13] Available at: http://www.naftc.wvu.edu/
[14] NAFTC Course list available at: http://www.naftc.wvu.edu/NAFTC/training/catalogs.html
[15] NAFTC Workshop and Course Description, Hydrogen Fuel Cell Engines and Related Technologies available at: http://www.naftc.wvu.edu/NAFTC/training/hydrogen.cfm
[16] NAFTC Workshop and Course Description, An Introduction to Hydrogen-Powered Vehicles available at: http://www.naftc.wvu.edu/NAFTC/training/intro_hydrogen.cfm
[17] NAFTC Workshop and Course Description, First Responder Safety Training: Hydrogen and Hydrogen Vehicles, available at: http://www.naftc.wvu.edu/NAFTC/training/first_responders_hydro.cfm

uses, transportation, and fuel cells) and Module Two focuses on emergency response to hydrogen incidents. This course is advertised as an awareness level training.[18]

Department of Defense (DoD)

DoD installations are testing hydrogen-fueled vehicles, requiring fueling stations. However, according to Robert Coonce, Certification Program Manager, U.S. Department of Defense Firefighter Certification System at Tyndall Air Force Base, Florida, not all installations are testing hydrogen fueled vehicles, and training is local. This local training is not a topic that is certified as per International Fire Service Accreditation Congress (IFSAC) or Pro-Board requirements.

Department of Homeland Security's Transportation Security Administration (TSA)

TSA does not currently have hydrogen training. Most of the training is on topics such as chlorine and toxins. All training is focused on security and security threats, and at this time, hydrogen is not seen as a security threat. They also do not have much online training. The group that does the training mainly utilizes DVD dissemination.[19]

National Association of Fire Marshals (NASFM)

NASFM does not have any hydrogen training. They are more research-focused in understanding the current opportunities in hydrogen. The Hydrogen Executive Leadership Panel (HELP) is a joint initiative of the NASFM, the Research and Innovative Technologies Administration of the U.S. Department of Transportation, and the International Consortium for Fire Safety, Health and the Environment (ICFSHE).[20] This panel was designed with a mission to bring together emergency responders, government regulators, scientists, consumers and experts from the automotive and energy industries to facilitate a safe and orderly transition to hydrogen and other alternative fuel sources.[21]

International Association of Chiefs of Police (IACP)

The IACP (including its Highway Safety Committee) offers no hydrogen or hydrogen-related training courses.

[18] Hydrogen Programming available at: http://www.h2education.com/index.php/sID/472aa1df/fuseaction/safety.main.htm
[19] Information gathered through a phone call between IAFC and TSA.
[20] http://www.firemarshals.org/programs/hydrogen-executive-leadership-panel/
[21] http://www.nasfmhydrogen.com/

State-Specific Training

At the state regional meetings, the training directors described the hydrogen training available in various states. A large number did not offer any such training because of a lack of hydrogen fueling stations or plants; however, many of these same state representatives indicated a need for a minimum of awareness training given the growth in hydrogen use and its potential for even further use.

The hydrogen training that is available is detailed by state below.

Illinois
The Illinois Fire Service Institute offers no hydrogen courses and hydrogen is not included in its hazmat awareness program. However, it has a good working relationship with the Center for Advanced BioEnergy Research at the University of Illinois, which is the university's primary research arm for bio-fuels.

Louisiana
Developed course for awareness to new vehicles design (with a small portion of awareness to alternative fuels like hydrogen)

Missouri
University of Missouri visited the state training leadership about two years ago to talk about a hydrogen project they were working on, using hydrogen as a fuel source, and the refueling station. They put two hydrogen fuel buses together. They announced that for the training component, they would go into the departments affected by the buses and refueling stations and train them. The training was a two-hour safety briefing.

North Dakota
North Dakota State University offers a *Hydrogen Fuel Stations Training* course, though the training is still in its early stages. It focuses on spill/accident response. A new wind-to-hydrogen research project, funded through DOE grants and announced in September 2008, has generated some interest in the course. The project harnesses wind to help power an electrolyzer that separates the hydrogen and oxygen contained in water. The resulting hydrogen is stored and used for transportation fuel.[22]

Oregon
Either sends people to HAMMER or brings in industry people to do training

South Carolina
Has been teaching hydrogen for years as part of liquefied and compressed gases

Virginia
Virginia's Department of Emergency Management offers a variety of hazmat training courses, but none are specifically devoted to hydrogen. Information and training on hydrogen is addressed in the *Chemistry of Hazardous Materials* course, where it is discussed as an element of the periodic table. Its properties are then applied to tactical operations, specifically to managing incidents defensively. The two-week course is 80 hours long and is conducted

[22] "Wind-to-Hydrogen Project," September 2008, available at: http://www.basinelectric.com/Electricity/Generation/Wind/Wind-to-Hydrogen_Project/index.html

primarily via lecture. A small portion of the course is hands-on, as students are required to make presentations as part of the course review

Appendix C

RFI Response Table

Request for Information (RFI) Response Table

I. IAFC Request for Information (RFI) Evaluation Criteria:

1) Description of available distance learning training capabilities and services to include:
   a) Capabilities and learning system features with a focus on distance learning environments
   b) Explanation of how the capabilities and learning system are robust, interesting, provide an environment for flexibility, and cater to a range of learning styles
   c) Project management services
2) Describe the full range of services provided by your organization ranging from time and materials to the complete development of a distance learning system
3) Identify the time needed for each of the service packages described
4) The organization's willingness to allow IAFC to own the learning system outright upon completion

II. Additional RFI Evaluation Criteria:

5) Type of entity responding
6) Experience developing learning products for Fire, HAZMAT or First Responder
7) Product demonstration included or available
8) Brief comments

III. NOTES:

1. Total of 41 responses reviewed
2. Responses provided in alphabetical order

Table 1. Responses to RFI for the IAFC Hydrogen ELC

Company Name	Entity Type	Addr Criteria 1a	Addr Criteria 1b	Addr Criteria 1c	Addr Criteria 2	Addr Criteria 3	Met Criteria 4	HAZMAT/ First Responder Experience	Demo	Comments
323link	Corp	Yes	Yes	No	Yes	No	No	Yes	No	Section 508; video and pod casting
Adayana	Corp	Yes	No	No	No	Yes	Yes	Yes	No	Primarily an LMS services provider
ADCIEO	Corp	No	No	Yes	No	No	No	No	No	Services company; no systems development
American Public University System	Univ.	Yes	Yes	Yes	Yes	Yes	No	Yes		Courses have to be part of the university system
Anne Arundel Community College	Univ.	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Asynchronous and synchronous online training development; LMS support; Interoperable modules (SCORM?); CEUs
Aptara	Corp	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Develops courseware: WBT, ILT, virtual, CBT, game-based, Web 2.0, mlearning; SCORM; course tracking with Moodle LMS; mini-LMS
C^2 Technologies	Corp	Yes	Yes	Yes	Yes	No	No	No	No	Extensive training developer, including simulations, LMS, LCMS
Certpoint Systems	Corp	Yes	Yes	Yes	Yes	Yes	No	No	No	Enterprise Learning Platform; no courseware development
Contextware	Corp	No	No	No	No	No	No	No	Yes	Online course demo was all text-based
Corporate University at Millersville	Univ.	Yes	Yes	No	Yes	Yes	No	Yes	No	Has created online gaming; most work is broadcast of classroom course
CSC	Corp	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Experienced SCORM, Section 508 courseware developer with good project management; must partner externally for LMS solution
Design2Train	Corp	Yes	No	Yes	Yes	Yes	Yes	No	Yes	eLearning courseware developer; no LMS solution
Desire2Lear	Corp	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Strong in LMS/LCMS/CMS development;

Company Name	Entity Type	Addr Criteria 1a	Addr Criteria 1b	Addr Criteria 1c	Addr Criteria 2	Addr Criteria 3	Met Criteria 4	HAZMAT/ First Responder Experience	Demo	Comments
n										Section 508; SCORM; cannot transfer ownership to IAFC
Detrick Lawrence Corp	Corp	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Pretty good video-based training development; SCORM; must partner externally for LMS solution
Element K	Corp	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Offers full range of services: LMS, courseware development, gaming, mobile learning, wiki, blog, SCORM; numerous industry awards
Emantras	Corp	Yes	Yes	Yes	Yes	No	Yes	No	Yes	SCORM courseware developer; gaming, video, simulation, mLearning; has LMS solution also
GBK Partnership	Corp	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Existing online courses can be customized; Flash, audio, video; SCORM, Section 508; LMS
Generation 21	Corp	Yes	Yes	No	Yes	Yes	No	No	No	Course development tools and LMS; can purchase ancillary features, e.g. social networking; does not develop courses
Harley Interactive	Corp	Yes	Yes	Yes	Yes	Yes	No	No	No	Courseware developer and LMS provider; comment report tool; SCORM
Hydrogen Safety, LLC	Corp	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Provider of Hydrogen-related WBT and seminars; has awareness courses and in-depth simulation-based training that it hosts; proposes a governance board composed of all stakeholders including funders
IDSI & ALS	Partner	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Award-wining training solutions provider; WBT, gaming, simulation; LMS; proposes change management consulting
InfoPro	Corp	Yes	Yes	No	Yes	Yes	Yes	No	No	Multimedia design/development; elearning; simulation/game/role-based learning; ILT/WBT/CBT; mlearning; custom LMS; SCORM;
Information Experts	Corp	No	Yes	Yes	No	Yes	No	Yes	No	Seems to be more of a courseware developer, no LMS solutions described
Intelitek	Corp	Yes	Yes	Yes	No	No	Yes	No	No	Offers Change Management services; LMS

Company Name	Entity Type	Addr Criteria 1a	Addr Criteria 1b	Addr Criteria 1c	Addr Criteria 2	Addr Criteria 3	Met Criteria 4	HAZMAT/ First Responder Experience	Demo	Comments
										development and hosting; web-based and blended courseware development; SCORM; will train IAFC on the system
Intrepid	Corp	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Offers wide range of training solutions including mobile learning, WBT, Virtual Classroom, ILT, OJT, Communities of Practice, wikis, blogs, social networking
inXsol	Corp	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Funded by NSF for Hazmat simulation training development
Lasselle-Ramsay	Corp	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Full service courseware developer; can custom build LMS or partner for LMS
LearnCom	Corp	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Courseware developer; SCORM; LMS provider
Leeds Metropolitan University	Univ.	Yes	Yes	No	Yes	No	No	Yes		The university doesn't typically partner with external clients; courses have to be part of the university system
Lucid Government Solutions	Corp Partnership	Yes	Yes	No	Yes	Yes	Yes	No	No	eLearning platform, LMS; SCORM; courseware development optional; social networking
MetaMedia	Corp	Yes	Yes	Yes	Yes	No	Yes	Yes	No	One-stop shopping; Open-source LMS integration; collaboration; mlearning; elearning, ILT, courseware development;SCORM; needs assessment;
MPRI	Corp	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Can do range of interactive courseware & gaming development; no mention of web 2.0; can develop LMS
ODG	Corp	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Seems to be a consulting company that must partner with courseware and system developers
OurTraining Room.com	Corp	Yes	No	No	No	No	No	No	Yes	Seems to be an LMS solution only
PerformTech	Corp	Yes	Yes	Yes	Yes	No	No	No	No	Award winning SCORM, Section 508 courseware developer only; no mention of LMS solution
Plateau	Corp	Yes	No	Yes	Yes	Yes	No	Yes	No	Industry leader in LMS; social networking;

Company Name	Entity Type	Addr Criteria 1a	Addr Criteria 1b	Addr Criteria 1c	Addr Criteria 2	Addr Criteria 3	Met Criteria 4	HAZMAT/ First Responder Experience	Demo	Comments
Systems										Web 2.0 tools; not a courseware developer
Remote-Learner.net	Corp partner with Moodle	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Uses Moodle LCMS; SCORM ; Section 508; content development; gaming; Web 2.0 tools
Roundbox Global	Corp	Yes	No	Yes	Yes	No	Yes	Yes	Yes	Full service provider of courseware and learning systems development
Staylor-Made Communications	Corp	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Consulting group; has some partners; good process and project management from inception to completion
Summit Training Source	Corp	Yes	Yes	Yes	Yes	Yes	No	No	No	Owns courses; offers course customization and development tools; LMS tools

Appendix D

Regional Meetings Instrument

Regional Meetings Instrument

These questions were used to engage the state training directors and hazmat team leaders in conversation about current and future training.

- Types of hydrogen training currently available in your state. – **current training**
- Types of online training you currently have in your state. - **current training**
- Data on any of the following:
  - Percentage of your first responders that have access to the internet. - **learner**
    - High-speed vs dial up?
  - Percentage of your training done online. - **current training**
  - Percentage of volunteer or combination departments versus career in your state. - **learner**
- Types of set-backs you have seen with regards to training: - **barriers**
  - Volunteer versus career
  - Location within state
  - Generational Differences
  - Others
- What you are looking for in a training system. – **optimal**
- Specific training requirements in each state. - **needs**

Additional Questions:

1. How are first responders currently trained?
2. What should result from an excellent ELC for first responders?
   a. First responders
   b. Learning system infrastructure
   c. Clients served
3. "Drivers … are the levers in an organization that encourage [and] maintain … performance."(Rossett, 1999). What are some drivers to a successful ELC?
4. What are some up-and-coming technologies that you will be addressing within the next 6-12 months?
5. What resources do you utilize when you have training or professional development need?
6. When giving an annual employee performance evaluation, is individual professional development included?
7. How do you know if training was successful?
8. How do you quantify success on emergency calls in your area?
9. For the ELC, do the first responders need to gain knowledge or practice skills?
10. What are a few of the best trainings you've received and why you benefited from them?

Appendix E

Regional Meeting Notes

REGIONAL MEETING NOTES

HYDROGEN FUELS TRAINING BACKGROUND

On September 24, 2009 the *Hydrogen Fuels Training and Education Research and Outreach Project* was added to the Hazmat Fusion Center cooperative agreement between the International Association of Fire Chiefs (IAFC) and the U.S. Department of Transportation's (DOT) Pipeline and Hazardous Materials Safety Administration (PHMSA). This project is funded by the U.S. Department of Research and Innovative Technology Administration.

The project is currently in the middle stages of *Phase I*, where the focus is on determining and articulating the current baselines for responder knowledge of hydrogen. Another integral component of *Phase I* is identifying and assessing the available hydrogen training mediums. The objective is to provide this training via a secure electronic learning community (ELC). Once the research and analysis of *Phase I* have been completed, the project can move forward in presenting an adequate, secure ELC that will enable volunteer and combination fire departments to receive critical training for responding to hydrogen related incidents.

This ELC will ensure volunteer and combination fire departments are able to keep current on trends and issues relating to hazardous materials response by providing a viable training option to help meet the competencies in the National Fire Protection Association (NFPA®) 472 standard. . This project will also become an invaluable addition to the current National Hazardous Materials Fusion Center partnership between U.S. Department of Transporation (DOT)-PHMSA and the IAFC.

REGIONAL MEETING APPROACH

A focal point of the research in *Phase I* was gathering information and insight from state training directors through seven regional meetings. Five of the meetings were conducted face-to-face and two WebEx seminars were held to reach those who could not physically attend but wanted an opportunity to participate. These meetings were held in conjunction with staff from the National Hazardous Materials Fusion Center (NHMFC) as a joint effort to collect information on hazmat teams and hazmat training. The International Association of Fire Chiefs (IAFC) staff hosted a meeting in each PHMSA region, inviting state training directors and hazmat team leaders from all 50 states to attend.

The regional meeting participants had the opportunity to help shape the *Hydrogen Fuels Training and Education Research and Outreach Project*. The attendees discussed potential distance learning and training strategies that can benefit the hazmat and first responder community. To aid attendees in preparation, they were given discussion points the week prior to the meeting and the discussion items pertaining to online learning and hydrogen are included at the end of this appendix. Participants were asked for their feedback and suggestions in creating an ELC for hazardous materials training, starting with a hydrogen training program. The meeting notes for the online and hydrogen training from all meetings are available in this appendix, as well as online at www.hazmatfc.com.

There was a variety of responses and input from across the states, with major takeaways indicating the need for online learning to be complemented by hands-on components to create a blended learning system. No state training directors indicated hydrogen-specific

training courses, but some identified training programs that may discuss or include hydrogen. Meeting minutes from the discussions for each meeting are included, along with listings of attendees and the states represented.

MOVING FORWARD FOR HYDROGEN FUELS TRAINING PROJECT

The National Hazardous Materials Fusion Center along with the *Hydrogen Fuels Training and Education Research and Outreach Project* is committed to continuing the bottom-up development process and is relying on the hazmat community, state training leadership, and other important stakeholders at large to help fully comprehend the landscape of the training for volunteer and combination departments, as well as the first responder community as a whole. The results and feedback from these five regional meetings will be used in conjunction with other research to develop a recommendation on what the most effective and efficient approach will be moving forward in creating online training. As these meetings have indicated, online training is very much needed in the first responder community, especially for the volunteer and combination departments. Moving forward, the process in creating the training and the invitation of key stakeholders in the development of any system will be the key to the success of this project keeping, in mind the expectations and needs that have come out of these meetings.

Eastern Region Meeting Minutes
Baltimore, Maryland
Hilton Garden Inn BWI Airport, Room Mariner I & II
February 9, 2009

In attendance:

Christopher Ackley (CT)
Jamie Bethard (DE)
Jerry Brennan (DE)
Theodore Cashel (NJ)
Geoffrey Donahue (MD)
Ronald Dunn (NY)
Patrick Flynn (PA)
Gary Fulton (PA)
Michael McIntyre (NJ)
Adam Piskura (CT**)**
Jennifer Dietz (IAFC)
Ed Plaugher (IAFC)
James Rist (IAFC)
Veronique Schaffrath (IAFC)
Thomas Wells (IAFC)
Kelly Wolfe (IAFC)
John Woulfe (IAFC)

MEETING INTRODUCTION

The Meeting began with a brief introduction from IAFC Assistant Executive Director Ed Plaugher explaining the importance of participation of key stakeholders in the process.

Veronique Schaffrath, Program Manager for the *Hydrogen Fuels Training and Education Research and Outreach Project*, started a discussion on electronic learning communities. The purpose of the dialogue was to engage training directors and hazmat officials on their experience and findings with training, both online and traditional, which could identify any benefits, gaps or needs that may arise from an online training system for first responders.

A number of topics and agenda items were addressed; meeting attendees had been given a list of discussion topics prior to the meeting so that they were fully prepared to participate.

SUMMARY OF FINDINGS FOR HYDROGEN FUELS TRAINING PROJECT

- **Needs** that a training system should deliver.
- Flexibility
    - Allowing students to complete the course around their schedule
    - Accessible to all who need it
- Interactive capabilities
    - Be able to access and interact with support 24/7 that can help explain the subject matter
    - Contain embedded videos
    - Must keep the interest of the tech savvy and at the same time not scare off those who are less comfortable using the system.
    - Suggestion to let the student choose the module. There was frustration over one refresher online course that forced an individual to be within a module for 13 minutes because that was the predetermined time it would take for someone to learn the material. However, if an individual is living and breathing certain

aspects of a training in his/her daily routine, he/she should be able to go directly to the testing for that particular knowledge component.

- Testing and evaluation portion
    - Must have a system that tests or assesses a student's retention and understanding of the information
    - If certification is the end result, which is best for states, the system needs to be built around the certification
    - Any testing components need to be constantly changing to ensure the learning of the material, and not just the answers
- Ability to serve different learning styles

Concerns about using an online training system or creating an ELC for training.

- Cost
    - Cheaper to train a few individuals (as few as four) in remote location with an onsite instructor (In New York, the cost per student for a 25-hour Fire Fighter I online course is $149).
    - Certain systems, like gaming, seem like good training opportunities, but have astronomical costs to use.
    - Follow-up testing for certification and hands-on competencies is required to meet both the NFPA® 472 standard as well as certification criteria; however, this will make the cost of the training program even more expensive.
- Bandwidth
    - Capability to serve a large population - need to ensure proper bandwidth and speed
- Time
    - Lengthy amount of time needed to develop a sufficient online training system or courses
- Real-time response
    - Giving students/first responders flexibility to complete coursework on own time creates problems if students need assistance. Need to have methods to reach support/instructors in real-time to simulate traditional classroom experiences where students can directly ask instructors questions.
- Accessibility
    - Some states' online systems have restrictions on usage, such as they are only available to state employees, which can cut off volunteer responders; need a secure training system that is accessible to all who would need to use the information

- Perception
    - Can encounter resistance because people don't think they will actually need hazmat training. There is a lack of perceived need, i.e. they wonder why they need to sit through the training.
- 'Empty brain syndrome'
    - Nothing to carry forward after completing the course of even being tested
    - Still occurs in tradidtional training
    - Certification could be natural end, but in Pennsylvania, certification is voluntary, and students would not be forced to that end
    - If they don't master a concept, allow them to use a different learning system to understand it

Ways to **measure success** of training system.

- Assessment that requires students to demonstrate competency
- Certification
    - Can certify the course meets requirements and standards, and let local jurisdictions certify individuals
- Refresher training
- Suggestion to test the "Japanese way" where the process to get the answer is tested, not the answer itself
- True success of training is demonstrated on-scene, when first responders are performing their duties; training directors do not get to truly observe or measure the success of the training because that is done in the field
- Full-scale exercises
    - Simulate what they will encounter in the field to truly test how well the information was relayed and understood
- Hands-on component
    - Difficult to develop a software package or online assessment that has this hands-on component needed to measure success of training

Good examples of training systems (all training systems, not just online)

- Department of Defense (DoD) online training has "knowledge checks" throughout the entire course, and testing at the end of each module, as well as final testing to ensure knowledge transfer
- OnTarget is not recommended
- Damage control school at the submarine school in Groton, CT is very hands-on, simulating an actual response situation forcing students to imitate an actual scenario
- Abottville (tabletop simulator) utilizes different scenarios and outcome levels

Generational Differences that may arise in using online training.

- Pushback from younger generation who are accustomed to certain bandwidths and capabilities
- Some resistance from older generation who prefer tutoring
- Younger generation brings 'gamesmanship' and need to be entertained in order to study or learn; can prefer "Playstation / Xbox / Wii" type of training system
- Target audience contains a mix between the three generations: those in the school system, those in the life system and the post-job system
    - Will need to break it down and have several approaches to address generational differences in learning; no one online training tool is perfect, and may be broken in half for two types of learners
        - Idea of splitting the two to address different types of learners
            - Learners don't want to be labeled, so let them pick from several options
        - People not as comfortable with online learning could be overwhelmed with so many options
            - Make documentation heavy enough that it is text based; don't need separate program, but must be easy to use (avoid big buttons that could insult people)

Salt Lake City Regional Meeting Minutes
Salt Lake City, Utah
Hilton Salt Lake City Airport
February 18, 2010

In attendance:

Mark Schuman (CO)
Jeffrey Farris (HI)
Robert Wetzler (ND)
Renee Lohr (ND)
Robert Knuth (ND)
Mariana Ruiz-Temple (OR)
Andrew Byrnes (UT)
Veronique Schaffrath (IAFC)
Thomas Wells (IAFC)
Kelly Wolfe (IAFC)
Shelton Jewette (IAFC)

MEETING INTRODUCTION

The Meeting began with a brief introduction from IAFC Hazmat Fusion Center Program Manager Tom Wells explaining the importance of participation of key stakeholders in the process and an overview of the meeting agenda.

The purpose of the meeting dialogue was to engage training directors and hazmat officials on their experience and findings with training, both online and traditional, which could identify any benefits, gaps or needs that may arise from an online training system for first responders and to identify and define hazmat teams across the country.

A number of topics and agenda items were addressed; meeting attendees had been given a list of discussion topics prior to the meeting so that they were fully prepared to participate.

VISIONING EXERCISE

Mr. Wells led the discussion to pose the question to the attendees: What will the hazmat responder look like in 2015? 2020? What do we need to prepare for in the future of hazmat response?

- Tiered response system now and in future
- Quick access to information, must be seamless
- Training to same standard and certified by one body. Standardization of certification
    - The gray area, authority having jurisdiction, but if they don't have the equipment, they can't train
- Still a fire-based hazmat teams/response
- Capabilities have to match certification level – if you are operations level certified, need the equipment
- Self-sustainable teams for when the funding runs out
    - Minnesota used a fuels tax to help fund hazmat and training and equipment
    - Utah uses hazmat transportation tax to help fund it
    - North Dakota doesn't have funding to sustain hazmat
- Responders need to have access to training of all types

- Less fractured system and communication between teams
- More online training – but will always need practical hands-on training as well
    - Utah certification test is online
- Multi-discipline in 2020 for hazmat; law enforcement will have more PPE
- 2020: Real-time advising, technical expertise to assist with real-time response

DEMONSTRATIONS

Hazmat Fusion Center Program Manager Kelly Wolfe demonstrated the hazmat fusion center beta reporting system and discussed its features.

Shelton Jewette, Education/Training and e-Learning IAFC Contractor, demonstrated a sample online training platform and discussed features of online learning systems that will benefit the end-user and make for effective training.

- Indicated that IAFC is taking the Grounded theory approach, which will examine the gaps in this problem, then determine the appropriate system that will result from filling the gaps and rectifying the problem
- Passed out a handout – Learning models of 19th, 20th and 21st centuries. Participation by all stakeholders is important to create a system that will be useful and solve the problem and the need that exists; we need to adjust to the changes
- Two standards: Sharable Content Object Reference Model (SCORM) compliant – allows us to put a training course on other Learning Management Systems (LMS) and is 508 compliant (covers users with disabilities)
- Many courses start with music or something to get attention
- Objectives should be written with student's perspective – students want to know beforehand what they will get out of the course.
- Self paced course – software should save location if you have to leave (bookmarking)
- Should have a knowledge test/assessment
- Learner control is important
- Suggestion from attendee: Should offer certificate or college credit, as done in Utah
- Should they be allowed to take exam first to see if they can pass? Many people do that to peek at the questions
- Should there be gate-keepers to make them do at least one module or ask questions throughout all modules so they can't skip them?
- Colorado is voluntary certification
- Should be disclaimer about if it meets certification requirements, etc.
- Utah can see this as a segment to blended approach for certification
- Put on DVD in case of Internet connection issues

SUMMARY OF FINDINGS FOR HYDROGEN FUELS TRAINING PROJECT

- What type of hydrogen training are you doing?
    - North Dakota: Hydrogen fuel stations training
    - Utah: none

    - Oregon: brings in industry and some in textbooks
        - Hazardous Materials and Management and Emergency Response (HAMMER) from Washington, OR sends people there
- What types of online training?
    - No hydrogen training currently
    - Responders seek hydrogen training on their own accord
    - Industry professionals come in to offer training
    - Some participants mentioned they offer online training, e.g. courses and degrees
    - One mentioned they are moving to online training
    - Video is used for online training
    - The online training is required
    - The online training is developed and maintained in-house
    - CEUs offered for completion
    - Online course was a conversion of a classroom course
    - A blended approach to training is preferred
    - LMS used for online training – Blackboard and Moodle
    - Some training is offered through partnerships with other agencies
    - Utah uses it for bachelor's degree and for certification and training classes
        - Firefighter (FF) I and II. Homework online and pre-reqs. Video features online. Moodle™ and BlackBoard.™ All SCORM and 508 compliant. Developing in house. Proctors used at testing centers for online
    - Colorado has nothing online statewide. Moving towards certification program online. Voluntary certification. Internal online program for FF I. No statewide online programs. What they have is Moodle™ based.
    - Hawaii does some online. Center of Public Safety excellence for continuous learning.
    - Oregon has FF I, fire investigators use online, developing in-house
- Who maintains online training?
    - Utah - faculty
    - Oregon - training specialist
    - All done in-house for all states
- Specific training requirements?
    - Approved by authorities in state for hazmat
    - Section 508 compliance
    - Certifications do not transfer state-to-state
    - Region trains, state certifies
    - Utah – voluntary, although hazmat is mandatory - training must be certified and approved
    - NFPA® 472
    - North Dakota Courage to Be Safe (CTBS), North Dakota Firefighter's Association (NDFA) delivers and puts together courses
    - Oregon - has to be on a regional hazmat team to be certified as technician level; others trained to awareness level
- What setbacks have been encountered?
    - Money/budget

    - Computer Literacy
    - Instability at the top, e.g. changes in Governing Board members
    - Culture
    - Accessibility, especially in rural area
    - Existence of a “digital divide” – generational gap
    - Chief doesn’t stay chief for long – lots of transition, and you need to have buy-in from the top, otherwise it won’t be a priority
- What are you looking for in a training system? What are your expectations?
    - Good content
    - Sole source maintenance
    - Branding that is all-inclusive of users (have various entryways online for different subgroups, such as police, fire, industry and health, so it can be tailored)
    - Performance-based
    - Blended approach (w/online synchronous apps, e.g. GotoMeeting)
    - Change Management, i.e. offer IT/online skills training
    - One-stop shop for training concerns
    - Easily accessible
    - User-friendly
    - GoToMeetings, etc. is great – but not everyone can access it or has enough computer literacy
- How do you know if training was successful?
    - How many access the training and do it – shows peer buy-in
    - How they perform in the field on an incident
    - How well they pass test/assessment
- Best training?
    - Passion from instructor
    - Relevance to work
    - Authentic
    - Dramatic
    - Face-to-face
    - Human element
- Statistics
    - North Dakota – 0% training online, 97% are volunteer or combination, 3% career
    - Oregon - 60% volunteer or so
    - Utah – 50-60% have Internet access, training online - 10% for certification, 100% for college credit, 79% volunteer
- Sometimes better with a schedule to complete the training with Facebook group, etc.

Southwestern Regional Meeting Minutes
Little Rock, Arkansas
Doubletree Hotel Little Rock
February 23, 2010

In Attendance:

Kenny Harmon (AR)
Christopher Foreman (AR)
Mike Ray (OK)
Steve George (OK)
Mark Vedder (OH)
Emmitt Cavalier (LA)
Richard Browning (LA)
Thomas Wells (IAFC)
James Rist (IAFC)
Jennifer Dietz (IAFC)
Veronique Schaffrath (IAFC)
Shelton Jewette (IAFC)

MEETING INTRODUCTION

At 10:50 AM Veronique Schaffrath, Program Manager for the Hydrogen Fuels Training and Education Research and Outreach Project, provided a brief introduction with the purpose of the meeting for collecting information and input on the two projects (Hazmat Fusion Center and Hydrogen/ELC).

Thomas Wells, Program Manager for the Hazmat Fusion Center, followed up with an overview of the meeting agenda. A brief video about Hazmat Fusion Center was shown to introduce the project. Mr. Wells followed up the video with background on how the Hazmat Fusion Center formed out of a partnership between the IAFC and PHMSA. During his introduction and explanation of the Fusion Center, Mr. Wells discussed the initial focus groups and provided an overview of the work and future for the online portal and Regional Incident Survey Teams (RIST).

Visioning Exercise

Mr. Wells led the discussion to pose the question to the attendees: What will the hazmat responder look like in 2015? 2020? What do we need to prepare for in the future of hazmat response?

- Responders are from various backgrounds
- Need standards
- Tech savvy responders, need tech savvy training
- Hazmat responders are not full timers
- Will need to sustain skills
- Will need standardized training and certification
- Must use training funds or lose the funds
- Will need to educate the public
- Shelton Jewette, Education/Training and e-Learning Contractor for the project, provided a visual demonstration of e-Learning features

An example of gaming for firefighters, Code3D, was shown. A comment was made that this would be a good simulation for those instances that are hard to replicate during training (e.g. train derailments).

SUMMARY OF FINDINGS FOR HYDROGEN FUELS TRAINING PROJECT

Concerns with electronic learning for first responders

- Integrity and accuracy, need means to ensure that students getting or earning credit for taking the course are actually the students doing the online work. Issues with using a 'buddy system' or piggybacking off someone who has already completed the courses.
- Common agreement that the hands-on component of training cannot be lost in training; time and time again have found value in hands-on training that comes from actually simulating the situations and scenarios that first responders will encounter on the job. Have found through evaluations that first responders want more hands-on training.
    - Room for error can be larger in electronic learning, computer based training cannot simulate the severity of error for first responders; therefore, the training does not create the sense of pressure under which first responders operate
    - The traditional classroom approach also lends itself to more discussion. When a student asks a question, everyone can hear it and hear the answer. There is more benefit to the good of the group.
    - A suggestion to put the course on the road and keep it blended. Some online, and for the hands-on component, the instructors will come to you.
- Access to computers in some areas is limited; representatives from Arkansas indicated that not everyone in their state has access to the computer or Internet, which limits the reach of electronic learning in certain areas.
- Lack of standardization in training makes it difficult to create an electronic system to use across the nation; need standardization to accompany building a widespread system.
- Generation Gap
    - Concern that the younger generation relying too much on electronics will result in them being challenged with hands-on component and being able to actually do the job in the field
    - Younger generation seems incapable of doing training if it isn't online or available on a personal electronic device
    - The pioneers or earlier generations who were originally trained in hazmat have established a system that has worked to reduce the number of major incidents, due in large part to the work that has been done over the years. However, that generation is starting to retire and doing less work on scene, and the newer generation hasn't had the experience with large incidents. In addition, becoming accustomed to gaming/electronics has created the perception of first response scenarios as more of a game to the student.

Current training in states:

- No hydrogen, ethanol or methanol is the biggest concern right now in Arkansas
- Online Training

- (Oklahoma): Most successful is hazmat operations (half online, half hands-on); knowledge base is online, with hands-on follow up. Mix of slides, notes, talking heads. Similar to adobe presenter. Have large testing base to address cheating. Still ongoing
- (Louisiana): still in the process, in-house design/building

Needs

- Interactive system to engage the learners can't be a video that a student can play and walk away from the computer as it runs; training needs to actively engage the user and require them to participate in the course
- Bookmarking: Ability to bookmark, being able to stop and start course based on individual schedule. Nature of first response is to be able to answer calls at all times, so participants need to be able to pause the courses if required to go out and respond in the field, and then be able to resume the training when they have time again.
- Preview a course: Ability to browse through or tour a course to gain an understanding of what it entails. If the first thing required is registration, it makes people less likely to want to join because of the hassle of registering and nothing to grab their attention or draw them into the actual course.
- Means to uphold integrity of course: There needs to be verification of identity to ensure that the individuals getting credit for completing the training are actually the ones who did the work
- Must have training that grabs and maintains the interest of the learner, while keeping it simple
- Keeping the system contemporary: Ability to update coursework so that it is not only recent, but also relative and relatable to participants
- A large testing bank so there are a number of questions to rotate through, which helps eliminate cheating
- Cost: A free training system makes all the difference in whether it can be used
- Utilizing blended learning: Since hands-on component is so critical in training, a blended approach is needed to prevent losing the value of hands-on training
- Courseware maintenance over time

Setbacks or **challenges** with training

- Can have difficulty determining the right objectives and curriculum for the training and coursework
- Discipline on the part of the learners/students, lack of control over different individuals' level of discipline during the training
- Learning disabilities that can impede on individual ability to retain and understand the information provided in training
- Keeping the online training relative and updated: With face-to-face instruction, the instructor can update their course as they please and bring in information or news as recent as that day to provide some relatable examples for training and also keep the course more interesting. This kind of updating is more difficult in an online based system that doesn't allow for the same individual discretion that individual instructors can utilize.

Is there any system in your state that could prevent you from using an online system (approval process)?

- Need to have information services to approve it (State information technology (IT) people)

Questions during discussion:
How do you determine that the person getting credit for the course actually took the course?

- Printed certificate and registered users
- Verifying that an individual actually took a course is an ongoing topic that has yet to be fully resolved
- Having an individual take a final exam with a proctor is one way to resolve it

Central Regional Meeting
Kansas City, Missouri
Four Points by Sheraton
February 25, 2010

In Attendance

Randy Novak (IA)
Dave Wickersheim (KS)
Raymond Palczynski (IL)
Jim McKenney (MO)
Kevin Zunwalt (MO)
Mike Booth (MO)
Chris Van Alstyne (DoD)
Amber Wells (IAFC)
Veronique Schaffrath (IAFC)
John Woulfe (IAFC)
Tom Wells (IAFC)
Shelton Jewette (IAFC)
Jim Rist (IAFC)

MEETING INTRODUCTION

Assistant Director of National Programs John Woulfe introduced the meeting, discussing the Programs Department, IAFC, and IAFC's partnership with DOT at 11 a.m.

Tom Wells, Program Manager for the NHMFC, introduced the NHMFC by showing the NHMFC's new video. Mr. Wells discussed the deliberate bottom-up building approach IAFC is taking for this project in order to get input from the people who will need the information the most.

Question posed: Are you happy with state of hazmat training in states?

Struggle with changes in NFPA® 472 – unclear on fire service components.
Believe it is time for a profile scan.

Department of Defense (DoD) is split, the National Guard forces working in states use NFPA® religiously, but none of the laws apply to the active duty units who work in the battlefield.

VISIONING EXERCISE

What is the future of the hazmat landscape?

- Capability of teams will improve with adequate funding
- Technology will be the determining factor of the future
- Don't see improvements at the operations level for rural states; they are struggling to get them to do basic training, whether it is the equipment or the inability to be able to purchase the equipment
- The approach will be different in different regions
- There is a pending state law right now; if that goes into effect, it will wipe out every hazmat team in the state of Missouri
- Funding is the biggest issue for teams
- Can see hazmat teams becoming specialized and doing no fire suppression
- Technician would be some kind of advance degree person, e.g. associate's degree

- Detection: Due to a lack of technology, an entry team will have to send readings/findings back to an on-scene lab. In the future, due to technology, the entry team will be able to identify a chemical while in the hot/exclusion zone.
- Sustainment of teams will be the biggest challenge (goes back to funding issue)
- It will still be a tiered response system
- Landscape will be diversified, partnering with the Federal Bureau of Investigation, training with different groups, bridge building, people from industry, law enforcement, etc.
- Education level of the individual will be higher and more tech savvy
- The money won't be there to support various specialized teams so they may try to combine technical rescue teams (TRT) and hazmat teams, but it is difficult to specialize in everything.
- Training must address cultural, and geographical differences in background, skills, learning needs and learning styles

Chris Van Alstyne (DoD) presented a presentation on the National Guard Homeland Regional Force Operations Estimate.

Shelton Jewette, Education/Training and e-Learning Contractor for the project, introduced the changing environment of training and provided a handout. He then explained important features in online training:

- Having the option of browsing a course before registering
- Table of contents
- Final exam, trackable
- Ability to survey course materials before completing a module
- Abiding by Section 508
- Putting learner in authentic environment
- Having a "Bookmarking" capability

Mr. Jewette did an overview of the characteristics of an online learner:

- Strong academic self-concept
- Exhibits fluency in the use of online learning technologies
- Possesses interpersonal and communication skills
- Understands and values interaction and collaborative learning
- Possesses an internal locus of control
- Exhibits self-directed learning skills
- Exhibits a need for affiliation

Trends of first responders

- Volunteers are getting older, not younger
- Young kids are working two jobs, so they don't have time to take all the training requirements
- There are more expectations from working adults today
- Blended training is going to be the training of the future; we will need to create separate training for training directors
- Stick with awareness, ops (operations), and tech (technician) as the names of the modules so that it is upfront on what it will cover. It will need to be divided out. Ops is more hands-on than awareness.

SUMMARY OF FINDINGS FOR HYDROGEN FUELS TRAINING PROJECT

Hydrogen Training

- Missouri
  - University of Missouri visited the state training leadership about two years ago to talk about a hydrogen project they were working on, using hydrogen as a fuel source, refueling station. They put two hydrogen fuel buses together. They announced that for the training component, they would go into the departments affected by the buses and refueling stations and train them. After one of the affected departments was checked, it was found that the only training they received was a two-hour safety briefing.
  - Missouri has no requirements for training
  - Online training implemented to reach large populations
  - Online training run by external partner
  - Over 1500 completions of online courses
  - Face-to-face course was converted to web-based
  - Online courses have won awards
  - Online courses are self-paced
- Illinois
  - Illinois has hydrogen training through the university
  - University of Illinois is doing something with the bus company. They want to figure out if hydrogen under low pressure can run. There is no fire training to their knowledge.

Online Training

- Missouri
  - Started with hazmat awareness because there was such a demand. Partnership with a college for a degree program. It is easier in the university setting because they don't have to run the online program. The state training leadership provides the university with the materials and subject matter experts (SMEs). There is a cost to this. They are able to fund it out of state dollars that are intended for hazmat training. The other online classes besides hazmat have a tuition fee. They enrolled over 1500 online who completed; 1,000 were in-state, and face-to-face was only 460. Will send the link to us. Just went through a rework on the class to the current standard and it just opened up last week—the center for distance and independent study, and it won an award. They did satellite, did Instructional Television (ITV), the gateways and the keeper of the gateways, not enough bandwidth.
- Illinois
  - Has eight classes online. It's always cheaper to do online. The awareness is self-study, but can e-mail a teacher if need be.
- Kansas University (KU) just did a survey on training systems
- Did have operations class online, blended approach. Because the website is open, it was problematic because they want their certificate. However, without the full training

(including the hands-on approach), a certificate cannot be awarded. They ended up pulling the class offline.

- National Fire Academy (NFA) has a portal of online courses. NFA is working with seven states' online systems to use parts of the training that can be grabbed and located on a website of an individual fire department. It will go to all 50 states. Could develop a system to be developed across the system. Should link these two systems. Like to see one central focal point that links to the 50 state training systems that links out to the fire departments.

Concerns of online:

- Sending out instructors can be cheaper than paying for online
- Employers (for industrial partners) typically want an instructor rather than online to ensure that the training is taken care of
- Rural areas don't currently have the need for the hydrogen training, maybe just a two-hour awareness, but this could change depending on new technologies
- Volunteers have so many other things competing for their time
- Culture is more of the problem than generational differences
- Change Management for using new technologies and Internet

Optimal online system

- Pitch courses as part of continuing education that already exist for volunteers – maintenance training
- No long videos – five minutes at most
- Retention of training
- Awareness-level content
- Keep it simple
- State What's In It For Me "WIIFM"
- Make is short, keep it simple
- Standardize training terms, e.g. awareness, level 1, etc.
- Link to national training
- Create lesson plans and instructor notes
- Needs to be developed as an online training as well as developed into a course that can be delivered by an instructor

Southern Region Meeting Minutes
Charlotte, North Carolina
Doubletree Charlotte
March 2, 2010

In attendance:

Ed Roper (SC)
Perry Bailey – (SC)
Jonathan Sowers
Jim Rist (IAFC)
Shelton Jewette (IAFC)
Veronique Schaffrath (IAFC)
Glenn Clapp – (NC)
Alan Rice – (AL)

MEETING INTRODUCTION

In addition to a warm welcome, a general agenda introduction was given by Veronique Schaffrath. Jim Rist briefed the attendees on the current status of NHMFC. The NHMFC is currently in the third year. Initially, as a way to build the fusion center from the ground up, focus groups were held in each of the five PHMSA regions. An advisory workgroup was established to determine what they (those who represent different industries) needed in a system. This group has now transitioned to an executive workgroup.

It was pointed out that there is a voluntary data entry system attached to the portal. Currently, a number of departments enter data as part of a BETA test. With the National Fire Incident Reporting System (NFIRS), there is a chance in the future that the best of both systems can be blended and a better, more user friendly NFIRS, can be developed. Remember that no data can be collected and analyzed without data submission.

RIST has been staffed in all five PHMSA regions and approximately 12 surveys have been completed. Attendees were briefed that all RIST surveys will be posted on the NHMFC Portal, with an executive summary on the public side and the whole report on the private side of the portal. All RIST surveys are scrubbed to ensure that all location and personal information is removed and that only information related to the incident for the purpose of learning "best practices" are left intact. RIST personnel are working with Texas Engineering Extension Service (TEEX) to educationally format the reports that come out of the portal.

Mr. Rist went over the special projects that the NHMFC is overseeing. The new hydrogen project was introduced, indicating that the project is currently in the research phase and that we are looking for input into how the training should be built.

VISIONING EXERCISE

"What will the hazmat responder of the future look like?"

- Methods of learning will shift
- New generation most comfortable with technology
- By default they will move to technology training where available

- Younger generation has a tendency to question everything; this could be safety issue during a call
- More electronics will be a part of training and will be utilized on the incident scene
- New generation will have trouble going back to hard copy if there is technology failure
- Will have trouble with manual basics
- More time constraints for volunteers
- Less volunteers/no volunteers?
- Move to private industry?
- Blended training is the answer – compromise/bridge between generations
- Concern of technology failure – responders need answers with urgency on scene

Shelton discussed learning. He handed out two information sheets titled "Learning Models for 19th, 20th, and 21st Centuries" and "Building Blocks for e-Success."

SUMMARY OF FINDINGS FOR HYDROGEN FUELS TRAINING PROJECT

Current Online Training

- Representatives from the states (South Carolina, Alabama, North Carolina) have used online learning as part of training.
- Alabama – has had instructors who build off of Moodle™. They use Blackboard™. In the testing mode, you can bookmark. Registration is required; they can't see the information before they go into the course. Does college credits for online; more colleges are starting to entertain non-traditional courses.
- North Carolina – seen systems where you can accomplish different chapters at different speeds, but you do have to spend eight hours in the course to meet OSHA criteria
- South Carolina - have college credits for regular classes. Have spent time and money developing traditional courses and they don't come. Depends on the topic.
- North Carolina - can do chats online. Adobe connect, once every two weeks.
- Alabama - hearing a lot of demand for online training, representative remains skeptical if online training will be capitalized on when it becomes available
    - Alabama mandates National Board on Fire Service Professional Qualifications (ProBoard) and/or International Fire Service Accreditation Congress (IFSAC) certification. They are piloting a program right now. They are finding they have gotten the technology ahead of the user. Never would have envisioned that. Can get them to look at the website, but not take the course. Have the campus setting for the career fire department. For the volunteer population, it will probably change as the demographics of the volunteers change. Web mediated instruction – a repository of resource materials that live instructor can access to make a better course. There is a role for this. Don't think the demographic is there to support it now. Web mediated resource will be the first step. Some people do it and latch onto it. The average volunteer firefighter is not there yet.

Expectations of a system:

- Reliability
- Creates retention
- Completion of the online portion readies the student to learn the skill set, if there is a hands-on training component required

- Quick - readily facilitated feedback for students
- Make the training desirable and interesting. What makes it interesting is not necessarily the bells and whistles. Relate to real work experiences.
- 508 compliance - Access to education and the eligibility for certification are two different things
- User determines speed and modules to go through, otherwise doesn't feel appreciated
- Tie it to accountability; people usually pick the fun ones first
- Have prerequisites - students need some baseline hazardous materials knowledge before they learn hydrogen. This format will allow a hydrogen training package to fit into a Firefighter II program which has prerequisites for liquid/compressed gas as per NFPA® 472 standard
- Needs to be part of "right to know training" for OSHA, or refresher training
- Applied knowledge
- Need innovative case-based education; need to make it interesting
- Should not be memory work. Should be how do you look it up in the book. If you try from memory while on scene in a stressful situation and get it wrong, it could be life/death.
- System should be geared to complement the existing system trainings that are out there
- Offer a reward, a neat patch or certificate
- Design the course, they will use it. State training staff is more time-constrained and reduced in staff than ever and will be accepting of any help. Current state budget restrictions are not allowing any new curriculum development.

Current Hydrogen Training/ Need for Hydrogen Training?

- You have to cover structure burns, house fires, car fires, etc.; you start to run out of open dates for new material for volunteer training
- Every fire is a hazmat event; they need to know fire and hazardous materials operations (ops)
- Sometimes students ask training staff why hazmat ops are required; Answer - many times you are in a hazmat situation without knowing it
- Students will need a lot of different training topics before hazmat ops
- Hydrogen is the easiest subject to teach; when it's burning you cannot see it, what is seen is the class A and/or B materials around it
- Topic being run into is detergent suicides, which impacts fire, law enforcement, EMS
- South Carolina has been teaching hydrogen for years as part of the hazmat ops, not per se, but as part of liquefied and compressed gasses
- Useful at company level training; always looking at fresh way to teach something
- Do not make it certification (ProBoard and/or IFSAC), but making it as a teaching aid would be best
- If there is a credential out there that is NFPA 472® compliant, they are willing to look at it
- Broad based curriculum support could be really good for the training directors. Anything for curriculum support would be invaluable—hydrogen based or other. They can make it accredited.
- Federal credentialing would be the best so there is one guideline and trainings could be used interchangeably. Attendees felt that NFPA® 472 was too subjective when you look at it alongside the Hazardous Work Operations and Emergency Responses (HAZWHOPPER) regulation, and other related standards and regulations; they would like the federal government to level the playing field and have one document, and that would also be true for the Federal Emergency Management Agency (FEMA) Credentialing and Team Typing.

Challenges to online training

- Can be difficult to convey the severity of situations found in hazmat response; how the response is handled can make the difference between life and death
- Learn more by discussion, when attendees can hear all of the questions
- Some educational and generational differences may make a person feel more comfortable in a classroom setting
- Population is very diverse and this has to be accommodated, even within a state
- Challenging to get people to engage in training
- Duplication of efforts is a concern, as it inundates end-user with too many options
- The economy is a setback now. Building the platform for this online. Most don't fund IT, and can't conduct distance learning without it.

Webex Meetings
Conducted from IAFC Headquarters
March 3, 2010

Meeting 1
8:00 AM – 10: 00 AM (Eastern Standard Time)

In attendance:

David Wall (GA)
John Buckman (IN)
Larry Hamby (IN)
Lanny Adkins (WV)
Veronique Schaffrath (IAFC)
Shelton Jewette (IAFC)
James Rist (IAFC)
Jennifer Dietz (IAFC)

MEETING INTRODUCTION

Thomas Wells, Program Manager for the Hazmat Fusion Center, began the meeting by providing an overview of the Hazmat Fusion Center. After explaining the background and formation of the Fusion Center he gave a brief description of the portal and RIST.

Then, Veronique Schaffrath, Program Manager for the *Hydrogen Fuels Training and Education Research and Outreach Project*, introduced the new project and provided a timeline.

SUMMARY OF FINDINGS FOR HYDROGEN FUELS TRAINING PROJECT

Experience with online learning

Shelton Jewette started the discussion by asking meeting attendees about their past experiences with electronic learning.

- Have you taken any end-of-course surveys for online courses? Response: sometimes
- Were you required to take the course before answering the survey? → yes
- Were you required to register? → yes
- Would there be a benefit to making the course available to general public? → no
- Was registration simple? → yes
- Did you have some sense of control over how you completed the course? → somewhat
- When you took the course, were you given the option to accept or receive college education (CAU)? → yes
- Do you know if your online course was accessible for those who may have disabilities (vision or hearing impairment), according to the American Disabilities Act? → no
- Anything else you think we should consider? → no

Veronique Schaffrath provided a demonstration of Code 3D as an example of gaming as one possible approach to electronic learning or training.

Current Hydrogen Training Available

- Online course for hydrogen made available by Department of Energy (DOE) training, hydrogen training that was overview of chemistry (fuel cells). This was about an hour long and was broken into several modules, with a test at the end and a certificate given. It was a new enough subject that could draw you in.
    - Were you given scenarios, how was it applied?: course provided simulations
    - Had a test at the end…received certificate
- Georgia: Nothing at this time

Current Online Training

- Indiana: lots of online training (public safety, ethics training, payroll…do have emergency response learning management system→ rules, response training). An in-house person is assigned to develop those courses full time.
    - Have taken some online courses, also helped develop some of these courses
    - Strong points: speed, short (if after 20 minutes there is no break between modules, you start to lose their interest and will aimlessly click through); test at the end generates a certificate (need some kind of acknowledgement for completion of course)
    - Amount of time to complete: State employees get a two-week block to complete the course. However volunteer firefighters may need more time due to the realities of their schedule constraints.
- National Incident Management System (NIMS) training that is online is too much power point and you lose the interest of the student, can't just have slide after slide…needs to be entertaining to keep attention…instructors can be entertaining and tailor the presentation of their course, need something to mirror that and can draw student in
    - Can tell a difference between people who were taught online and in-person; lack of interaction put this group at disadvantage and they required extra attention
- Four-day acting officer course. This is a blended, relatively new course. Has a chat room. Takes six weeks (online is longer than in-person) with a one-day, in-classroom session before providing the test.
    - Live chat is missing; chat isn't required, but is a benefit to students who participate
    - One-day classroom session: morning is spent doing command simulations
    - Adobe product
    - Have 24 students in class. For instructors, grading homework is harder to manage than in the 12-student online courses.
- Jones & Bartlett (Firefighter I & II)
    - For the ones who completed it, there was a very high pass rate; however, not everyone took it actively, so there was some lost cost in that
    - Facilitator is accessible (e-mail, chat & phone); facilitator gets back to you within 48 hours, and that resource is helpful to the students enrolled in the courses
    - West Virginia recently used blended learning of Jones & Bartlett where instructors can monitor students and adjust to benefit the students.

Overall, they are happy with the courses. Instructor can see where students are deficient, which allows for insight into how to better adjust or tailor the course to individuals to enhance learning.

Types of setbacks/barriers for Online Training

- Acceptance
  - Is gaining acceptance as a viable way to learn
- Cost
  - Maintaining service, system costs or hardware can be expensive and add up, which can be a lot for already strapped departments; it can depend on the department's resources
  - Can save some travel expenses, but there is always a cost no matter what we do; volunteers are more concerned about the subject matter for the course
- Generational Differences
  - Majority of people over the age of 30 (still the majority of our audience) who have not engaged in online learning are less receptive to the shift
  - Need to get older personnel in the habit of doing online training
- Conversion courses (go from face-to-face to online, or start as online)
  - Couple have been face-to-face and converted into online
  - To get word out and have awareness of different web courses (usually web courses arise out of need and requests)

What you are looking for in a training system?

- Need to have interaction and instructor to keep students actively involved, and address/answer questions as you go along

- What do we need in this system (ELC) or course itself?
  - Need hazmat experts involved
  - Stay focused on the hydrogen aspect and try to keep it within an hour; the longer it becomes, the harder it is to manage and keep attention of the students. As standards are updated, the course needs to maintain relevance, but trying to incorporate it into the training can make it longer and more complicated.

Importance of hydrogen as a topic for first responders?

- West Virginia: see a lot of hydrogen commercially used in annealing of metals, working with plants. However, there is limited knowledge. Would benefit from awareness on the topic of hydrogen.
- Indiana: deal with ups and downs of industry, no plants are manufacturing hydrogen. However, still need to learn more about the topic to be prepared for responding to hydrogen incidents. Whether it's a problem today or five years from now is hard to say, but something to be knowledgeable about and prepared.
- Georgia: not many hydrogen sites (production or fueling).

Meeting 2
4:00 PM – 6:00 PM (Eastern Standard Time)

In attendance:

Julie Olsen-Fink (OR)
Mark Ayers (OR)
Eriks Gabliks (OR)
Ron Bowen (WA)
Jeff Pardue (LA)
Wayne Colburn (MD)
Veronique Schaffrath (IAFC)
Shelton Jewette (IAFC)
James Rist (IAFC)
Jennifer Dietz (IAFC)

MEETING INTRODUCTION

James Rist, Program Coordinator, provided some background history on the Hazmat Fusion Center. Rist explained the several facets of the Hazmat Fusion Center with the Portal, RIST and Special Projects (training packages).

Then, Veronique Schaffrath, Program Manager for the *Hydrogen Fuels Training and Education Research and Outreach Project*, introduced the new project and provided a timeline. She identified the purpose of the meeting as a means to gather feedback from attendees.

SUMMARY OF FINDINGS FOR HYDROGEN FUELS TRAINING PROJECT

Experience with Online Learning

- Maryland: has three programs that are mixed/blended training→Hazmat operations, Emergency Vehicle Operator Course (EVOC) and EMT refresher; have to go to a location for the "practical" and skills demonstration part
    - Course is self paced with date restriction; students work on their own time and are given a timeframe to complete by
    - In the EMT course, the test is online (didactic part of the refresher)
- Washington: work with Washington State Patrol and do a lot of modular training, ability to bookmark; haven't developed a lot of online training, but using existing resources Texas Engineering Extension Service (TEEX)
- Louisiana: developing Firefighter I online course; 23 modules are broken up into lessons (20 minutes each), and exams are taken upon completion. Combining different kinds of media.
- Oregon: Instructor I Distance Learner program, 16-hour online program followed by 16-hour, hands-on component
- States who have resources of universities have connection to online learning
- Incorporating **Section 508**(Government requirement for Americans with Disabilities Act)?
    - Maryland: Have had to provide larger font on written exam for legally blind student
- **SCORM**
    - Allows online courseware to be interoperable between different systems
- **Learner control:** In courses you have used or worked with, does the learner have a level of control?
    - Louisiana: nonlinear, can enter any module, but you must follow the sequential order of a given module. Multiple games and activities with interactivity. Must manually advance to the next slide

- **Gaming:** What level of gaming?
    - Louisiana: flash game software, use program called Articulate that has various engagements associated with that software.
- **Instructor role**
    - Class of 20 students with an instructor who has ability to access the system and monitor the students. Instructor can also be contacted with questions, and is in more of a mentor role than instructor.
    - Oregon: Fire Institute Classes (300-400 level college systems) use online systems of Blackboard™/WebCT, more academic than skills level class
- **Registration:** Do you need to register? How Long Does it Take?
    - Maryland: must register online through the homepage, registration period set by dates
    - Louisiana: must create an account with a password, do get credit for the classes. For in-state it must be approved by a fire chief.
    - In early stages, so unsure of waiting period, but will put in some security measures to confirm
- **Number** of people completing the course?
    - Oregon: since converting from CD-ROM to the website, the completion rates have been doing well. Staff have administration rights so they can monitor the students and help motivate them to go through the course.
    - Louisiana: will be rolled out in June (not online yet)
    - Maryland: started out slow, but has grown as people are more aware of it
- **Who** is running your online system? In-house with a staff?
    - Maryland: mix of CD to get started
    - About a dozen have fire training systems in conjunction with universities (Louisiana and Maryland). Maryland has regional locations to create more opportunities.
    - University system has access to staff and online support

Types of hydrogen training currently available in your state.

- Oregon: do not have too many hydrogen facilities; is not a big issue yet, so there isn't much training
- Maryland: nothing specific on hydrogen, is mentioned and discussed in some classes.
- Washington: no organized training, but have looked at HAMMER
- Lots of training is defensive (reactive rather than proactive)
- Louisiana: developed course for awareness to new vehicles design (with a small portion of awareness to alternative fuels like hydrogen)

Types of setbacks you have seen with regards to training:

- Having all sorts of versions is a nightmare
- Once you develop a program, you have to have someone watching the standards for when they change, capability to update as needed
- Most states adopted OSHA 1910, and adopted NFPA® 472 as a way to get there.Retain-ability
    - Needed to slow down course because students were blowing through the class and not retaining the information
    - Need testing to ensure that information is being absorbed
    - Some level of monitoring, ensure security and legitimacy to the online programs (issues of honesty and plagiarism)
- Incentives for course

    - Oregon: level of certification is an incentive (promotions can be contingent on levels
- Professional Development
    - Hazmat teams tend to be busy and don't have many open hours, but others in the department can do more in-house training
- Bandwidth
    - Number of departments do not have connection to Internet in rural areas
    - Shuffle and movement in the department--disrupts and complicates having consistency (sometimes training officers aren't comfortable or favorable with online learning and that can change things)
- Costs
    - Issues with overtime in training, so online has been able to save time as people do the courses on the job without travel (OR saved $300,000)
    - Career departments have cited savings in overtime
    - No charges for the courses (no charges for the students)

What you are looking for in a training system?

- Podcasts: have become popular with agencies considering it as an option
- Washington: absorbing and using the technologies that are already out there
- Do you want it available to the general public, such as FLSA issues? Also, need structure to keep up integrity of courses and certification. Disconnect between online training and actual hands-on skill requirements of the job (people certified in a number of levels, but have never run a call).
- Youtube is being used as a resource for information; there can be issues with validity
- Academics are staying away from the Wiki sites due to problems with Wikipedia because of the difficulty in verifying accuracy
- Web 2.0 / Mobile learning

What do you think is necessary to make this course a success?

- User-friendly system, and information kept current
- Missouri fire rescue institute online hazmat awareness (police and fire used it)
- Maryland is looking forward to online training that is more available
- Moodle™ format that can be incorporated into our training
- Need some stories or narratives because it is new and upcoming fuel so they will need something brought up because they cannot bring in their own experiences to relate to the subject matter
- Need interactive scenarios after plugging through some of the materials

How long should the course be?

- However long, it takes to cover the material
- Three to four hours at the most is a good working area
- Can be scalable: four-hour program with four one-hour modules

Discussion Items

Below are the discussion points sent to attendees prior to the meeting.

Electronic Learning Items to Discuss

These are some of the topics we will be discussing at the meeting. Please take a look and come prepared to participate in discussions that will shape the future of responder training.

- Types of hydrogen training currently available in your state.
- Types of online training you currently have in your state.
- Data on any of the following:
    - Percentage of your first responders that have access to the Internet.
        - High-speed vs dial up
    - Percentage of your training done online.
    - Percentage of volunteer or combination departments vs career in your state.
- Types of setbacks you have seen with regard to training:
    - Volunteer vs career
    - Location within state
    - Generational differences
    - Others
- What you are looking for in a training system.
- Specific training requirements in each state.

Appendix F

A Concept for a Comprehensive First Responder Training System

NORTHROP GRUMMAN

A Concept for a
Comprehensive First Responder Training System (ComFRTS)

Submitted to:
The International Association of Fire Chiefs

May, 2009

TABLE OF CONTENTS

Comprehensive First Responder Training System (ComFRTS)

The Northrop Grumman team looks forward to supporting this nation's first responders and other emergency response personnel with a Comprehensive First Responder Training System (ComFRTS). Our instructional systems developers, human performance analysts, and other professionals will deliver best-in-class training and performance support products and services.

Providing extraordinary results on time and within budget.

Introduction

First responders including firefighters, police, and emergency medical services personnel, must be informed, trained and equipped for virtually any situation, including natural or human-induced disasters, acts of terrorism, hazardous materials, and other emergencies. Effective command and control is also needed for incident response. Further, the psychological impact upon first responders needs to be considered following any critical incident. The Comprehensive First Responder Training System (ComFRTS) concept described in this paper addresses these and other needs for the nation's first responders. ComFRTS includes not only focused, on-demand training, but human-systems integration, performance support, learning and knowledge management, and evaluation for continuous improvement.

Currently, Federal, State, Local, and Tribal organizations are providing training to hundreds of thousands of first responders nationwide. These training curricula vary widely in content and format. Thus, first responder proficiency ranges from unskilled novice levels to highly skilled experts. This applies to both individual competency and to teams. New or modified curricula are needed to address emerging first responder systems, technology, missions, and equipment. As shown in Figure 1, implementation of ComFRTS curricula will reduce the present variability in knowledge, skills, and abilities (KSA) among the nation's first responders, bringing all ComFRTS-trained personnel up to the higher desired proficiency levels. This is critical to the future safety and well being of our nation.

Effective emergency response requires a diverse range of KSA and these are increasing in number and complexity. In the past, instructor-led training (ILT) and hands-on exercises have been partially effective for providing the nation's first responders with the KSA needed to address all emergencies. However, given the number of Federal, State, Local, and Tribal first responders to be trained and their broad distribution throughout the nation, ILT is no longer efficient. Demand is high for new training and performance support tools/technologies to meet first responder needs. These training tools need to be made available when and where needed to provide repeatable, standardized instruction and performance support to our first responder force throughout the nation.

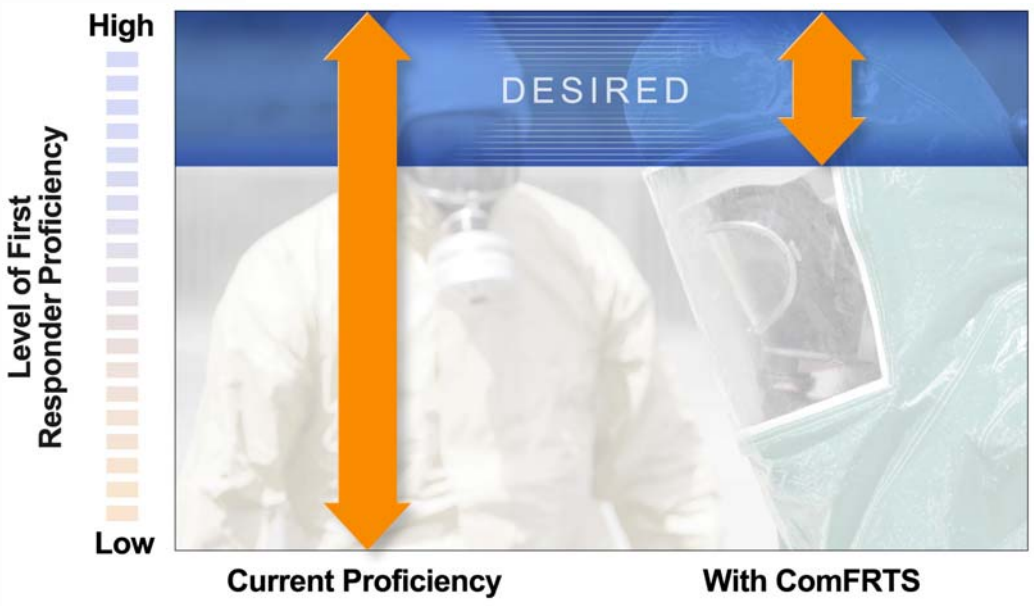

Figure 1. ComFRTS will bring higher, more uniform levels of KSA to our nation's first responders.

Industry data from the American Society of Training & Development (ASTD) and the Society of Applied Learning Technology (SALT) indicate that ILT costs tend to increase over time. Technology-based training costs tend to decrease over time, especially for high-throughput programs involving many courses and remotely distributed learners. With current training technology (lower-cost servers, robust, flexible tools, and broad distribution capabilities), such training delivery often is less expensive than ILT out the outset. This situation would seem to apply to current programs that educate and train the nation's first responder workforce comprised of nearly one million people.

In view of today's more efficient, user-friendly, standardized authoring packages, technology-based instruction brings lower recurring costs than ILT in the out-years (Figure 2). Courseware is easier to modify and can be rapidly edited to reflect mission, policy, procedure, or equipment changes. While Figure 2 content is not based on actual first responder training costs, the curves illustrate the principle of lower recurring costs over time with e-learning and other technology-based instruction relative to ILT. For large learning populations such as first responders, the cost savings can be significant. Studies on learning effectiveness (e.g., American Airlines, Caterpillar University) have found that e-learning is equally effective for many KSA and in many instances more effective than ILT. Younger generations of learners quickly identify with, and adapt to, interactive e-learning.

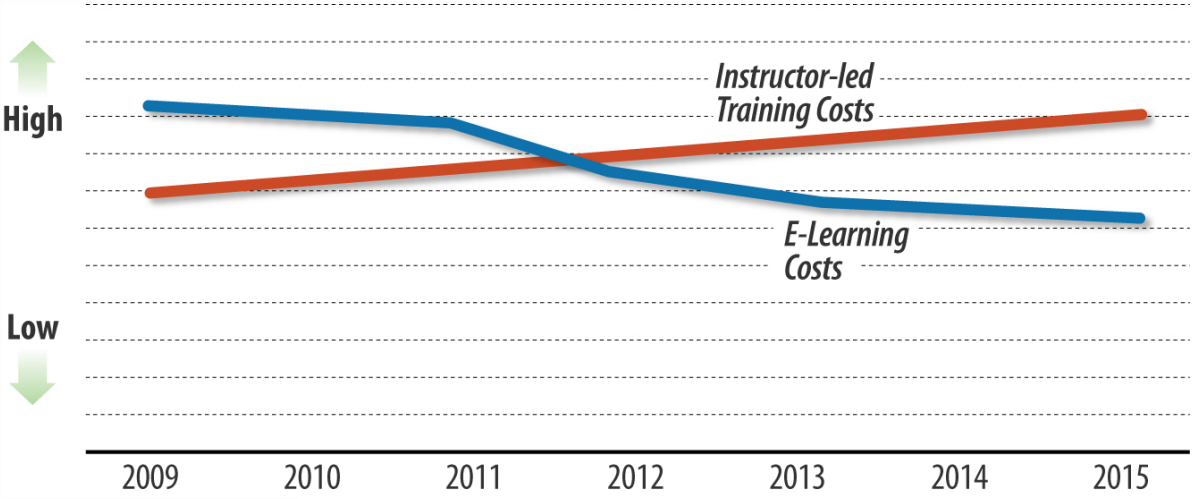

Figure 2. Studies have shown that e-learning conserves recurring training costs relative to instructor-led training.

Certainly there are best-in-class first responders whose emergency decisions and actions should be incorporated into all training, especially into e-learning programs. First responder subject matter expert (SME) and instructor KSA can and should be captured electronically for knowledge management and mentoring purposes. This rationale underlies the ComFRTS approach described in the following sections.

The benefits of e-learning and other on-demand performance support and training methods are even more significant for *first responders located in remote and rural regions of* the U.S. Senator Ben Nelson of Nebraska has remained at the forefront in advocating performance and training support for firefighters, police, medical and other key personnel, and especially for those first responders throughout rural America. Our ComFRTS concept, described below, fully supports all first responder training including those located in remote areas.

Approach

Northrop Grumman's ComFRTS approach (Figure 3) will encompass the full range of first responder training requirements. This training systems approach represents the collective experience and expertise of government and industry instructional designers and technologists over the past 25 years. Five major ComFRTS components - *people, hardware, software, courseware, and systematic processes/procedures* - are shown as well as examples of items within each training system component. It is the treatment of inter-relationships among the five key components that sets the ComFRTS approach apart from conventional training programs. The product of ComFRTS is a *blended learning approach* that utilizes all methods/media to promote learning when and where needed by first responders.

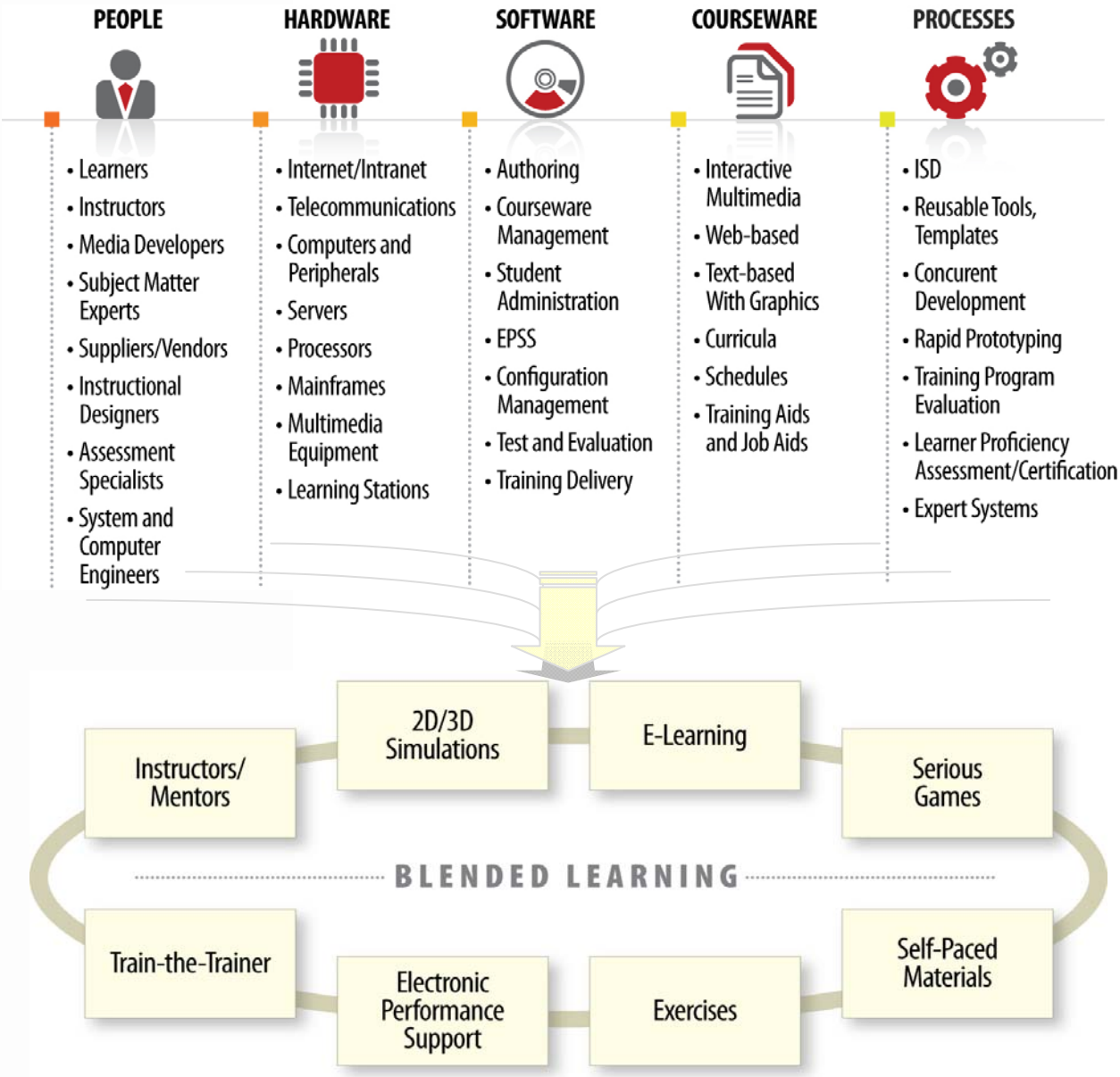

Figure 3. The ComFRTS approach includes all training system elements and their inter-relationships to meet the full range of first responder training requirements using a blended learning approach.

Instructional Systems Development (ISD). The cornerstone of ComFRTS is the ISD process which has been applied routinely within government and industry training programs since the early 1960s. The top-level ISD model included in ComFRTS is shown in Figure 4. ISD characteristics include:

- Training requirements and objectives are clearly defined and organized prior to development or modification of content
- First responder target audience, mission and technology KSA, and expectations are clearly defined
- Each ISD phase builds on data from the preceding ones and feeds subsequent phases
- Formative and summative evaluation verifies user KSA and training system integrity
- The model is closed loop and employs feedback to enable training refinements over time
- Existing training data or other resources are fully leveraged to save time and development costs

Northrop Grumman's ISD-based approach will ensure that all first responders are trained to perform their missions safely and efficiently.

Prior to beginning the ISD analysis, actual vs. desired first responder performance is assessed, working with SMEs and key stakeholders. The purpose of this activity is to differentiate training-related and non-training-related performance issues. If needed interventions are determined to be training-related, the ISD process is initiated. If not, other interventions are sought. First responder performance data can be obtained or derived from lessons learned by Federal and regional paramedics, police, and firefighting organizations. If performance shortfalls are found not to be training-related, the ISD model is not applicable and non-training solutions (e.g., policy/ procedure changes, job re-design, human factors, organizational or management changes, recruiting/hiring, incentives) are recommended. A 2006 study [1] assessed After Action Reviews (AARs) from four major emergency/disaster responses – Andrew, Katrina, Oklahoma City and 9/11. Results indicated that standardized training and exercises would have greatly improved incident command and response. Improved training was cited as the key intervention to improve first responder performance. However, other factors cited were a need for more coordinated leadership, improved communications, better planning and resources, and incentives to institutionalize response at all levels.

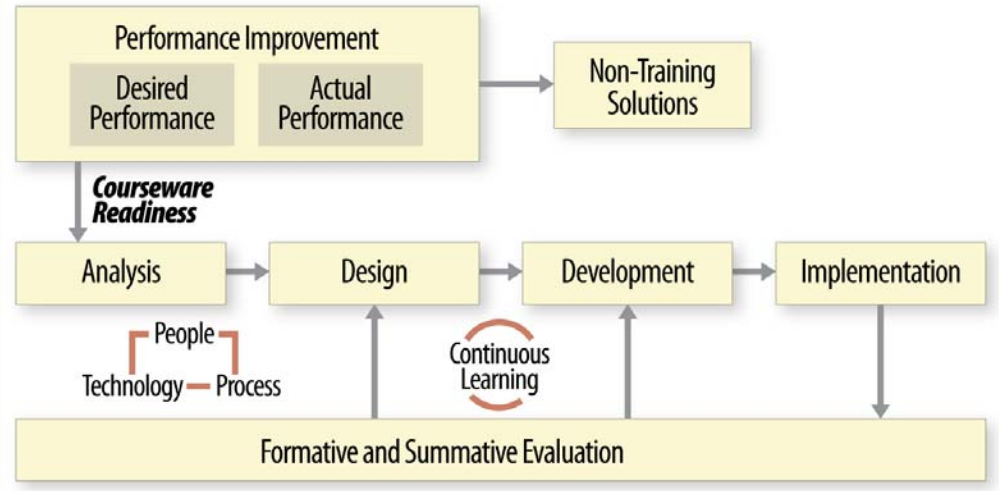

Figure 4. ISD ensures that first responder training is linked to all emergency response decision and action requirements.

The ISD Analysis and Design phases present opportunities for time and cost savings. Our team is prepared to apply our Levels of Necessity (LON) model (Figure 5) to identify first responder training content, job-task analysis data, learning objectives, lesson plans from existing instructor-led courses, graphics, video, multimedia elements, or other resources that can be applied to speed development and reduce costs. This is advisable for incorporating the best available first responder training while saving time and development costs. In situations with less complexity, more time constraints, and fewer resources, a 1st- or 2nd-level LON effort is performed.

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[1] Donahue, A. and Tuohy, J., Lessons We Don't Learn, *Homeland Security Affairs*, July, 2006

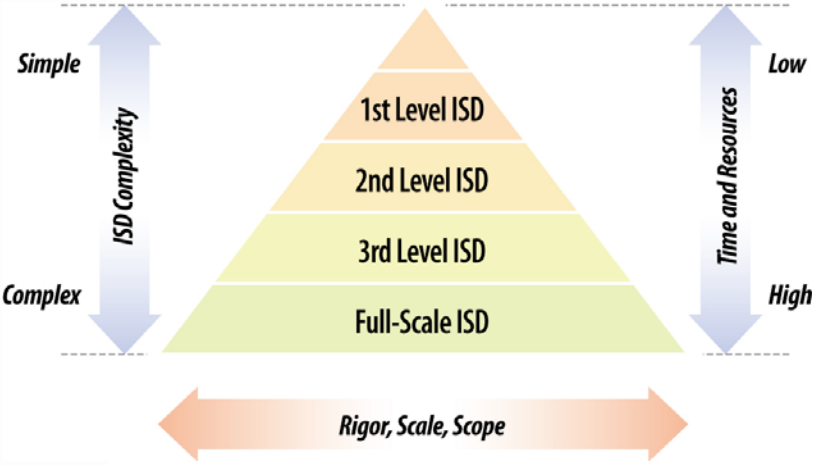


Figure 5. Northrop Grumman's Level of Necessity (LON) Model will save time and development costs by reusing, adapting, or repurposing existing first responder training data.

ISD is accomplished by our multidisciplinary teams with skills in project management, instructional design and development, training technology, software engineering, multimedia production, 2D/3D animation, Web-based courseware authoring, quality and configuration management, test and evaluation, and technical writing. An example of team composition is shown in Figure 6. Skill sets are assigned only as needed to support the requirements of a given ISD phase. Subject matter expertise is assigned internally and/or externally to ensure the technical accuracy and realism of emerging courseware products. Project costs will be conserved by assigning *only* the skill sets needed for a given ISD phase.

ISD Analysis. The initial activity performed during this phase is the training system requirements analysis (TSRA) which may consist of one or more of the following:

- Mission, Job, Task Analysis
- Target Audience Analysis
- User Needs Assessments
- Training Technology Assessments
- Initiate Learning Objectives Definition
- Media/Method Analysis

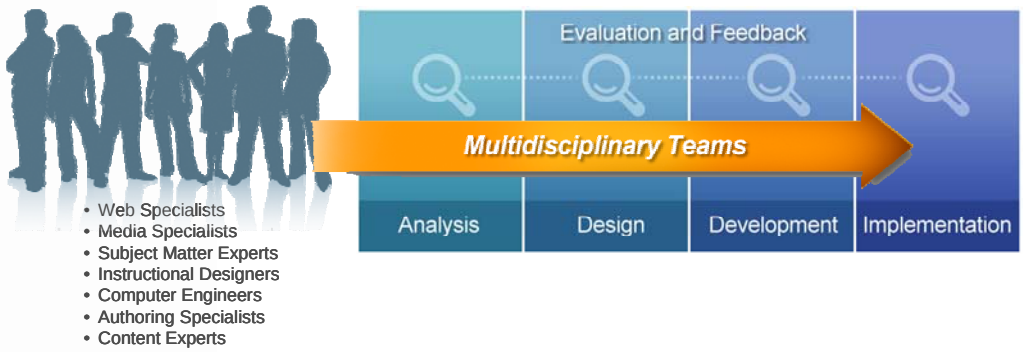


Figure 6. Multidisciplinary teams ensure that the right talent is applied only when needed, saving resources, labor charges, development time, and travel costs.

The Analysis phase sets the blueprint for a sound training approach

The target audience for first responder training includes a broad range of skills and experience among firefighters, law enforcement, emergency medical personnel, dispatchers and others. Background and experience range from newly assigned personnel to those with extensive and/or specialized KSA.

Our team will delineate common and unique performance requirements across first responder populations by conducting a survey of needs/skill sets. We will use our *eSurvey*, as required, combined with targeted interviews of representative first responder sample groups. Training content must address policy, planning, procedures, geographical and even cultural differences, without compromising the uniformity of instruction. Human System Integration (HSI) interventions may also be required to provide improvements in work systems or equipment that reduce or eliminate 'train-arounds' and enhance first responder performance.

We are fully prepared to support the IAFC and other key stakeholders in conducting the TSRA (Figure 7). The tools employed by our training analysts for conducting the TSRA may include:

- Structured individual, group or multi-level interviews
- Surveys and questionnaires (including our *eSurvey*) with appropriate follow-up
- Time-based and event-based job observations (real or simulated)
- Video recordings of individual and team performance
- Operational sequence diagrams
- Case studies
- Flow charts and decision tables
- Phone surveys
- Reviews of personnel and operational records
    a. demographics
    b. emergency response types, complexity, volume
    c. other related experience
    d. education
    e. employee morale
    f. certification
    g. budget
    h. training technology and media reviews

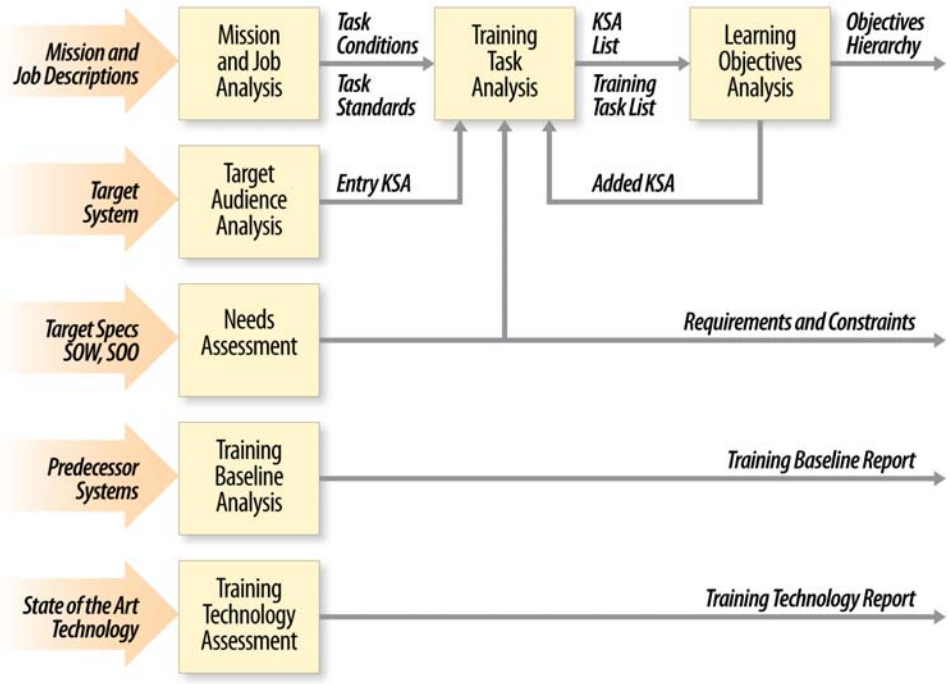


Figure 7. The TSRA will define what needs to be trained and how best to proceed with ComFRTS design and development.

We will develop learning objectives hierarchies consisting of sharable content objects (SCOs), Figure 8, that are fully compliant with Advanced Distributed Learning (ADL) requirements http://www.adlnet.gov/index.cfm, using the Sharable Content Object Reference Model (SCORM). Each SCO contains a learning objective, content to support that objective, and evaluation linked to objective and content. The goal is to reinforce and sustain meta-skills[1] using SCOs. When uploaded to a Learning Management System (LMS), SCOs can be packaged and delivered via DL to any given first responder organization. This provides tailored, yet standardized training that is easy to access and use.

SCORM compliant courseware is reusable, repeatable, measurable, and LMS-compatible. SCOs can also be distributed via CD-ROM or a secure intranet to support standardized first responder training. SCORM compliant WBT also reduces travel costs and instructor workload, includes built-in assessment, and lends itself to training many first responder tasks and procedures.

[1] *Meta-skills are cognitive strategies that an individual applies to the processing of new information in a novel situation (one that is not previously experienced). These skills include chunking or organizing new information, recalling relevant schemas, adding the new information to the old schemas, and creating new schemas.*

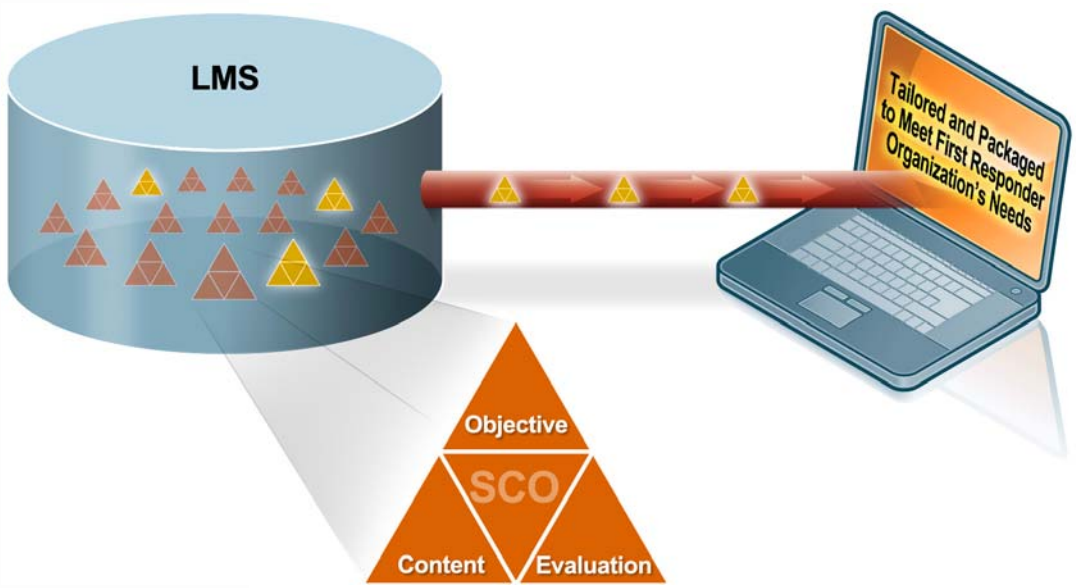


Figure 8. Sharable Content Objects (SCOs) support standardized first responder training and can be tailored to individual needs within and across regions.

Our team will develop learning objectives hierarchies consisting of SCOs that are fully compliant with ADL requirements. Our SCORM process (Figure 9) yields repeatable, scalable training that can be uploaded to any LMS, for use by first responder trainees using internet-capable computers anywhere, at any time.

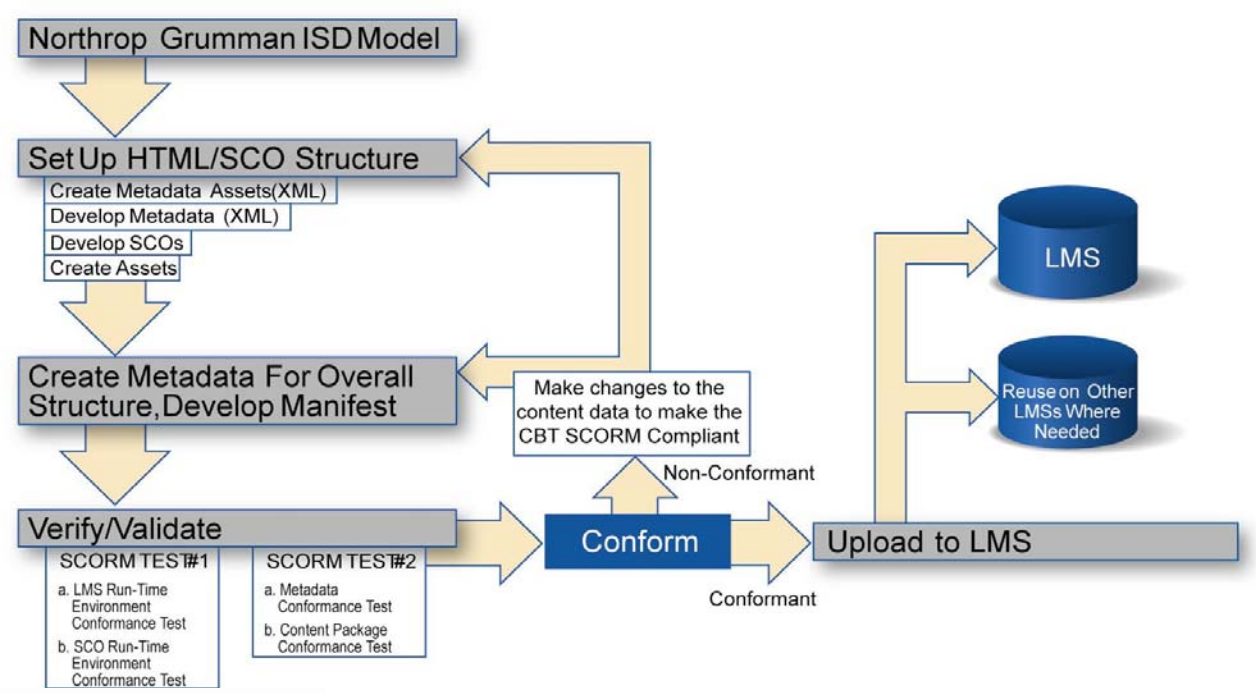


Figure 9. The SCORM process yields repeatable, scalable, standardized instruction that can be uploaded to any LMS, then repurposed and reused across all first responder training settings.

It's important to note that SCOs are useful not only to support e-learning, but for all blended learning types (Figure 3). While SCOs have become virtual requirements for enterprises employing a LMS, they can be deployed to any Web server, to CD-ROM, or to DVD. In short, we develop courseware in order to be easily distributed through various means (Web, LMS, CD-ROM, DVD). Additionally, sections of the courseware can be taken and used for instructor aids in classroom and exercise learning environments. Through a contract with the DOE Emergency Operations Training Academy, we delivered CD-ROMs on Radiation Awareness. The client then distributed this training to some 50,000 first responders across the nation.

One important activity of the ISD Analysis phase is to define which media and methods can be applied to yield the most effective learning. Using a media allocation process (Figure 10), a blend of instructor-led training (ILT), Web-based training (WBT), computer-based simulations, games, job aids, self-paced learning packages and other media/methods can be sequenced to promote KSA acquisition and retention. The media allocation process is one of several key activities of effective ISD.

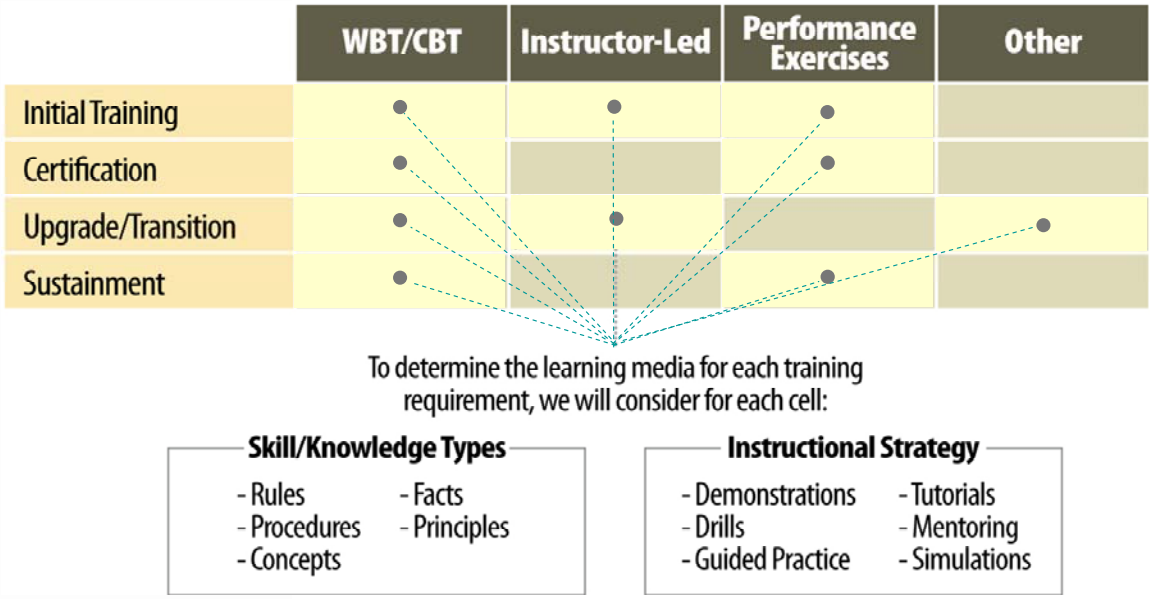


Figure 10. Media/method allocation supports blended learning by assigning and sequencing the most effective training strategies to the types of first responder KSA to be trained.

ISD Design. The Design phase molds the training program from data produced in the Analysis Phase. One of the principal activities conducted within this phase is the Training System Design Specification process (Figure 11) which produces the overall ComFRTS design. All training services / products will be designed to support the first responder mission based on data acquired in the Analysis phase. Included will be demonstrations, simulations, gamed-based scenarios/vignettes, and other methods that engage the learner and provide feedback and remediation.

ISD Development. The Development phase consists of several sub-phases intended to identify, produce and test training content.

Tasks performed within the ISD Development phase will include:

- Courseware authoring
- Simulation, scenario, game production
- Student throughput determinations
- Training 'take-aways', Quick Guides, and Job Aid development

- Quality control checks
- Lesson specifications and curriculum development
- Audio-visual media production and review
- Training schedule development
- Instructor identification and scheduling, as required
- Facilities / classroom identification and scheduling, as required
- Facilities operation and management, as required
- Course and lesson evaluations
- Student self tests and unit tests
- Certification exams
- Individual Tryouts (ITOs) and Team Tryouts (TTOs)

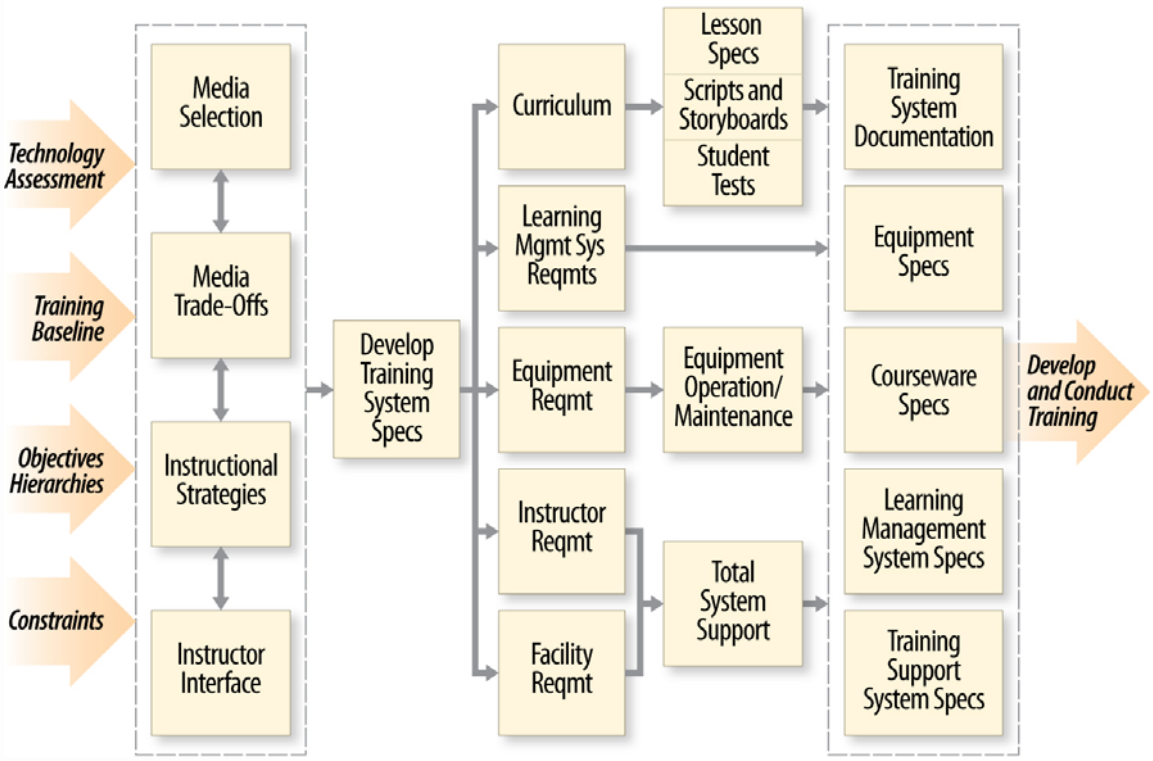


Figure 11. Training system design specification process provides the ComFRTS architecture.

Figure 12 shows the ComFRTS curriculum development process. Before implementing the curriculum, we will ensure that all learning objectives are clearly defined and sequenced, that stakeholder reviews by IAFC and other SME organizations occur, and that lesson plans and schedules are in place and approved.

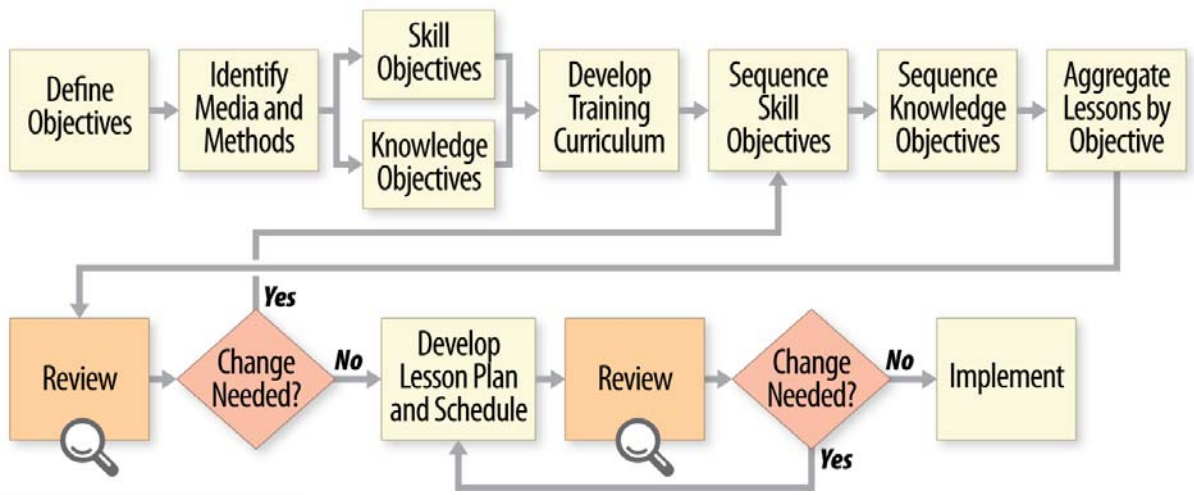


Figure 12. The curriculum development process lays the foundation for effective first responder training. Stakeholder reviews ensure technical accuracy and currency of training content.

Figure 13 shows a high-level depiction of the ComFRTS WBT development process. This assumes that results of media analyses support the use of interactive WBT (or CBT using DVDs/CDs) as an effective instructional medium. All WBT is SCORM compliant for reusability and standardized instruction when and where needed.

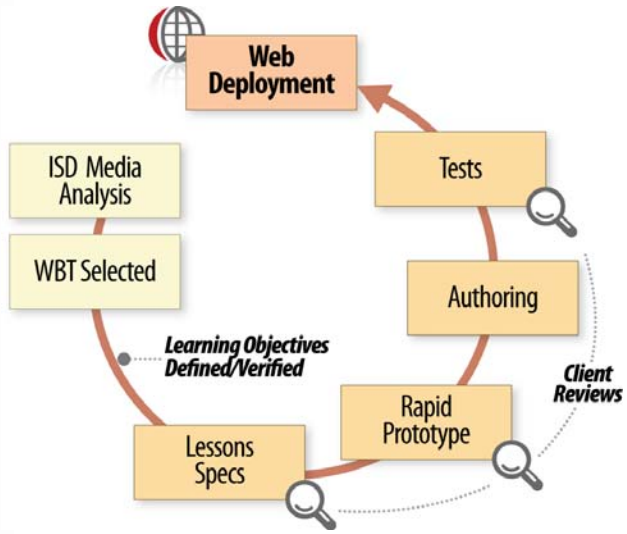


Figure 13. Our WBT development model includes rapid prototypes and validation testing with frequent client reviews. Internal and external tests validate WBT content and currency.

ASTD reports that Caterpillar University constructed a mathematical model to calculate the cost components of various training delivery methods. When similar programs were compared, e-learning was found to be less expensive to deliver almost regardless of learner population. For learner populations larger than 100, e-learning held a clear cost advantage. As the population increases, this difference becomes more pronounced. Even with a population as small as 100 and a class as short as one hour, e-learning was 45 percent less expensive than instructor-led training ($9,500 vs. $17,062 or $76/learner). When large populations are modeled (40,000+), the cost advantage of online learning is even greater, with savings as

high as 78 percent ($1.1 million vs. $5 million or $99/learner). Thus, technology based instruction, a key element of ComFRTs, has been documented to save time and delivery costs.

Instructionally sound WBT incorporates principles of adult learning theory. Table 1 outlines some of these principles. ComFRTS WBT is designed to engage the learner with scenario and exercise content similar to emergencies that are encountered in the field. WBT self-assessments are developed to check various types of learning outcomes. All self assessments are designed to achieve validity, reliability, and usability.

Table 1. Distance learning principles for effective ComFRTS instruction.

Online Instructional Phase	1. Information presentation 2. Guiding student practice 3. Practice 4. Evaluation of learning
Objectives are Foundation	Clear, measurable objectives linked to job requirements
Problem-Centered Content	Relevant content that transfers easily to the workplace; hands-on and applied
Deliberate Structure	Provide chunking, sequence, and pace to reduce demands on short-term memory
Meaningful Feedback	Guided and independent practice includes prompts and remediation
Effective Assessments	Tests to verify that learner can perform required functions
Practice for Mastery	Allow rehearsal and repetition, especially for difficult content
Engage the Learner	Frequent interaction with content and capability to move around in lesson
Use Multimedia	Graphics, animation, audio, and video increase engagement, stimulate interest, and maintain attention
Self-Directed Learning	Online learning requires motivated learners with basic computer skills and willingness to learn how to learn online

An example of a WBT navigation strategy is shown in Figure 14. In this case, students are provided a tutorial on the use of the modules, followed by easy access to the WBT module of interest. In the example shown, all applicable modules would be available for student access with the appropriate user name and password. If a building-block approach is employed, students would need to master content (i.e., pass a test) for a given module before proceeding to the next module. If no prerequisites are required, the student could select any module.

Once in the module, the student receives an introduction and overview along with the learning objectives. As the student progresses through the scenario, he/she receives practice with feedback and self-evaluates at the completion of the module (summary quizzes). If objectives are mastered, the student proceeds to the next module. If remediation is required, the program branches the student back into the relevant content for further self practice. This cycle is programmed to continue until the student has mastered the content at his/her own learning pace. At the end of each module, the student may print out and take away module content and test results for refresher reviews. As needed, the student will have the opportunity to interact with a SME or instructor.

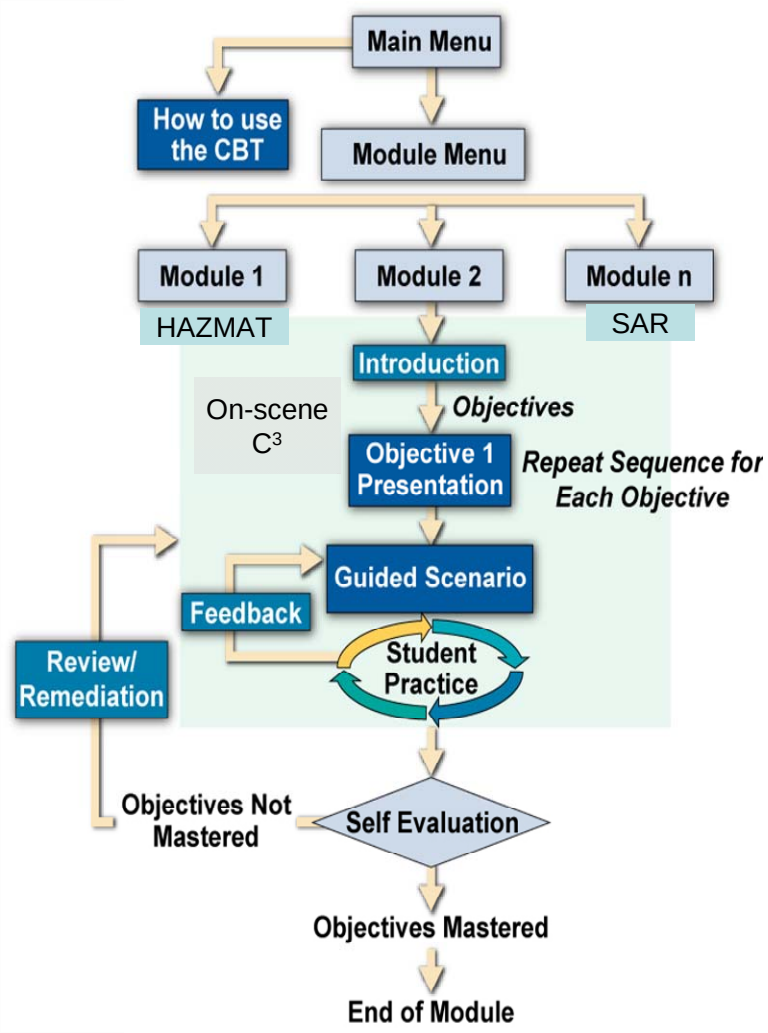


Figure 14. Sample WBT module navigation strategy provides student practice, remediation, immediate guided feedback, and documents end-of-module proficiency.

The WBT user interface must provide ready access to the courseware when and where needed, with programs that are intuitive and user oriented. We recognize that first responders will have a very broad range of hardware and software resources, and that those in remote sites may have limited access to the Web. Northrop Grumman will work with stakeholder organizations to provide all required hardware and software running on standard MS operating systems. Learning content can be provided on CDs to those users with limited or no Web access.

Based on our experience, learner computer literacy will vary across and within regions. Our team will ensure that all first responders feel comfortable learning and using the training system by providing user tutorials and help functions. We also will set up and staff a Help Desk as required. Our staff includes those with advanced degrees in human factors engineering and human-computer interface design. We recently generated User Interface (UI) Guidelines for the Health and Human Services to support a military electronic

medical records system. These UI guidelines will be adapted to the design of the ComFRTS training interface.

Within ComFRTS, ILT will be required to deliver and sustain certain KSA, mainly those involving eye-hand coordination, psychomotor skills, and manual dexterity. Instructors and SMEs may also be required to guide KSA development for first responder teams. Table 2 shows guidelines and best practices for planning, preparing, and delivering effective ILT. Northrop Grumman provides ILT to support many of our large systems development programs including space, aviation, shipbuilding, C4ISR, medical, and missile defense. Thus, we are experienced in the design, development and delivery of ILT as well as in WBT.

Table 2. Instructor led training guidelines.

- Learning objectives defined and measurable?
  - Learning objectives based on job/task analysis?
  - SME interviews?
  - Documentation reviews?
- Learning strategies incorporated based on content?
  - Simulations, exercises, demos, guided discussions
- SMEs involved in training analysis?
- SMEs validate content for accuracy?
- Target audience well defined?
  - Locations, expectations, reading levels, background and experience
- Any existing training materials?
- Any operational documentation for review?
- Lesson plans developed for classroom use?
- Course syllabus and schedule with topics/dates?
- Measures and criteria defined for student KSA?
  - How will student proficiency be evaluated?
- Measures of training delivery effectiveness?
  - How will training delivery effectiveness be evaluated?
- Classrooms and facilities pre – arranged?
- Support equipment working and used prior to training?
- Lessons sequenced properly?
- Content of course linked to training objectives?
- Graphics clear and understandable?
- Slides legible with good figure/background contrast?
- Slides cluttered with too much text or too many graphics?
- Handouts available to support slides?
- Student Guides developed and distributed at beginning of course?
- Can Student Guides effectively be used on the job after training?
- Opportunity for learners to ask questions and participate?
- Opportunity for learners to evaluate course content and instructor delivery of training?
- Opportunity to conduct dry run of training?
  - Videotaped rehearsal with feedback?
- Do instructors have demonstrated platform skills?

Our Northrop Grumman Training Tools. ComFRTS employs state-of-the-art, industry-approved Commercial Off-the-Shelf (COTS) training development tools (Figure 15). Our development teams use these tools to generate or adapt instructional content that engages the learner, provides interactivity and focused feedback, and includes built-in evaluation.

Our Tools

Software	Description
Adobe Photoshop, Illustrator and InDesign	Professional standard for desktop digital imaging, graphics, layouts for print and digital publishing
Adobe Flash and Flex Builder	Professional industry-leading authoring environment to create engaging interactive experiences
Adobe Dreamweaver	Industry's leading web authoring tool for developing web sites/pages
Adobe Premiere Pro, Soundbooth, Adobe After Effects, Final Cut	Professional start-to-finish video and audio production solution
Adobe Captivate	Used to capture screen interactions and develop quizzes
MS Visual Studio	Used to program Web applications
Maya/LightWave/Carrara/Poser/3D Studio Max	Standard professional 3D tool used to create high fidelity 3D objects and models
SQL Server	Tools and resource to help manage SQL Server and MSDE databases

Hardware	Description
IIS Web Server	A powerful web server that provides a highly reliable, manageable, and scalable web application infrastructure
3D Rendering Box	Professional server-side rendering tool
Canon LX1s digital camera with 16x zoom lens and fluid head tripod	3 CCD MiniDV Digital Video Camera (NTSC)
ARRI light kit with filters	4 piece lighting kit with stands and filters
Mackie 12-channel mic/line mixer and Canon shotgun microphone	Audio mixer and Long-distance microphone
Nikon SLR Digital Camera	High resolution digital camera

FRAMEWORKS and STANDARDS	Description
ASP.Net C# and VB	Server Application Framework and Run-time
Java/J2EE/DOJO/TAPESTRY	Server Application Framework and Runtime
Actionscript	Scripting Language for Flash/Flex
HTML/CSS/XML/ AJAX	Front-end Markup Languages
ColdFusion	Server Application and Scripting Language
PHP/ mySQL	Server Application, Scripting, and Query Language
WebSphere WCM	Content Management System
WIKI	Mark-up Language
SCORM	ADL Courseware Standard
HiSoft AccVerify Professional (508 Compliance)	508 Compliance Testing Suite

Figure15. Our state-of-the-art COTS tools produce engaging, interactive WBT keyed to first responder requirements.

Our ComFRTS internal tools of efficiency save development costs, reduce travel, and are offered at no cost to the Government.

In addition to COTS tools, we will employ, *at no cost*, our own internal Web-based tools (Table 3) for design and development of ComFRTS training products/services. Our tools have been proven in support of the DoD, CDC, DOE, and other clients to yield appreciable project efficiencies by saving time and development costs. Use of these tools will facilitate close coordination with First Responder SMEs throughout the nation and conserve travel costs.

Table 3. Our Web-based Tools of Efficiency will reduce development time, cost, and risk.

Tool	Description	Feature/Benefits
eDX	Web-enabled tool that provides real-time project collaboration between geographically dispersed clients, project managers and training development teams.	• Individualized log-in for added security • Significant reduction in review cycle time • Provides electronic audit trail of all project/client requests • Real-time information about change requests, costs, and task status
ISDx	Web-enabled collaboration tool that simplifies and expedites the storyboarding and development process enabling designers and developers to create, store and manage course content.	• Remote access for all users • Dynamically generated XML files that interact with Flash content • Dynamically generated folder structures
eSurvey	Web-enabled survey development tool used to gather data from client respondents who are geographically dispersed.	• Generates reports containing descriptive and summary statistics • Higher response rates than manually distributed surveys lending to more reliable statistical analysis • Little to no cost – easy to deploy • Adjustable parameters to capture statistics of client interest
TimeTracker	A web-enabled Basis of Estimate (BOE) tool that captures, tracks and reports labor hours in near real- time that are expended by staff to include projects, labor categories, and specific tasks.	• Electronic warehousing of project files • Easy retrieval of labor and project information via query tools • Facilitated cost estimates for future projects
eStoryBoard Manager	Web-enabled tool that decreases storyboard development time by enabling clients and the development team to upload content for review, provide comments and approve final versions.	• Electronic log of client/development team communication • Content easily viewable via commonly used application files (.pdf, .swf, .doc) • Color-coded lesson indicators for quick visual status
custom LMS	A Learning Management System (LMS) tailored to meet client requirements to deliver, manage and report staff training completion.	• Easy-to-use interface for both administrators and users • Tracks course completion • Password protected • Deployable on customer servers

As shown in Figure 3, ComFRTS employs *a blended learning approach* using instructor-led courseware, WBT/CBT, simulations, exercises and games, hands-on practice, train-the-trainer, job aids, and other forms of training and performance support to meet all first responder learning objectives. WBT will be useful for familiarizing first responders on:

- Radiation awareness, Weapons of Mass Destruction (WMD) or hazardous materials (HAZMAT)
- Individual and team firefighting and emergency medical tactics, techniques, and procedures
- Operation and maintenance of emergency response vehicles, equipment, systems

- Mission execution and communication procedures within and across first responder teams
- Command and control policy/procedures

Instructor-led and hands-on training will impart more complex subject matter requiring judgments, inductive/deductive reasoning, decision making, or critical thinking skills. We will incorporate self-assessments into the courseware to enable students to check their KSA as they move through the modules. ComFRTS will be technically accurate, standardized, measurable, instructionally effective and efficient, and compliant with all first responder specifications and standards/guidelines. Both individual tryouts (ITOs) and team tryouts (TTOs) will be conducted as required with SME first responders to meet these requirements. Feedback from ITO sessions will be incorporated into ComFRTS. TTOs will be conducted using representative first responder trainees representing firefighting, law enforcement and emergency medical groups. TTOs (Figure 16) involve participants from distributed sites using a representative range of first responder resources and conditions. TTOs are designed to adequately stress the system by involving all target variables and players in realistic training scenarios. TTOs approach the actual field environment in terms of fidelity and performance requirements. Based on the results of first responder TTOs, revisions will be made to all affected ComFRTS components.

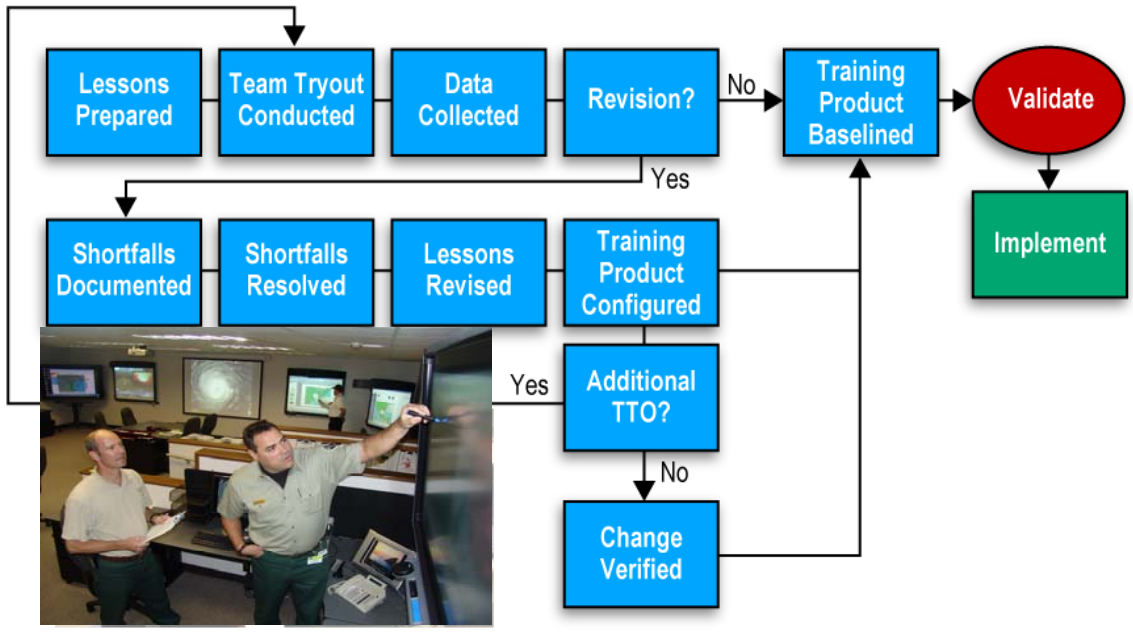


Figure16. Team Tryouts (TTOs) can be used to validate ADL and other training product content.

ComFRTS will include national standards and guidelines for designing and developing engaging first responder training based on industry best practices.

ISD Implementation. During ISD Implementation, ComFRTS training content will be delivered using a blended learning approach (Figure 3). WBT is available as required, and the process for implementing and conducting ILT is shown in Figure 17. In addition to student and instructor assessments, ComFRTS will assess technology-based media and other training system elements. Student and instructor data are recorded and maintained in an LMS or other designate first responder training database. All training facilities and equipment become part of the LMS as well. If student pass criteria are met or exceeded, trainees will be approved for assignment to their jobs and missions. They will later need *recurrent training* as KSA degrade over time and *upgrade or transition training* for new tasks, jobs, missions, or equipment operation/maintenance.

Tasks to be performed during the Implementation phase include:

- Training hardware/software installed and networked, as required
- Computer based courseware tested / uploaded to Web, as required
- Facilities and support resources assigned, as required
- LMS implementation, as required
- Instructor assignments, as required
- Delivery of instruction (WBT, classroom, hands-on, exercises)
- Evaluation of student performance
- Evaluation of ComFRTS
- Feedback of deficiencies and updates to ComFRTs
- Incorporation of first responder mission, job, and operational equipment changes into ComFRTS

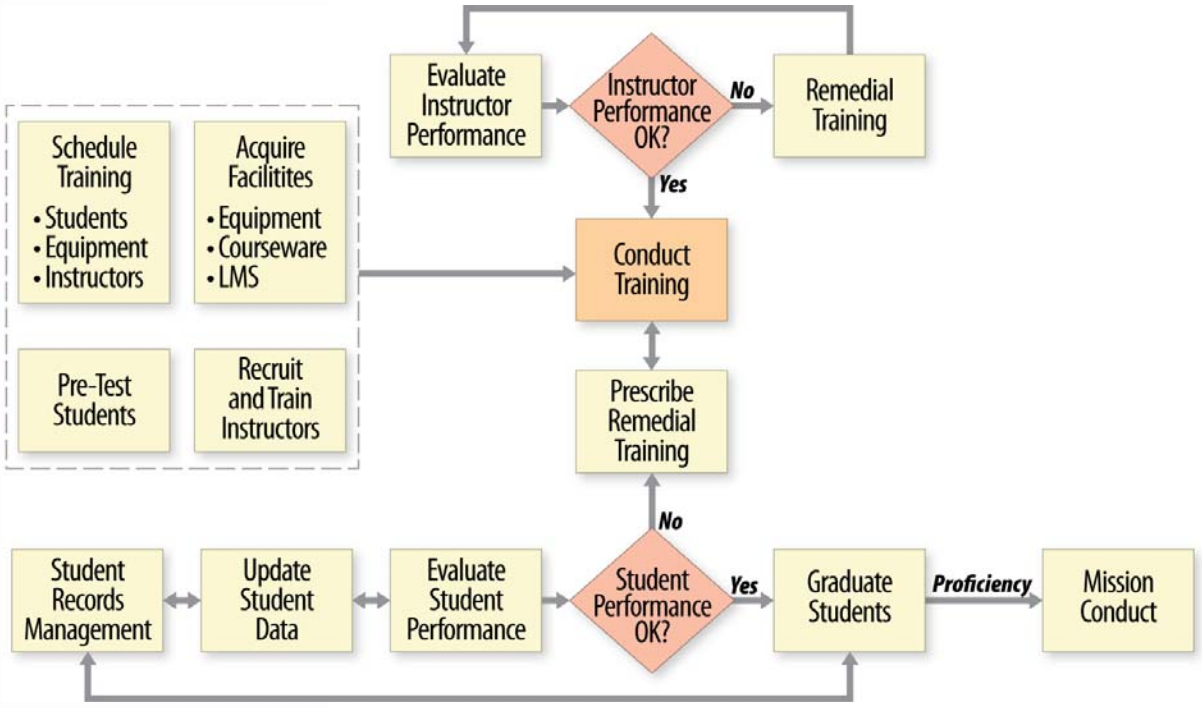


Figure 17. ILT includes assessments of both student and instructor performance with remediation.

ISD Evaluation. The foundation of ISD is evaluation. Training evaluation cuts across all ISD phases and is intended to verify that:

- Required KSA are achieved and demonstrated by all first responder trainees
- All ComFRTS components (Figure 3) are operating effectively and efficiently

Other benefits of training evaluation include:

- Documents who has acquired first responder KSA
- Quantifies trainee learning rates
- Determines degree to which learning objectives accurately represent actual performance requirements and operational standards
- Identifies interventions that can be used to improve ComFRTS over time

Evaluation documents first responder proficiency, learning rates, and helps identify problem areas.

The ComFRTS model will ensure that evaluation is used to measure training effectiveness, to benchmark and refine training development processes, and to document training outcomes. The ComFRTS training evaluation process is shown in Figure 18. There are four primary levels of training evaluation – two that occur within training (left side of the figure), and two following training (right side of the figure). The process incorporates all aspects of formative (level 1), summative (level 2), and operational (level 3) evaluation. Note that ComFRTS uses feedback from field personnel (supervisors and managers) to improve the training system. This level 3 assessment is one of the most commonly overlooked aspects of training evaluation.

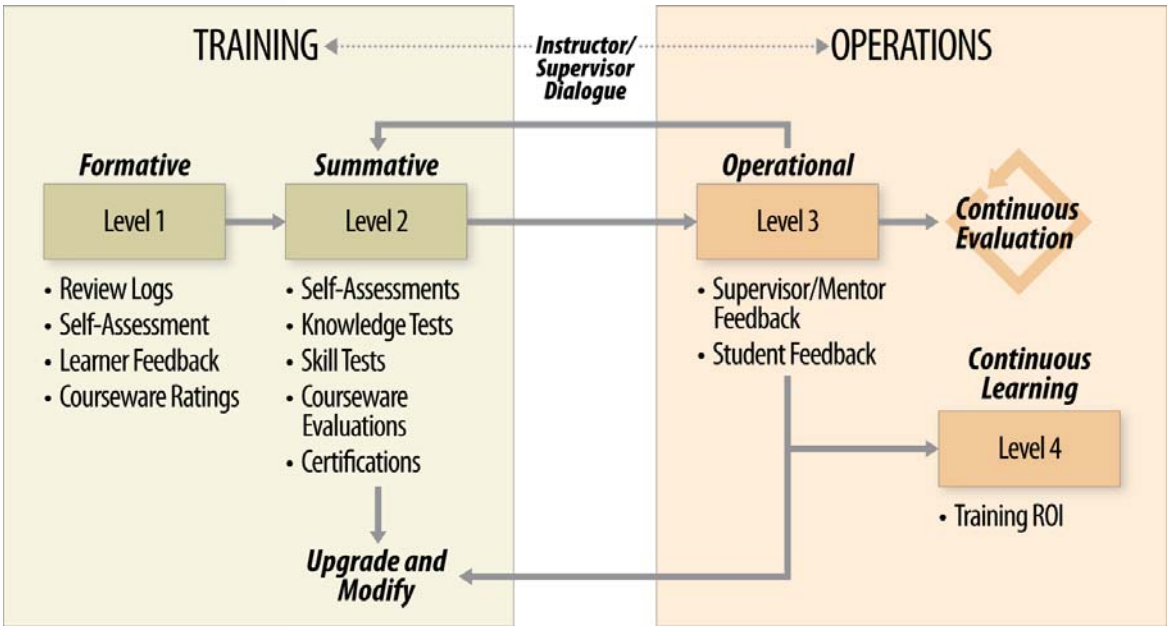


Figure 18. Training evaluation ensures that formative, summative, and operational data are applied to document first responder student proficiency, quantify ROI, and improve the system over time.

Learning, Performance and Knowledge Management. One of the benefits of ComFRTS will be the capture and dissemination of information needed to help Federal, State, Local, and Tribal first responders perform their jobs and missions more effectively and efficiently. Learning and knowledge management is critical to leveraging lessons learned and best practices. Our team is knowledgeable and experienced in these areas, having been key participants in the study to evaluate and select the LMS to support Northrop Grumman, a 125,000 person enterprise.

Our familiarity and experience with LMSs can be fully leveraged to field a Nationwide First Responder LMS (Figure 19). Our team is prepared to develop a fully functional LMS to support all first responders. We have worked with major LMS vendors and can adapt our *E-Class LMS* to ComFRTS requirements. Our team is fully prepared and qualified to maintain training currency for first responders at National, State, Local, and/or Tribal levels via the use of this LMS.

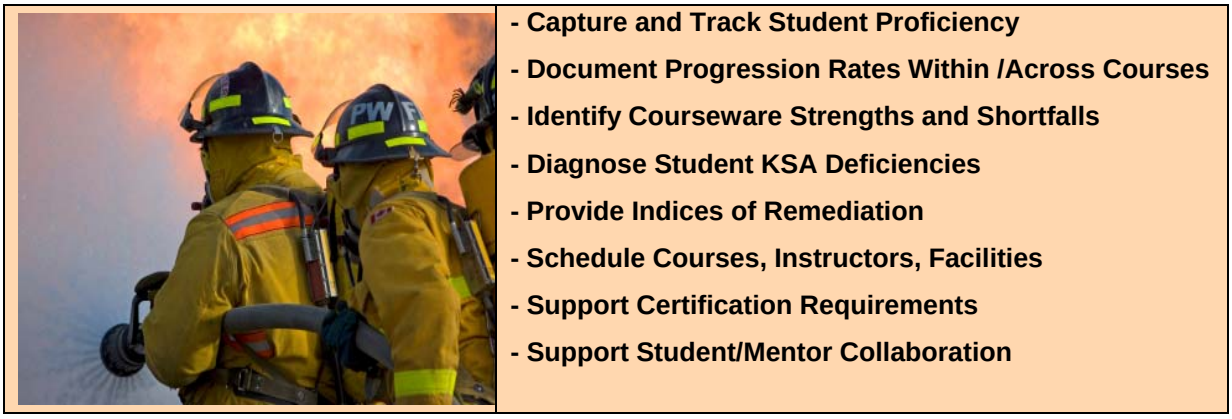


Figure 19. The ComFRTS First Responder LMS provides training accountability and improved training management and administration.

Another ComFRTS feature is that key training information can be used to mentor and assist users within and across organizations. Training data can be used to provide performance support, personal or electronic mentoring, and information on demand when and where needed. Thus, LMS and training data can be a precursor to the implementation of a National First Responder Enterprise Knowledge Management System (KMS). A general concept for this KMS is shown in Figure 20.

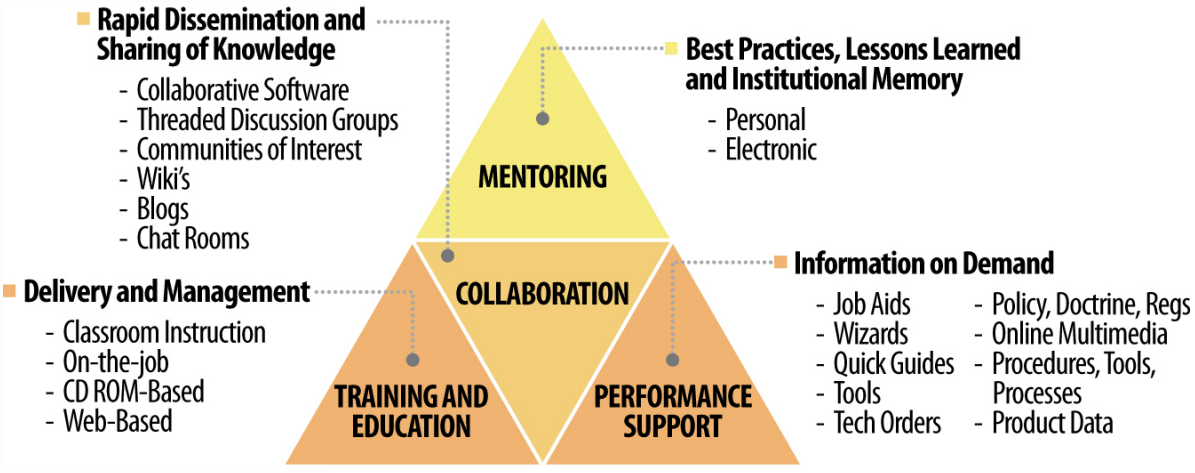
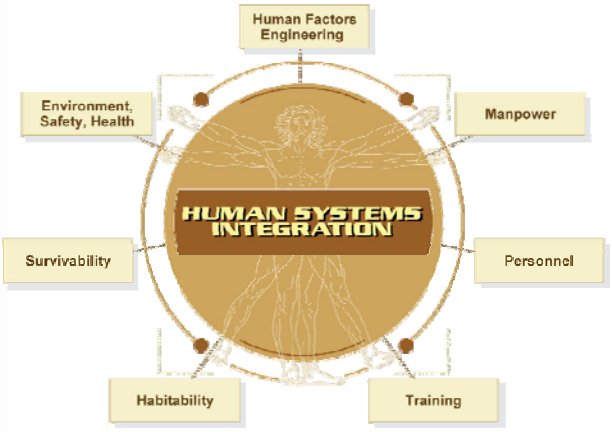


Figure 20. A National First Responder Knowledge Management System (KMS) will enable mentoring, collaboration, performance support, plus collection/distribution of best practices and lessons learned.

Human-System Integration (HSI). ComFRTS will employ a Human-Systems Integration (HSI) approach (Figure 21) to address human performance issues. HSI considers Manpower, Personnel, Training (MPT), human factors engineering (HFE), systems safety, environmental safety and health (ES&H) issues, habitability, and survivability of all human-in-the-loop issues. This approach has the following goals for first responder equipment and systems:

- Produce/procure systems that are safe, efficient, and easy to use
- Apply human-centered design and usability principles
- Enhance operability, reliability, and maintainability
- Increase the efficiency of individuals and teams
- Reduce human error
- Simplify human interaction with systems
- Enhance human productivity to ensure mission success



Manpower *Spaces*	Personnel required to operate, maintain, support, manage, and train all system elements
Personnel *Faces*	Required aptitudes, skill levels, qualifications
Training *Qualify & Certify*	Courseware, training aids, simulators/devices, etc.
HFE *Human–equipment Interface*	System interfaces effectively with human capabilities
Safety *System Conditions*	Procedures for minimizing severity and/or probability of system hazards
Health Hazards *Personnel Health Risks*	Eliminate or reduce conditions/hazardous materials
Survivability *Fratricide Avoidance*	Reduction of engagement by friendly forces and attack probability by adversary
Habitability *Quality of Life & Service*	Living conditions conducive to job and mission accomplishment

Figure 21. Human-Systems Integration (HSI) will ensure that individual and team performance issues are considered in the overall design and implementation of first responder systems, and equipment.

Quality Assurance. Northrop Grumman views quality as a goal that starts and ends with the client, and drives our support on every project. The ComFRTS QA process will utilize first responder SMEs, project leads, QA specialists and other key stakeholders to review training and performance support products continuously for technical accuracy, currency, and instructional effectiveness. The ComFRTS QA model is shown in Figure 22. As shown, the client requirements (center of the graphic) guide our QA process by helping us define requirements, and by continuous review and approval of the product/service. The center ring shows our development phases and tasks. The outermost ring includes some of the tools we use to improve accuracy, effectiveness, efficiency, and ultimately, product/service quality.

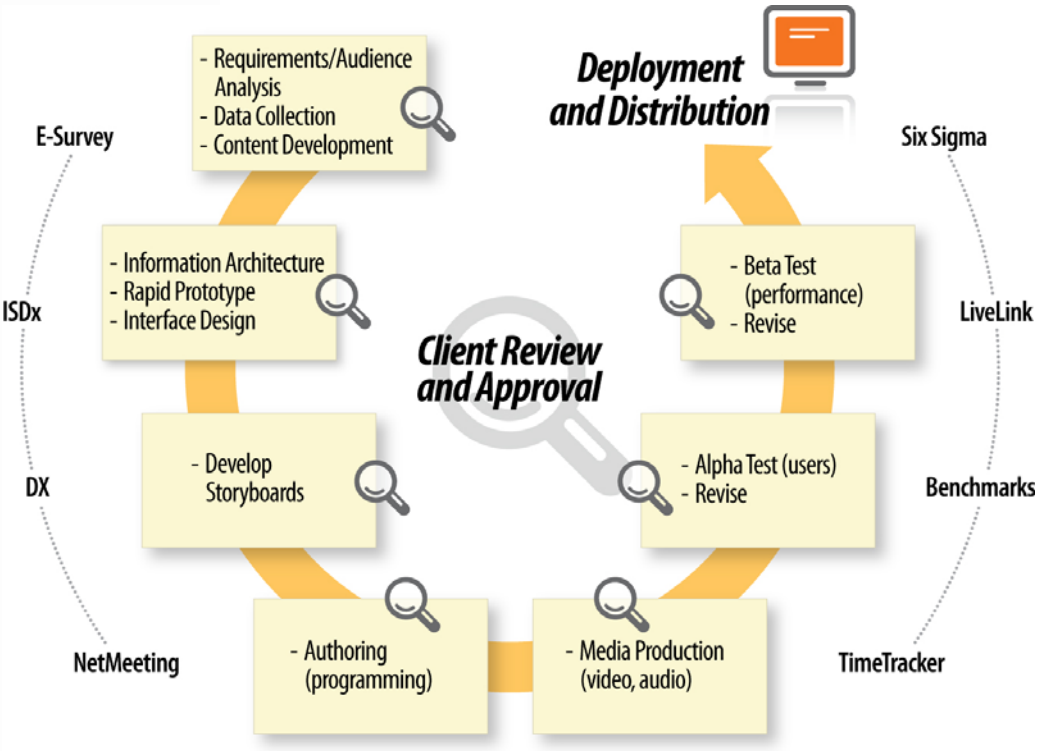


Figure 22. ComFRTS will utilize a proven QA process to ensure highly effective first responder products and services, delivered on schedule and within budget.

Northrop Grumman Team Training Experience

Our team has designed, developed and delivered training products/services for hundreds of Government clients. Table 4 shows a sample of these clients and training types. We have developed and delivered thousands of hours of ILT and WBT, and have collaborated with clients from coast to coast using our tools. We are experienced in carrying out structured interviews with SMEs and other program personnel to glean the most valid and appropriate information to be included as training objectives. We use Six Sigma tools such as Pareto charts and descriptive and inferential statistics for process improvements. We have carried out mission functional area analyses that produce data to provide critical training strategies.

Our large-scale training support includes robust tools and processes that can be directly leveraged to ComFRTS support.

Table 4. Northrop Grumman Training Support – Sample Client Base.

• DHS Transportation Security Administration Screener Training • DHS National Level Exercise 09 and Regional Exercise Programs • DHS Biometrics training • DHS Homeland Secure Data Network training • USCG Nationwide Automatic Identification System • USCG National Security Cutter training • USCG Port Security	
• USN carrier, submarine, and surface ship training (AMSEC) • Training support to USN and USCG software and systems (Sperry Marine) • USN E-2D training support • USN Zumwalt-Class Destroyer (DDG 1000) training • USN Nuclear Powered Aircraft Carrier training (Nimitz and Gerald R.Ford-class) • USN Virginia-class submarine training	
• USAF F-35 Joint Strike Fighter Training • USAF B-2 Training • USAF Global Hawk training • USAF ICBM Prime Integration Contract (IPIC) • USAF Aircraft Alerting EMP Communication Equipment (AACE) • USAF Logistics (WRALC Education and Training Services) • USAF Professional Control Force (505th ECS) • USAF Air and Space Operations Center Formal Training Unit • USAF Kinetic Energy Interceptor training	
• USA CASCOM Property Book Unit Supply Enhanced (PBUSE) • USA Battle Command Training Program (BCTP) • USA Digital Leader Development Center (DLDC) • USA Force XXI Battle Command Brigade-and-Below (FBCB2) • USA Research Institute Learning R&D • USA Armor Center Training Support	
• Joint Warfighting Center (JWFC) training and exercise support • Joint Stars training support • Joint Fire Scout training • USEUCOM Regional Joint Intelligence Training Facility	
• DOE National Training Center Support • DOE Emergency Operations Training Academy • DOE Nevada Test Site training and performance support • DOE Radiological Assistance Program Training • DOE Consequence Management training support	

ComFRTS is learner-centered and focused on first responder requirements. Our professional staff includes those with advanced degrees in instructional systems design, training technology, software engineering, and human factors engineering. Our team developed training plans, student and instructor guides, Programs of Instruction (POI), Training Support Packages (TSPs), Lesson Plans, and interactive courseware for operators and maintainers of C2 systems, weapon systems, and electronic medical records systems. We support the Department of Homeland Security in planning, conducting, and managing both national and regional exercise programs.

ComFRTS also includes a train-the-trainer (T^3) methodology and we have conducted T^3 sessions for a wide range of Government clients. Our T^3 methodology reflects our understanding that subject matter expertise is necessary but not sufficient to effectively conduct training. Skills in learning theory, instructional design, media, communications, and information organization are also required, as are an understanding of the laws of readiness, exercise, effect, primacy/currency, and intensity.

Project Management

Northrop Grumman employs a proven industry-leading project management system that can be tailored to meet specific management and administrative requirements. The system is MS Office–compliant and employs a Work Breakdown Structure (WBS) and Activity-based Costing (ABC) process that provide or facilitate:

- Cost analyses and financial management
- Project control
- Program risk analyses
- Configuration management
- Project reviews
- Internal and external reporting

These tools combined with our own internal remote collaboration tools (*DX, eStoryboard, eSurvey, TimeTracker*, and others [Table 3] will ensure that ADL products are delivered on time and within budget. To support direct lines of communications with the IAFC and other client stakeholders, and to maintain an efficient management structure, Northrop Grumman will:

- Take full responsibility for delivering all ComFRTS products and services included in the SOW or other tasking documents.
- Appoint the project manager as the single point of contact for all management and decisions affecting this support.
- Provide facilities and resources to support all staff working on this contract. These services will be under our direct control.
- Ensure that the lines of communication are open to enable our team to be fully responsive to all client tasking requirements. Our chain of command is lean; our project lines of responsibility are simple and direct.

- Ensure that there are no extra layers of management to slow decisions or impede customer interface. The PM will report directly to the Operating Unit Director of the Northrop Grumman Technical Services sector.
- Deliver! There is no middleman, no diffusion of responsibility, and no uncertainty as to who will make the decisions. Team Northrop Grumman and the PM are solely responsible, accept the leadership role, and will deliver training products on time and within budget.

Figure 23 illustrates Northrop Grumman's proven financial management system, which enables the PM to provide timely, accurate labor hours and ODC cost expenditure reports to the client. This interactive system and its associated analysis tools support estimating, comparison of actual versus estimated hours expended during work execution, and invoicing.

Northrop Grumman uses an integrated, client/server-based enterprise resource planning system to manage all planning, estimating, controlling, and monitoring for financial and program control support. Specifically, we use the SAP-based financial management system. Figure 23 shows the overall monitoring architecture, including the major modules of the SAP system. It provides the PM immediate visibility and status of financial, accounting, material, and other program management functions. SAP provides a comprehensive set of integrated financial management tools used to provide monthly cost and schedule status reports.

SAP can help manage and mitigate problems through easy accessibility to current financial management data. The PM and designated program controllers can download SAP data for cost and schedule tracking, alternatives analysis, problem resolution, and progress measurement. SAP offers complete integration with commercial packages such as MS Project and Excel. Northrop Grumman currently uses these packages as the principal tools for schedule and resource allocation planning and reporting.

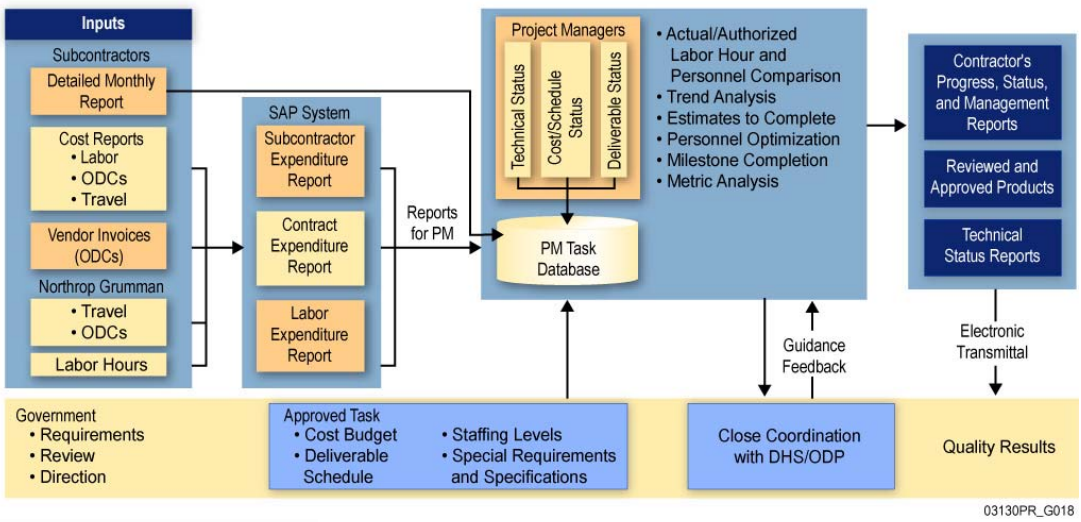


Figure 23. Northrop Grumman's SAP-based financial management system provides ready access to current financial data for efficient project management.

In addition to our remote collaboration tools (Table 3), we employ full Livelink capabilities (Figure 24). Livelink brings together geographically dispersed individuals and work groups through a secure, fully Web-based and open-architected, dynamic collaboration environment. Northrop Grumman has used Livelink successfully on several programs.

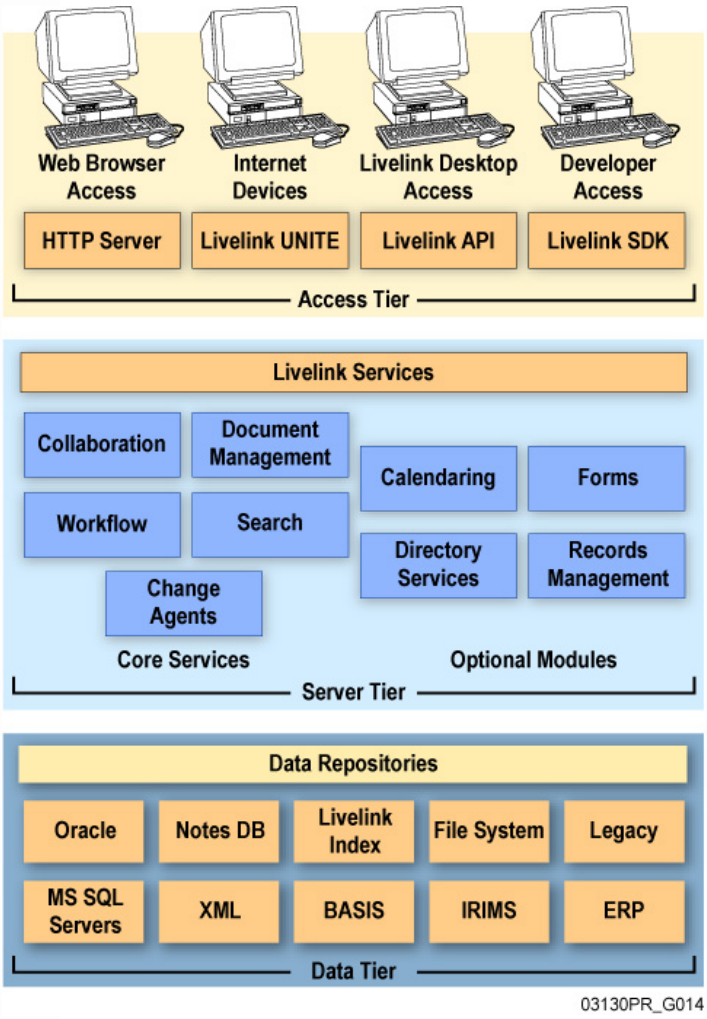


Figure 24. Livelink enables our team to provide any scale of collaboration needed.

Summary

This White Paper has proposed a Total Training Systems Approach (ComFRTS) that uses blended learning to support first responders in meeting/exceeding all objectives at reduced cost and improved efficiency. Such an approach is needed to bring structure, consistency, and improved management to all first responder training resources. As a corporation, Northrop Grumman has consistently used a systems approach on virtually all of our large programs and the ComFRTS program is no exception. ComFRTS includes proven tools and methodologies as well as our own internal tools that are offered at no cost to the Government. These tools are designed to provide effective and efficient training content and management. ComFRTS is needed to ensure that standardized, measurable, repeatable processes are included in all Federal, State, Local, and Tribal first responder training support.

Pricing

Pricing for ComFRTS support will be provided to IAFC based on further discussions regarding scope and complexity of support.

Contact Information

For more information, contact:

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(505)280-4506 (M)
jerry.childs@ngc.com

Appendix A – Key Personnel Resumes

Following are resumes of the key personnel who will design, develop, and implement the Comprehensive First Responder Training System (ComFRTS).

PROGRAM MANAGER /TECHNICAL LEAD	Jerry Childs
Education ■ Ph.D., Engineering Psychology, Texas Tech University Professional Certifications and Training: ■ Psychology (Testing) ■ Six Sigma Green Belt Certified ■ FAA Private Pilot	
Years of Experience: 35	

SUMMARY OF EXPERIENCE AND QUALIFICATIONS

Jerry was recently designated Chief Scientist, Northrop Grumman Technical Services. As Director, Training and Performance Engineering, he has been responsible for providing human performance and training support for Northrop Grumman's government contracts. His responsibilities also include business development for training systems programs, staffing and functional management of training contracts, and direction of program activities to ensure that training and performance support products are responsive to client requirements. He is an active member of the Corporate Systems Engineering Advisory Group (SEAG) and the Human Systems Integration (HSI) Community of Practice.

He has 35 years of progressive experience in the management and conduct of performance improvement programs sponsored by the Departments of Defense, Energy, and Transportation, by other governmental agencies such as the National Aeronautics and Space Administration (NASA) and the Federal Aviation Administration (FAA), and by private industry. His technical skills are in the areas of applied human factors engineering, training systems analysis, design, development, and evaluation, corporate performance improvement, operational performance assessment, work process measurement, functional and program management, and business development.

Project Management

Jerry serves as Project Manager for Northrop Grumman training support to the Centers for Disease Control and Prevention (CDC). He led teams in the development of Web-based training (WBT) to support the Documentum database as well as the Laboratory Response Network Results Messenger (LRN RM), an application used by laboratories for capture and management of specimens and laboratory test results. He managed a team responsible for developing training for the CDC Vaccine Ordering and Distribution System (VODS). This covers WBT, instructor-led training, and train-the-trainer approaches.

He supported the Air Force Distributed Mission Training (DMT) program in the development of a Briefing/Debriefing (BDB) system capability. He also supported the Navy DMT program in developing a distributed performance measurement capability using artificial intelligence to capture instructor pilot elements for assessing DMT proficiency.

He supported the F-35 (Joint Strike Fighter) Courseware Integrated Product Teams (IPTs). His responsibilities included scheduling, hosting, managing, and facilitating IPT meetings in El Segundo, CA.

Jerry supported the Army Research Institute (ARI) in research and development of training tools and methods.

Under contract to the Defense Information Systems Agency (DISA), he developed Human Systems Integration (HSI) concepts, including human–computer interface design, to support DISA systems engineering, modeling and simulation efforts.

He was responsible for design and development of supervisory and management training to support civilian employees on the USAF Warner-Robins Education and Training Services contract.

He was project manager for interactive courseware (ICW) and video development support to the Aircraft Alerting Communications EMP (AACE) project and to the Remote Sensing Lab/Nevada. Northrop

He managed a WBT development effort to support the Force XXI Battle Command Brigade and Below (FBCB2) program under contract to the Army. He also supported the development of WBT for the Global Combat Support System-Army (GCSS-A), a technology-based logistics support system. He provided instructional design support to the USAF Air Program Information Management System (APIMS) WBT effort.

Jerry led a team that supported a Federal Express Air Operations initiative to transition to Web-based training for their 6,000 pilots and mechanics.

He managed a team supporting the Department of Energy (DOE) in training analysis and program development. He works closely with DOE to provide this support. A team led by Dr. Childs completed an analysis of the functional requirements for Emergency Operations (EO) at all DOE Tier One sites. He led an effort to conduct job/task analyses to support DOE Radiological Assistance Program (RAP) teams. These analyses produced training requirements for conducting EO and RAP training throughout the DOE complex. He also led an effort to develop a program for a new DOE job function, the Nuclear Security Systems Engineer (NSSE).

DOE support projects have involved 1) the development of WBT to support radiation awareness among state and local government agencies and 2) determination of emerging job functions and training requirements for the counterintelligence analysts and cyber staff. Another initiative required the development and implementation of WBT to support job functions conducted by Remote Sensing Laboratory Nevada (RSLN) field monitoring personnel. Dr. Childs was project manager of aircrew training research sponsored by the Air Force Research Lab (AFRL). The charter of this program was to provide distributed simulation and training of higher-order cognitive skills in aircrews. New course syllabi were developed that incorporated team training, crew resource management, situation awareness, and other higher-order cognitive skills. He managed a task to provide Crew Resource Management (CRM) research and development support to the 58th Special Operations Wing at Kirtland AFB. A CRM evaluation plan was developed under this support effort.

He directed a team of courseware developers in converting and upgrading seven modules of instruction to support the Central Secondary Item Stratification System (CSIS) database for the USAF.

Jerry directed the daily work activities of 35 instructional designers and courseware developers. He provided design guidance to technology-based training products and assisted in the development of proposals to General Motors and other commercial clients.

He was Principal Investigator on a Courseware Development IR&D program. Goals of the program were to develop tools and procedures for use in courseware development processes and to investigate and implement interactive multimedia technology.

He served as project manager for the distributed simulation program sponsored by the Army Research Institute.

Jerry managed a project sponsored by the Air Force Operational Test and Evaluation Center (AFOTEC) to develop a comprehensive evaluation plan to be applied to all Aircrew Training System (ATS) programs.

As project manager of an FAA-sponsored contract, Dr. Childs led a research team comprised of some 170 personnel in conducting a 2-year longitudinal study to empirically determine skill retention patterns among newly certificated private pilots.

He designed and conducted an FAA-sponsored transfer-of-training study of a fixed-base multiengine training device.

He served on a Task Force that conducted a national synergy study to address training and simulation issues.

Jerry has served on Northrop Grumman's Training Working Group as a member of the Systems Engineering Advisory Group (SEAG). He was recently selected to serve on the Advisory Panel to the Joint Warfare Training Center (JWFC).

He participated on a team responsible for conducting research to determine the training effectiveness of Navy Device 15 F8, a weapons systems trainer for the E-2C aircraft.

He participated in the production, implementation, and management of CBT programs for commercial business jet crews under contract to SimuFlite International and other aviation training firms.

Publications and Presentations

Jerry has authored / co-authored more than 65 professional publications including several Human Factors journal articles, a chapter in Roscoe's *Aviation Psychology* and a human performance improvement chapter in *Design for Manufacturability*, a manufacturing engineering handbook. He authored chapters on Training Systems Evaluation in both editions of Handbook for Human Factors Testing and Evaluation. He has served on subcommittees of the Interservice/Industry Training Systems Conference (IITSEC), and Southwest Airlines Training Advisory Committee. He has also been a member of the Aviation Industry CBT Committee (AICC).

LEAD INSTRUCTIONAL SYSTEMS DEVELOPER	William V. Smith

Education

- M.A., Organization Learning and Instructional Technology (OLIT), Instructional Systems Design (ISD), University of New Mexico
- B.A., Remote Sensing and Satellite Imagery, University of New Mexico

Years of Experience: 15

SUMMARY OF EXPERIENCE AND QUALIFICATIONS

Will is a Training Project Manager with a background in the development of courseware and interactive training design and development. He develops courseware for the Department of Defense, the Department of Energy, and various other government/commercial organizations. Will has been the principal designer and developer of Northrop Grumman's tools of efficiency including DX, ISDx, and eStoryboard Manager.

Will is fully knowledgeable in the ADDIE process, having applied instructional systems design talent to a variety of DoD, DOE and CDC distance learning projects. He develops engaging learning experiences for both instructor-led training (ILT) and SCORM compliant computer/web-based training (CBT/WBT); defines production processes and procedures to efficiently create courseware; and develops ADL products on time and within budget. In addition, Will is an expert in process improvement and configuration management; a Six Sigma–certified Green Belt, he creates tools to facilitate real-time collaboration and increase productivity. He is experienced and proficient in all Microsoft Office software as well as Adobe Photoshop, Illustrator, Premier, Dreamweaver, Flash, Captivate, ColdFusion, and Audition. His skills are fully compliant with the ADL SOP used by the USCG to develop ADL products.

Human Performance Analysis

Will has performed gap analyses, functional areas analyses, and other front-end studies designed to improve user and maintainer performance. He developed courseware for the U.S. Air Force (USAF), following the Air Force-approved Instructional Systems Development (ISD) model, a counterpart of the USCG ADDIE model. Working closely with subject matter experts and the USAF, he has experience with developing course analysis documents, control charts, plans of instruction (POIs), and instructor aid/presentation files.

Will contributed to a Department of Energy training analysis project by researching documentation and conducting interviews and survey development. The result was an analysis designed to assist Emergency Operations sites across the entire DOE complex with future training planning and development.

Will performed a gap analysis leading to the design and development of WBT instruction. Using industry accepted user interface standards, he designed graphical user interface for the CDC Documentum and Laboratory Response Network Results Messenger (LRN RM) systems software. He led a team in converting instructor-led Documentum courseware into on-demand WBT and performance support for the CDC. Interactive systems training and performance support were developed for the LRN RM that utilized scenario-based content and self tests to engage users and provide feedback.

He created a certification exam and feedback mechanism for a training assessment program at Johnson Controls. The exam was designed to improve business processes by assessing core knowledge and skills for multiple job functions. A feedback mechanism allowed instructors to quickly view their students' performance and evaluate training effectiveness.

Instructional Systems Development

Currently, Will oversees several training projects for the United States Army, Air Force, and Marine Corp. He is responsible for developing WBT training aids for the Army's Combined Arms Support Command – Property Book Unit Supply Enhanced (CASCOM–PBUSE) logistics application, for creating online instruction for instrumentation for the USAF School of Aerospace Medicine, and for developing ILT for the U.S. Marine Corp's M9 ACE (Armored Combat Earthmover).

Will was the lead instructional designer and courseware developer for the Aircraft Alerting Communications EMP (AACE) System, the Air Program Information Management System (APIMS), and the Electronic Technical Order Management System (ETOMS). These projects relate strongly to USCG requirements for ADL services in that they produced interactive courseware and performance enhancement products and they followed the ADDIE model. He also developed maintenance instructor-led courseware for Northrop Grumman's large Education and Training Services contract at Warner-Robins Air Logistics Center.

Will developed SCORM compliant WBT for the Federal Emergency Management Agency (FEMA), the Army Sergeants Major Academy Battle Staff NCO Course (BSNCOC), the Air Force Command Core, and Wheeling-Pittsburgh Steel Company's new Management Information System. He has also designed and developed numerous internal Northrop Grumman management courses.

The courseware Will developed for the Army's CASCOM–PBUSE trains unit supply personnel as well as commanders, logistics personnel, and property book officers on the Web-based PBUSE software. He has also developed training modules for the Joint Readiness Training Center–Information Systems (JRTC-IS) Computer-Based Instruction (CBI).

As a working manager, Will is fully prepared and experienced to lead all CG-13 task orders. He will assemble a multidisciplinary team that uses only the skill sets needed to support a given ADDIE phase. Finally, he will ensure ADL product effectiveness with all services and deliverables provided on schedule and within budget.

INSTRUCTIONAL SYSTEMS DEVELOPER	Jennifer VanBerschot

Education

- Ph.D., Organizational Learning and Instructional Technologies (Focus – Online Education), University of New Mexico
- M.A., Organizational Learning and Instructional Technologies (Focus – Organizational Development), University of New Mexico
- B. A., Teaching of Spanish, University of Illinois

Professional Certifications and Training:

- Illinois Secondary Teaching Certificate

Years of Experience: 8

SUMMARY OF EXPERIENCE AND QUALIFICATIONS

Jenna is a Senior Learning and Development Specialist/Instructional Designer working for the Learning and Communications Solutions (LCS) group within Northrop Grumman's Technical Services sector. She has more than 8 years of training and education experience with a wide range of clients in the governmental, corporate, educational, and academic arenas. Her experience encompasses instructional design, research, evaluation and analysis, content development, online education, language, and culture. She is fluent in written and spoken Spanish.

Human Performance Analysis

She is knowledgeable of principles and practices current to the human performance field, including job analysis, recruitment and selection, affirmative action, classification, compensation, organizational development, feedback on performance, and supervision. She has excellent skills in English grammar and usage and has published a variety of written documents. Furthermore, she has extensive experience presenting before groups with varying levels of technical knowledge.

Jenna has acted as a project leader and completes tasks on time and according to budget. She has experience in working on assignments with highly technical subject matter and elevated impact and visibility. In the area of training development, she has prepared project plans that incorporated milestones, resources needed, objectives, and performance standards. She has experience in training trainers so that they can better disseminate information. Jenna regularly confers with officials and supervisors regarding the practices, rules, policies and procedures of developing and modifying human resource practices so that she can provide solutions and alternatives to current practices, as well as recommend improvements in preparation for implementation of the changes.

Instructional Systems Development

Jenna has more than 8 years of experience in all phases of Instructional Systems Development (ISD), with expertise in the analysis, design, and development of various training products/solutions. She also has extensive experience in the implementation and evaluation of face-to-face and Web-based training.

As an instructional designer, she uses proven research techniques to gather relevant data and then actively works with her team and Subject Matter Experts (SMEs) to analyze training requirements, define learning objectives, formulate instructional approaches, and specify learning strategies. Dr. VanBerschot utilizes ISD methodologies to develop training and educational products that respond to new trends, recent threats, diverse audiences, and varying training environments.

Publications

Linder-VanBerschot, J. A., Borden, A., & Pagels, A. L. (In Press). Marketing online learning for a global campus: An international research exploration. In U. Demiray & S. Sever (Eds.). *Marketing online education in global campus: An integrated approach.*

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INSTRUCTIONAL SYSTEMS DEVELOPER	Rebecca Castro

Education

- Ph.D. Candidate, Curriculum and Instruction, Northern Arizona University
- M.A., Organization Learning and Instructional Technology (OLIT), Instructional Systems Design (ISD), University of New Mexico
- B.S., Public Relations, Central Missouri State University

Professional Certifications and Training:

- National School Reform Faculty Certified Facilitator

Years of Experience: 7

SUMMARY OF EXPERIENCE AND QUALIFICATIONS

Becca is an Instructional Systems Developer with more than 7 years of experience. Her background as an educator, program and admissions director for the Sustainable Global Leadership Alliance, and consultant for the New Mexico Education Network Center provide her with an array of indispensable skills. She contributes an exceptional skill set to her position through her experience and education.

Instructional Systems Development

Becca is responsible for developing +materials for both Web-based and stand-up training, including testing and evaluation materials.

She developed training aids for the Army Property Book Unit Supply Enhanced logistics application, creating online instruction for instrumentation for the U.S. Air Force (USAF) School of Aerospace Medicine and developing computer-based training (CBT) for the U.S. Marine Corp's M9 ACE (Armored Combat Earthmover). These products are similar to the Advanced Distributed Learning (ADL) products to be developed for the U.S. Coast Guard (USCG). The ADDIE model was used to guide all instructional design and development tasks.

Becca has led training projects for internal Northrop Grumman clients, overseeing and participating in all aspects of development including task analysis, design document development, storyboarding, and evaluation. She also developed and documented the Instructional Systems Development (ISD) process used by Northrop Grumman's Learning and Communications Solutions (LCS) Group.

Becca has performed analyses and developed courseware for the USAF. She ensured that the Air Force ISD model was applied to the development of all courseware. Working closely with subject matter experts and the USAF, she has developed course analysis and design documents, control charts, plans of instruction, and PowerPoint presentation files. She was the lead instructional designer and courseware developer for the Joint Patient Tracking System (JPATS) courseware for the Force Health Protection and Readiness group.

Becca is a former public school educator and has developed and implemented leadership curricula for various non-governmental organizations (NGOs). She has also worked as an organizational learning consultant facilitating various business development processes.

INSTRUCTIONAL SYSTEMS DEVELOPER	Damien Sánchez

Education

- M.A., Organizational Learning and Instructional Technology, University of New Mexico
- B.U.S, (Organizational Learning and Instructional Technology), University of New Mexico

Years of Experience: 4

SUMMARY OF EXPERIENCE AND QUALIFICATIONS

Damien is an instructional designer with 4 years of experience working in a variety of professional settings. He is fully knowledgeable in the ADDIE model, having applied it to several projects. He has successfully completed projects for clients in the professional world and academia. Damien has developed strong Web design and graphic design skills in the process of developing a variety of project and departmental Web sites. Excellent project management skills helped He complete his work in a timely and efficient manner. He has a solid foundation in face-to-face training, having conducted a variety of workshops for youth and college-age students on topics such as the legislative process and digital storytelling. In the past year, Damien has continued to develop the aforementioned skills by successfully working with internal Northrop Grumman clients and the U.S. Army on a range of demanding projects, several which included ADL products and performance improvements.

Instructional Systems Development

Damien has worked on numerous projects in the governmental and academic arenas. He is currently an instructional designer with Northrop Grumman's Learning and Communications Solutions group. He specializes in ISD and brings a variety of graphic and Web design skills to the table. He is also well versed in usability principles and project management. He strives to apply these skills on every project he is involved with.

As a principal member of the Saba Courseware Conversion project, Damien was responsible for creating and maintaining progress sheets for the development of learning objects and working with other members of the team to complete the project on time and produce a quality product. He helped manage the project by maintaining progress sheets and effectively dividing work among team members to achieve optimal results.

As a key member of the PBUSE Training Aid project, Damien relied heavily on his skills as an instructional designer in developing software simulations. These simulations followed the ADDIE principle, linking content to Army logistics requirements. On the 6 Sigma training project, Damien worked directly with clients and SMEs to design and develop a product that met their instructional needs. He was also responsible for the initial conceptualization of the 6 Sigma Training Center's Web interface.

Damien has been responsible for editing and maintaining XML files crucial to a variety of projects including PBUSE, Courseware Conversion, and IWO Web. All of the simulations he has worked on were utilized in a Web-based environment. He also has a wealth of experience designing and developing Web sites for academia.

WEB AND GRAPHIC DESIGNER	Zac Van Note

Education

- B.F.A., New Mexico State University

Professional Certifications and Training:

- Numerous courses in Web design, multimedia, databases and programming.

Years of Experience: 22

SUMMARY OF EXPERIENCE AND QUALIFICATIONS

Zac has been involved in computer graphics and design since 1987. Before earning his B.F.A. in graphic design at New Mexico State University, he was writing, drawing, and publishing comic books professionally. In the years since college, he's worked as an in-house graphic designer and as a freelancer, creating catalogs, Web sites, and a wide range of printed and interactive marketing materials. He is currently working as an Interactive Designer for the Learning & Communications Solutions (LCS) group, part of Northrop Grumman's Technical Services sector.

Since 1999, Zac has taught hundreds of classes at the University of New Mexico and Santa Fe Community College, including Photoshop, Illustrator, InDesign, Digital Prepress, Color Theory, Dreamweaver, Flash, and HTML. In 2006, he was nominated by students and selected as Instructor of the Year at the University of New Mexico Continuing Education Department. He has also contributed to several books on Web development software as an author and technical editor for New Riders and Thomson–Course Technologies. In 2002 he contributed two chapters to the very successful *Dreamweaver MX* Magic, from New Riders publishers. He recently provided significant inputs to a 200-page User Interface Design Guidelines document developed for a military client.

Graphic Design

Zac has extensive experience using a wide range of computer hardware and software on Windows and Macintosh platforms. He has extensive experience with Dreamweaver, Flash, Fireworks, Photoshop/ImageReady, Quark XPress, PageMaker, InDesign, Illustrator, CorelDRAW, Adobe Acrobat, Freehand, FrontPage, GoLive, FinalCut Pro, Microsoft Office, Contribute, Captivate, (X)HTML, CSS, ASP, ASP.net, PHP, JavaScript, and more. He will be fully prepared to apply his skills in the use of all USCG ADL product development tools.

Zac also has several years of experience teaching classes in graphics software and design theory. Other experience includes professionally tutoring dozens of people one-on-one on various computer applications and providing on-the-job software training to a group of 20 users. His Web design and development experience includes creating dozens of sites, from static HTML pages to dynamic applications (using JavaScript, ASP, PHP, ASP.net, and ColdFusion). The majority of applications have been built using classic ASP with Dreamweaver and hand coding of HTML/CSS.

Zac's multimedia experience includes creation of Web demonstrations, as well as CD-ROMs and DVDs incorporating audio, video, and 2-D animation using Flash, FinalCut Pro, Premiere Pro, After Effects, and other tools. His graphic arts background includes experience in page layout, digital photo-manipulation, publication design, and identity system design. He has extensive experience working closely with copywriters, photographers, service bureaus, and sheet-fed, digital, and Web printers.

MEDIA SPECIALIST AND WEB DESIGNER	Vickie Aranda

Education

- Associate Degree in Advertising Design, Colorado Institute of Art
  - Sales, Marketing, Communications, Advertising, and Graphic Design

Professional Certifications and Training:

Macromedia University, online course in Macromedia software and HTML Network

Years of Experience: 25

SUMMARY OF EXPERIENCE AND QUALIFICATIONS

Vickie has 25 years of combined experience in print design and production specialist, interactive design, advertising, and marketing. She has successfully provided award winning marketing, communications and publication production and design services exceeding client expectations; sold development projects providing significant cost benefits to clients; and provided oversight to technical and promotional writers and designers. Ms. Aranda has proved outstanding at creating and implementing advertising campaigns for print, broadcast, and interactive formats. She has strong communication skills and is able to work with clients, colleagues, and management successfully. Vickie is also able to perform expertly under tight deadlines and in high-pressure situations.

WEB and GRAPHIC DESIGN / MULTIMEDIA / INTERNET DEVELOPMENT

Vickie is currently an Interactive Systems Designer/Developer for Northrop Grumman. She supports the Training and Interactive Systems Group and the Learning and Communications Solutions Group, service organizations offering technology-based training, information products, and Web applications. In this capacity, she is responsible for Web design, testing, quality assurance, and providing marketing and design services to support internal and external clients.

In performing her duties, she utilizes the following programs: Macromedia Dreamweaver, Macromedia Flash, Adobe Creative Suite 2 (Illustrator, Photoshop, InDesign, Bridge), and Microsoft Office.

PROJECT MANAGEMENT

Vickie is project manager and designer for *TS Magazine* and the award winning *SRD Compass*, both Northrop Grumman internal publications. As a project manager, she is responsible for planning production schedules for the various steps in the design process; analyzing and projecting development costs and developing project budgets and workflow. She also has experience managing print, video and television, and internet marketing projects.

VIDEOGRAPHER AND WEB DEVELOPER	Steven Wenrich
Education ■ B.S., Broadcast Production, Eastern New Mexico University	
Years of Experience: 12	

SUMMARY OF EXPERIENCE AND QUALIFICATIONS

Steve has more than 12 years of combined experience in multimedia development, programming, graphic design, video production, Web development, and computer animation/illustration. As a Web Software Developer for Northrop Grumman Technical Services, his experience and excellent skill set serve as tremendous assets to his current position. His work in development, art direction, design, and animation/illustration encompasses a broad array of computer applications.

Steve has worked for a wide range of military, government and commercial clients. He specializes in the development of Web-based training (WBT) and Web applications as well as graphic design and video production. He has a wide array of skills that encompass graphical user interface (GUI) design, programming, database design, information design, graphic design, videography, video editing, compositing, and animation.

Video Production

Steve is responsible for video production, including videography, lighting, sound, production, direction, editing, graphics, animation, and compositing. He works in all areas of multimedia/Internet development, including feature specification, design, programming, deployment, and testing. He also works in a wide array of frameworks, specifications and languages, including WC3, ASP.net 2.0, PHP, ActionScript 3.0, JavaScript, XML, XHTML, SQL, MySQL and Flex. He has also performed development for the Northrop Grumman portal.

Steve also designs marketing collateral, posters, tradeshow displays, and many other products for internal, government, and military clients. He is experienced and proficient in Adobe CS4 (Photoshop, Illustrator, Flash, Dreamweaver, Premier, After Effects, and InDesign), Adobe Flex Builder, Microsoft Visual Studio, and a range of Microsoft Office applications.

PROGRAMMER Kottamasu	Shyam
Education ■ M.S. Candidate, Computer Engineering, University of New Mexico ■ B.S., Computer Science, University of New Mexico Professional Certifications and Training: ■ Oracle (9i), ed2go MTSU ■ Network Plus Certification, ed2go MTSU	
Years of Experience: 5	

SUMMARY OF EXPERIENCE AND QUALIFICATIONS

Shyam is an experienced, self-motivated, team-oriented and results-driven individual seeking an employment which can utilize my skills of Systems Analysis, Systems Administration, Software/Hardware/Systems Engineering, Database Administration and Networking.

Programming

Shyam has over 5 years experience programming in C#, C++, VB, .NET Framework, Windows Services, and Internet/intranet Web applications using various core technologies such as XML, JavaScript, ASP.NET, AJAX, CSS, HTML, .NET Remoting, and Web Services. His over 5 years of database experience have encompassed RDBMS–MSSQL Server 2000, 2005; MySQL 5.0; Oracle Database 9i, 10g. Database projects have involved design, development, management, maintenance, administration of databases. SQL queries, stored procedures, triggers, views, bulk insert and format files, user-defined functions, cursors, and reporting services.

His systems administration experience has involved installation of Installation and maintenance of Windows 2000, 2003 Servers. He is an excellent troubleshooter of computer hardware and software problems. He is also experienced in Active Directory management. His FPGA and HDL experience encompasses Xilinx's Spartan 3E and Virtex-II Pro XC2VP30 PLBs with Xilinx ISE & EDK10.1, ChipScope Pro 10.1 and ModelSim XE III 6.3d, VHDL. His projects in this area have involved Wave generations, AC97 AUDIO CODEC using Virtex-II Pro, Two Function Calculator, Sequence Detector, Counter with LCD, Serial RS 232, ChipScope Pro, LabVIEW Interfacing. Shyam is experienced in rapid application prototyping, effort estimation, design and testing techniques for distributed real-time applications.

He is proficient in requirements analysis, software engineering techniques, Object Oriented Design using UML and CASE tools, and Logical Data Modeling (LDM). His over 5 years of operating system experience has spanned MS DOS; MS Windows 98/00/ME/XP/2003Server; UNIX - GNU/Linux, Red Hat Linux, and Debian.

Shyam's projects have involved the following:

- an Airline Reservations System (C++).
- Hotel Management software (Visual C++).
- Semaphores and Deadlocks (C++).
- a Recycle Bin in UNIX Shell Script (tcsh).
- User Login Statistics in UNIX Shell Script (tcsh).
- Programmed Client-Server applications in Python/Perl and UNIX using sockets.
- a Shopping Cart app with Credit Card Validation and Pay Pal. (ASP.NET, VB.NET and SQL).
- Library Management System Software (VB.NET).

- a VB.NET application similar to MS Word.
- a Linear Feedback Shift Register Program(C# and VB.NET).

Shyam's certifications include the following:

- Oracle (9i), ed2go MTSU, (May 2005)

  Structured Query Language (SQL), Oracle's SQL*Plus, and other valuable tools used to develop, manage, and reference an Oracle database. Data Definition Language statements to create, update, and delete database objects. Data Control Language statements to give or delete access rights to database objects. Data Manipulation Language statements to insert, update, and delete records from a database.

- Network Plus Certification, ed2go MTSU, (May 2003)

Topologies, the OSI Seven-Layer model, protocol suites, modern network operating systems, network hardware, cabling standards, remote connectivity, Internet connections, network troubleshooting. Counts as one of the elective exams for the Microsoft Certified Systems Administrator (MCSA)

Appendix G

NFPA 472 for Hydrogen Competency Mapping

NFPA 472 for Hydrogen Project - Competency Mapping

I. Introduction – What is this document?

This document identifies the minimum training competencies (based on the 2008 edition of NFPA 472, Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents - Chapters 4, 5, 6, and 8) for an emergency responder to incidents involving hydrogen in manufacturing, storage, transportation, use, disposal, and as a potential weapon of mass destruction.

Responders to emergencies involving hydrogen shall be trained to perform the following tasks:

- Detect the presence of hydrogen
- Analyze an emergency involving hydrogen
    - o Initiate command and control - initiate notification, initiate incident command
    - o Survey a hydrogen incidents
    - o Collect and interpret hazard and response information
    - o Assess damage to hydrogen containers
    - o Predict behavior of hydrogen and its container
    - o Estimate potential harm (outcomes)
- Plan a response
    - o Determine the response objectives
    - o Identifying action options
    - o Select and use appropriate personal protective equipment
    - o Selecting the appropriate emergency and technical decontamination
    - o Develop an incident action plan including safety and health considerations
- Implement the incident action plan
    - o Establish and enforced scene control procedures
    - o Product control
    - o Use selected PPE
    - o Perform air monitoring and sampling
    - o Perform victim rescue and recovery
    - o Perform emergency and technical decontamination
- Evaluate progress in an emergency involving hydrogen
    - o Evaluate and communicate status of planned response
- Terminate the incident
    - o Transfer command and control
    - o Conduct debriefing
    - o Perform post incident analysis
    - o Conduct a critique
    - o Reporting and documenting the incident

This document is specifically for hydrogen but can serve as the template for design and development of the courses for product-specific hazardous materials.

1. This document includes a matrix detailing the competencies for a hydrogen specific course to be delivered to fire departments across the country. This matrix includes both

knowledge and skills based competencies. Skill based competencies are highlighted in the matrix.

2. Where this document addresses the minimum competencies for emergency response to hydrogen at the operations level. However, the operations level responder needs to address all hazards that may be present which requires competence beyond that included in this matrix.

II. Chapter 4 Competencies for Awareness Level Personnel

4.2.1* Detecting the Presence of Hydrogen. Given examples of various situations, awareness level personnel shall identify those situations where hydrogen is used, manufactured, stored, or transported and shall meet the following requirements.

(2) Identify the UN/DOT hazard class and division for hydrogen.
(3)*Identify the primary hazards associated with hydrogen.
(4) Identify the difference between hydrogen incidents and other emergencies.
(5) Identify typical occupancies and locations in the community where hydrogen is manufactured, transported, stored, used, or disposed of.
(6) Identify typical container shapes that can indicate the presence of hydrogen.
(7) Identify facility and transportation markings and colors that indicate hydrogen, including the following:
(a) Transportation markings, including UN/NA identification number marks
(b) NFPA 704, Standard System for the Identification of the Hazards of Materials for Emergency Response, markings
(c)*Military hazardous materials/WMD markings
(d) Special hazard communication markings for hydrogen
(f) Container markings
(8) Given an NFPA704 marking, describe the significance of the colors, numbers, and special symbols.
(9) Identify U.S. and Canadian placards and labels that indicate hydrogen.
(10) Identify the following basic information on material safety data sheets (MSDS) and shipping papers for hazardous materials:
(a) Identify where to find MSDS.
(b) Identify major sections of an MSDS.
(c) Identify the entries on shipping papers that indicate the presence of hydrogen.
(d) Match the name of the shipping papers found in transportation (air, highway, rail, and water) with
the mode of transportation.
(e) Identify the person responsible for having the shipping papers in each mode of transportation.
(f) Identify where the shipping papers are found in each mode of transportation.
(g) Identify where the papers can be found in an emergency in each mode of transportation.
(11)*Identify examples of clues (other than occupancy/ location, container shape, markings/color, placards/ labels, MSDS, and shipping papers) the sight, sound, and odor of which indicate hydrogen.

(12) Describe the limitations of using the senses in determining the presence or absence of hydrogen.
(13)*Identify at least four types of locations that could be targets for criminal or terrorist activity using hazardous materials/WMD.
(15)*Identify at least four indicators of possible criminal or terrorist activity involving hydrogen.
(20)*Identify at least four indicators of secondary devices.

4.2.2 Surveying Hydrogen Incidents. Given three examples of hazardous materials incidents, Awareness level personnel shall, from a safe location, identify those situations where hydrogen is involved by name, UN/NA identification number, or type placard applied and shall meet the following requirements:
(1) Identify difficulties encountered in determining the specific identity of hydrogen at facilities and in transportation.
(2) Identify sources for obtaining the names of, UN/NA identification numbers for, or types of placard associated with hydrogen in transportation.
(3) Identify sources for obtaining the names of hydrogen at a facility.

4.2.3* Collecting Hazard Information. Given an incident involving hydrogen (name, UN/NA identification number, or type placard), awareness level personnel shall identify the fire, explosion, and health hazard information by using the current edition of the DOT Emergency Response Guidebook and shall meet the following requirements:
(1)*Identify the three methods for determining the guidebook page for hydrogen.
(2) Identify the two general types of hazards found on each guidebook page.

4.4.1* Initiating Protective Actions. Given a scenario involving hydrogen, the emergency response plan, the standard operating procedures, and the current edition of the DOT Emergency Response Guidebook, awareness level personnel shall be able to identify the actions to be taken to protect themselves and others and to control access to the scene and shall meet the following requirements:
(1) Identify the location of both the emergency response plan and/or standard operating procedures.
(2) Identify the role of the awareness level personnel during a hydrogen incident.
(3) Identify the following basic precautions to be taken to protect themselves and others in hydrogen incidents:
(a) Identify the precautions necessary when providing emergency medical care to victims of hydrogen incidents.
(b) Identify typical ignition sources found at the scene of hydrogen incident.
(c)*Identify the ways hydrogen is harmful to people, the environment, and property.
(d)*Identify the general routes of entry for human exposure to hydrogen.
(4)* Given an incident involving hydrogen (name, UN/NA identification number, or type placard), identify the following response information:
(a) Emergency action (fire, spill, or leak and first aid)
(b) Personal protective equipment necessary
(c) Initial isolation and protective action distances
(5) Given the name of a hazardous material, identify the recommended personal protective equipment from the following list:
(a) Street clothing and work uniforms
(b) Structural fire-fighting protective clothing
(c) Positive pressure self-contained breathing apparatus

(d) Chemical-protective clothing and equipment
(6) Identify the definitions for each of the following protective actions:
(a) Isolation of the hazard area and denial of entry
(b) Evacuation
(c)*Sheltering in-place
(7) Identify the size and shape of recommended initial isolation and protective action zones.
(8) Describe the difference between small and large spills as found in the Table of Initial Isolation and Protective Action Distances in the DOT Emergency Response Guidebook.
(9) Identify the circumstances under which the following distances are used at hydrogen incidents:
(a) Table of Initial Isolation and Protective Action Distances
(b) Isolation distances in the numbered guides
(10) Describe the difference between the isolation distances on the orange-bordered guidebook pages and the protective action distances on the green-bordered ERG (Emergency Response Guidebook) pages.
(11) Identify the techniques used to isolate the hazard area and deny entry to unauthorized persons at hydrogen incidents.
(12)*Identify at least four specific actions necessary when an incident is suspected to involve criminal or terrorist activity.
4.4.2 Initiating the Notification Process. Given scenarios involving hydrogen, awareness level personnel shall identify the initial notifications to be made and how to make them, consistent with the emergency response plan and/or standard operating procedures.

III. Chapter 5 Core Competencies for Operations Level Responders

5.2.1* Surveying Hydrogen Incidents. Given scenarios involving hydrogen, the operations level responder shall survey the incident to identify the containers, determine whether hydrogen has been released, and evaluate the surrounding conditions and shall meet the requirements of 5.2.1.1 through 5.2.1.6.
5.2.1.1* Given scenarios involving hydrogen, operations level responder shall identify the general shapes of containers in which the hydrogen are typically found.
5.2.1.1.1 Given examples of tank cars, the operations level responder shall identify the cryogenic liquid tank car for transporting hydrogen
5.2.1.1.2 Given examples of intermodal tanks, the operations level responder shall identify the cryogenic liquid and tube module tanks used for transporting hydrogen
5.2.1.1.3 Given examples of cargo tanks, the operations level responder shall identify the compressed gas tube trailers and cryogenic used for transporting hydrogen
5.2.1.1.4 Given examples of storage tanks, the operations level responder shall identify those tanks used for storage of hydrogen, as follows:
(1) Cryogenic liquid tank
(3) Pressure tank
5.2.1.1.5 Given examples of non-bulk packages, the operations level responder shall identify those packages used for storage of hydrogen, as follows:
(3) Cylinders
(5) Dewar flask (cryogenic liquids)
5.2.1.2 Given scenarios involving hydrogen, the operations level responder shall identify the markings that differentiate one container from another.

5.2.1.2.1 Given examples of the following marked transport vehicles and their corresponding shipping papers, the operations level responder shall identify the following vehicle or tank identification marking:
(1) Highway transport vehicles, including cargo tanks
(2) Intermodal equipment, including tank containers
(3) Rail transport vehicles, including tank cars
5.2.1.2.2 Given examples of facility containers, the operations level responder shall identify the markings indicating container size, product contained, and/or site identification numbers.
5.2.1.4* The operations level responder shall identify and list the surrounding conditions that should be noted when a hazardous materials/WMD incident is surveyed.
5.2.1.5 The operations level responder shall give examples of ways to verify information obtained from the survey of a hydrogen incident.
5.2.1.6* The operations level responder shall identify at least three additional hazards that could be associated with an incident involving terrorist or criminal activities.
5.2.2 Collecting Hazard and Response Information. Given scenarios involving hydrogen, the operations
level responder shall collect hazard and response information using MSDS, CHEMTREC/CANUTEC/SETIQ,
governmental authorities, and shippers and manufacturers and shall meet the following requirements:
(2) Identify two ways to obtain an MSDS in an emergency.
(3) Using an MSDS for a specified material, identify the following hazard and response information:
(a) Physical and chemical characteristics
(b) Physical hazards of the material
(c) Health hazards of the material
(d) Signs and symptoms of exposure
(e) Routes of entry
(f) Permissible exposure limits
(g) Responsible party contact
(h) Precautions for safe handling (including hygiene practices, protective measures, and procedures for cleanup of spills and leaks)
(i) Applicable control measures, including personal protective equipment
(j) Emergency and first-aid procedures
(4) Identify the following:
(a) Type of assistance provided by CHEMTREC/CANUTEC/SETIQ and governmental authorities
(b) Procedure for contacting CHEMTREC/CANUTEC/SETIQ and governmental authorities
(c) Information to be furnished to CHEMTREC/CANUTEC/SETIQ and governmental authorities
(5) Identify two methods of contacting the manufacturer or shipper to obtain hazard and response information.
(6) Identify the type of assistance provided by governmental authorities with respect to criminal or terrorist activities involving the release or potential release of hydrogen.
(7) Identify the procedure for contacting local, state, and federal authorities as specified in the emergency response plan and/or standard operating procedures.
5.2.3* Predicting the Likely Behavior of a Material and Its Container. Given scenarios involving hydrogen, the operations level responder shall predict the likely behavior of the material or agent and its container and shall meet the following requirements:

(1) Interpret the hazard and response information obtained from the current edition of the DOT Emergency Response Guidebook, MSDS, CHEMTREC/CANUTEC/SETIQ, governmental authorities, and shipper and manufacturer contacts, as follows:
(a) Match the following chemical and physical properties with their significance and impact on the behavior of the container and its contents:
i. Boiling point
ii. Chemical reactivity
iii. Corrosivity (pH)
iv. Flammable (explosive) range [lower explosive limit (LEL) and upper explosive limit (UEL)]
v. Flash point
vi. Ignition (autoignition) temperature
vii. Particle size
viii. Persistence
ix. Physical state (solid, liquid, gas)
x. Radiation (ionizing and non-ionizing)
xi. Specific gravity
xii. Toxic products of combustion
xiii. Vapor density
xiv. Vapor pressure
xv. Water solubility
(b) Identify the differences between the following terms:
i. Contamination and secondary contamination
ii. Exposure and contamination
iii. Exposure and hazard
iv. Infectious and contagious
v. Acute effects and chronic effects
vi. Acute exposures and chronic exposures
(2)*Identify three types of stress that can cause a container system to release its contents.
(3)*Identify five ways in which containers can breach.
(4)*Identify four ways in which containers can release their contents.
(5)*Identify at least four dispersion patterns that can be created upon release of hydrogen.
(6)*Identify the time frames for estimating the duration that hydrogen will present an exposure risk.
(7)*Identify the health and physical hazards that could cause harm.
(8)*Identify the health hazards associated with hydrogen from the following:
(b) Asphyxiant
(d) Convulsant
(f) Highly toxic
(g) Irritant
(h) Sensitizer, allergen
(i) Target organ effects
(j) Toxic

5.2.4* Estimating Potential Harm. Given scenarios involving hydrogen, the operations level responder
shall estimate the potential harm within the endangered area at each incident and shall meet the following requirements:
(1)*Identify a resource for determining the size of an endangered area of a hydrogen incident.

(2) Given the dimensions of the endangered area and the surrounding conditions at a scenarios involving hydrogen incident, estimate the number and type of exposures within that endangered area.
(3) Identify resources available for determining the concentrations of hydrogen within an endangered area.
(4)*Given the concentrations of scenarios involving Hydrogen, identify the factors for determining the extent of physical, health, and safety hazards within the endangered area of the incident.
5.3.1 Describing Response Objectives. Given at least two scenarios involving hydrogen, the operations level responder shall describe the response objectives for each example and shall meet the following requirements:
(1) Given an analysis of scenarios involving hydrogen and associated exposures, determine the number of exposures that could be saved with the resources provided by the AHJ.
(2) Given an analysis of a hydrogen incident, describe the steps for determining response objectives.
(3) Describe how to assess the risk to a responder in rescuing injured persons at a scenarios involving hydrogen incident.
(4)*Assess the potential for secondary attacks and devices at criminal or terrorist events.
5.3.2 Identifying Action Options. Given scenarios involving hydrogen (facility and transportation), the
operations level responder shall identify the options for each response objective and shall meet the following requirements:
(1) Identify the options to accomplish a given response objective.
(2) Describe the prioritization of emergency medical care and removal of victims from the hazard area relative to exposure and contamination concerns.
5.3.3 Determining Suitability of Personal Protective Equipment. Given examples of hydrogen incidents,
including the anticipated type of exposure, the operations level responder shall determine whether available personal protective equipment is applicable to performing assigned tasks and shall meet the following requirements:
(1)*Identify the respiratory protection required for a given response option and the following:
(a) Describe the advantages, limitations, uses, and operational components of the following types of respiratory protection at hydrogen incidents:
i. Positive pressure self-contained breathing apparatus (SCBA)
ii. Positive pressure air-line respirator with required escape unit
iii. Closed-circuit SCBA
iv. Powered air-purifying respirator (PAPR)
v. Air-purifying respirator (APR)
vi. Particulate respirator
(b) Identify the required physical capabilities and limitations of personnel working in respiratory protection.
(2) Identify the personal protective clothing required for a given option and the following:
(a) Identify skin contact hazards encountered at hydrogen incidents.
(b) Identify the purpose, advantages, and limitations of the following types of protective clothing at hydrogen incidents:
i. Chemical-protective clothing: liquid splash–protective clothing and vapor-protective clothing
ii. High temperature–protective clothing: proximity suit and entry suits
iii. Structural fire-fighting protective clothing

5.3.4* Identifying Decontamination Issues. Given scenarios involving hydrogen incidents, operations
level responders shall identify when emergency decontamination is needed and shall meet the following requirements:
(1) Identify ways that people, personal protective equipment, apparatus, tools, and equipment become contaminated.
(2) Describe how the potential for secondary contamination determines the need for decontamination.
(3) Explain the importance and limitations of decontamination procedures at hazardous materials incidents.
(4) Identify the purpose of emergency decontamination procedures at hydrogen incidents.
(5) Identify the factors that should be considered in emergency decontamination.
(6) Identify the advantages and limitations of emergency decontamination procedures.
5.4.1 Establishing and Enforcing Scene Control Procedures. Given two scenarios involving hydrogen, the operations level responder shall identify how to establish and enforce scene control, including control zones and emergency decontamination, and communications between responders and to the public and shall meet the following requirements:
(1) Identify the procedures for establishing scene control through control zones.
(2) Identify the criteria for determining the locations of the control zones at hydrogen incidents.
(3) Identify the basic techniques for the following protective actions at hydrogen incidents:
(a) Evacuation
(b) Sheltering-in-place
(4)*Demonstrate the ability to perform emergency decontamination.
(5)*Identify the items to be considered in a safety briefing prior to allowing personnel to work at the following:
(a) Hydrogen incidents
(b)* Hydrogen incidents involving criminal activities
(6) Identify the procedures for ensuring coordinated communication between responders and to the public.
5.4.2* Preserving Evidence. Given two scenarios involving hydrogen incidents, the operations level responder shall describe the process to preserve evidence as listed in the emergency response plan and/or standard operating procedures.
5.4.3* Initiating the Incident Command System. Given scenarios involving hydrogen incidents, the operations level responder shall initiate the incident command system specified in the emergency response plan and/or standard operating procedures and shall meet the following requirements:
(1) Identify the role of the operations level responder during hydrogen incidents as specified in the emergency response plan and/or standard operating procedures.
(2) Identify the levels of hydrogen incidents as defined in the emergency response plan.
(3) Identify the purpose, need, benefits, and elements of the incident command system for hydrogen incidents.
(4) Identify the duties and responsibilities of the following functions within the incident management system:
(a) Incident safety officer
(b) Hazardous materials branch or group
(5) Identify the considerations for determining the location of the incident command post for a hydrogen incident.
(6) Identify the procedures for requesting additional resources at a hydrogen incident.

(7) Describe the role and response objectives of other agencies that respond to hydrogen incidents.

5.4.4 Using Personal Protective Equipment. The operations level responder shall describe considerations for the use of personal protective equipment provided by the AHJ, and shall meet the following requirements:

(1) Identify the importance of the buddy system.
(2) Identify the importance of the backup personnel.
(3) Identify the safety precautions to be observed when approaching and working at hydrogen incidents.
(4) Identify the signs and symptoms of heat and cold stress and procedures for their control.
(5) Identify the capabilities and limitations of personnel working in the personal protective equipment provided by the AHJ.
(6) Identify the procedures for cleaning, disinfecting, and inspecting personal protective equipment provided by the AHJ.
(7) Describe the maintenance, testing, inspection, and storage procedures for personal protective equipment provided by the AHJ according to the manufacturer's specifications and recommendations.

5.5.1 Evaluating the Status of Planned Response. Given two scenarios involving hydrogen incidents, including the incident action plan, the operations level responder shall evaluate the status of the actions taken in accomplishing the response objectives and shall meet the following requirements:

(1) Identify the considerations for evaluating whether actions taken were effective in accomplishing the objectives.
(2) Describe the circumstances under which it would be prudent to withdraw from a hazardous materials/WMD incident.

5.5.2 Communicating the Status of the Planned Response. Given two scenarios involving hydrogen incidents, including the incident action plan, the operations level responder shall communicate the status of the planned response through the normal chain of command and shall meet the following requirements:

(1) Identify the methods for communicating the status of the planned response through the normal chain of command.
(2) Identify the methods for immediate notification of the incident commander and other response personnel about critical emergency conditions at the incident.

IV. Chapter 6 Competencies for Operations Level Responders Assigned Mission-Specific Responsibilities

6.2 Mission-Specific Competencies: Personal Protective Equipment.

6.2.3.1 Selecting Personal Protective Equipment. Given scenarios involving hydrogen, the operations level responder assigned to use personal protective equipment shall select the personal protective equipment required to support mission-specific tasks based on local procedures and shall meet the following requirements:

(1)*Describe the types of protective clothing and equipment that are available for response to a hydrogen incident based on NFPA standards and how these items relate to EPA levels of protection.
(2) Describe personal protective equipment options for the following hazards:
(a) Thermal
(b) Radiological
(c) Asphyxiating

(d) Chemical
(e) Etiological/biological
(f) Mechanical
(3) Select personal protective equipment for mission-specific tasks at hydrogen incidents based on local procedures.
(a) Describe the following terms and explain their impact and significance on the selection of chemical protective clothing:
i. Degradation
ii. Penetration
iii. Permeation
(b) Identify at least three indications of material degradation of chemical-protective clothing.
(c) Identify the different designs of vapor-protective and splash-protective clothing and describe the advantages and disadvantages of each type.
(d)*Identify the relative advantages and disadvantages of the following heat exchange units used for the cooling of personnel operating in personal protective equipment:
i. Air cooled
ii. Ice cooled
iii. Water cooled
iv. Phase change cooling technology
(e) Identify the physiological and psychological stresses that can affect users of personal protective equipment.
(f) Describe local procedures for going through the technical decontamination process.
6.2.4.1 Using Protective Clothing and Respiratory Protection. Given the personal protective equipment provided by the AHJ, the operations level responder assigned to use personal protective equipment in hydrogen incidents shall demonstrate the ability to don, work in, and doff the equipment provided to support mission specific tasks and shall meet the following requirements:
(1) Describe at least three safety procedures for personnel wearing protective clothing.
(2) Describe at least three emergency procedures for personnel wearing protective clothing.
(3) Demonstrate the ability to don, work in, and doff personal protective equipment provided by the AHJ.
(4) Demonstrate local procedures for responders undergoing the technical decontamination process.
(5) Describe the maintenance, testing, inspection, storage, and documentation procedures for personal protective equipment provided by the AHJ according to the manufacturer's specifications and recommendations.

6.4 Mission-Specific Competencies: Technical Decontamination.
6.4.3.1 Selecting Personal Protective Equipment. Given scenarios involving hydrogen, the operations level responder assigned to technical decontamination shall select the personal protective equipment required to support technical decontamination based on local procedures, emergency response plan, standard operating procedures, and incident action plan (see Section 6.2).
6.4.3.2 Selecting Decontamination Procedures. Given scenarios involving hydrogen, the operations level responder assigned to technical decontamination shall select a technical decontamination procedure that will minimize the hazard and spread of contamination and determine the equipment required to implement that procedure and shall meet the following requirements:
(1) Identify the advantages and limitations of technical decontamination.

(2) Describe the advantages and limitations of each of the following technical decontamination methods at hydrogen incidents:
(a) Absorption
(b) Adsorption
(c) Chemical degradation
(d) Dilution
(e) Disinfection
(f) Evaporation
(g) Isolation and disposal
(h) Neutralization
(i) Solidification
(j) Sterilization
(k) Vacuuming
(l) Washing
(3) Identify sources of information for determining the correct technical decontamination procedure and identify how to access those resources at hydrogen incidents.
(4) Given resources provided by the AHJ, identify the supplies and equipment required to set up and implement technical decontamination.
(5) Identify the procedures, equipment, and safety precautions for processing evidence during technical decontamination at hydrogen incidents.
(6) Identify procedures, equipment, and safety precautions for handling tools, equipment, weapons, criminal suspects, and law enforcement/service animals brought to the decontamination corridor at WMD incidents that involve hydrogen.

6.4.4.1 Performing Technical Decontamination. Given scenarios involving hydrogen, the operations level responder assigned to technical decontamination shall describe the technical decontamination duties assigned based on local procedures, emergency response plan, standard operating procedures, and incident action plan and shall meet the following requirements:
(1) Identify the role of the operations level responder assigned to technical decontamination at hydrogen incidents.
(2) Describe the procedures for implementing technical decontamination within the incident command system.

6.4.4.2 Performing Technical Decontamination Identified. Given scenarios involving hydrogen, the operations level responder assigned to technical decontamination shall demonstrate the ability to set up and implement the following types of decontamination based on local procedures, emergency response plan, standard operating procedures, and incident action plan:
(1) Technical decontamination in support of entry operations
(2) Technical decontamination for ambulatory and non-ambulatory victims

6.4.5.1 Evaluating the Effectiveness of the Technical Decontamination. Given examples of contaminated items that have undergone the required decontamination, the operations level responder assigned to technical decontamination at hydrogen incident shall identify procedures for determining whether the items have been fully decontaminated according to the standard operating procedures of the AHJ or the incident action plan.

6.4.6.1 Reporting and Documenting the Incident. Given a scenario involving hydrogen, the operations level responder assigned to technical decontamination at hydrogen incidents shall complete the reporting and documentation requirements consistent with the emergency response plan or standard operating procedures and shall meet the following requirements:

(1) Identify the reports and supporting technical documentation required by the emergency response plan or standard operating procedures.
(2) Describe the importance of personnel exposure records.
(3) Identify the steps in keeping an activity log and exposure records.
(4) Identify the requirements for filing documents and maintaining records.

6.6 Mission-Specific Competencies: Product Control.

6.6.3.1 Identifying Control Options. Given scenarios involving hydrogen, the operations level responder assigned to perform product control shall identify the options for each response objective and shall meet the following requirements as prescribed by the AHJ:
(1) Identify the options to accomplish a given response objective.
(2) Identify the purpose for and the procedures, equipment, and safety precautions associated with each of the following control techniques at hydrogen incidents:
(a) Absorption
(b) Adsorption
(c) Damming
(d) Diking
(e) Dilution
(f) Diversion
(g) Remote valve shutoff
(h) Retention
(i) Vapor dispersion
(j) Vapor suppression

6.6.3.2 Selecting Personal Protective Equipment. Given scenarios involving hydrogen, the operations level responder assigned to produce control shall select the personal protective equipment required to support product control based on local procedures, emergency response plan, standard operating procedures, and incident action plan (see Section 6.2).

6.6.4.1 Performing Control Options. Given an incident action plan for a hydrogen incident, within the capabilities and equipment provided by the AHJ, the operations level responder assigned to perform product control shall demonstrate product control functions set out in the plan and shall meet the following requirements as prescribed by the AHJ:
(1) Using the type of special purpose or hazard suppressing foams or agents and foam equipment furnished by the AHJ, demonstrate the application of the foam(s) or agent(s) on a spill or fire involving Hydrogen.
(2) Identify the characteristics and applicability of the following Class B foams if supplied by the AHJ:
(a) Aqueous film-forming foam (AFFF)
(b) Alcohol-resistant concentrates
(c) Fluoroprotein
(d) High-expansion foam
(3) Given the required tools and equipment, demonstrate how to perform the following control activities:
(a) Absorption
(b) Adsorption
(c) Damming
(d) Diking
(e) Dilution
(f) Diversion
(g) Retention

(h) Remote valve shutoff
(i) Vapor dispersion
(j) Vapor suppression
(4) Identify the location and describe the use of emergency remote shutoff devices on Hydrogen transport containers in transportation.
(5) Describe the use of emergency remote shutoff devices at fixed Hydrogen facilities.
6.6.4.2 The operations level responder assigned to perform product control shall describe local procedures for going through the technical decontamination process.

6.7 Mission-Specific Competencies: Air Monitoring and Sampling.

6.7.3.1 Given the air monitoring and sampling equipment provided by the AHJ, the operations level responder assigned to perform air monitoring and sampling shall select the detection or monitoring equipment suitable for detecting or monitoring hydrogen.
6.7.3.2 Given detection and monitoring device(s) provided by the AHJ, the operations level responder assigned to perform air monitoring and sampling shall describe the operation, capabilities and limitations, local monitoring procedures, field testing, and maintenance procedures associated with each device.
6.7.3.4 Selecting Personal Protective Equipment. Given scenarios involving hydrogen, the operations level responder assigned to air monitoring and sampling shall select the personal protective equipment required to support air monitoring and sampling based on local procedures, emergency response plan, standard operating procedures, and incident action plan (see Section 6.2).
6.7.4.1 Given a scenario involving hydrogen and detection and monitoring devices provided by the AHJ, the operations level responder assigned to perform air monitoring and sampling shall demonstrate the field test and operation of each device and interpret the readings based on local procedures.
6.7.4.2 The operations level responder assigned to perform air monitoring and sampling shall describe local procedures for decontamination of themselves and their detection and monitoring devices upon completion of the air monitoring mission.

6.8 Mission-Specific Competencies: Victim Rescue and Recovery.

6.8.3.1 Given scenarios involving hydrogen incidents, the operations level responder assigned to victim rescue and recovery shall determine the feasibility of conducting victim rescue and recovery operations at an incident involving Hydrogen and shall be able to perform the following tasks:
(1) Determine the feasibility of conducting rescue and recovery operations.
(2) Describe the safety procedures, tactical guidelines, and incident response considerations to effect a rescue associated with each of the following situations:
(a) Line-of-sight with ambulatory victims
(b) Line-of-sight with non-ambulatory victims
(c) Non-line-of-sight with ambulatory victims
(d) Non-line-of-sight with non-ambulatory victims
(e) Victim rescue operations versus victim recovery operations
(3) Determine if the options are within the capabilities of available personnel and personal protective equipment.
(4) Describe the procedures for implementing victim rescue and recovery operations within the incident command system.
6.8.3.2 Selecting Personal Protective Equipment. Given scenarios involving hydrogen, the operations level responder assigned to victim rescue and recovery shall select the personal

protective equipment required to support victim rescue and recovery based on local procedures, emergency response plan, standard operating procedures, and incident action plan (see Section 6.2).
6.8.4.1 Given a scenario involving Hydrogen, the operations level responder assigned to victim rescue
and recovery shall perform the following tasks:
(1) Identify the different team positions and describe their main functions.
(2) Select and use specialized rescue equipment and procedures provided by the AHJ to support victim rescue and recovery operations.
(3) Demonstrate safe and effective methods for victim rescue and recovery.
(4) Demonstrate the ability to triage victims.
(5) Describe local procedures for performing decontamination upon completion of the victim rescue and removal mission.

V. Chapter 8 Competencies for Incident Commanders

8.2.1.1 Given scenarios involving hydrogen and access to printed and technical resources, computer databases, and monitoring equipment, the incident commander shall collect and interpret hazard and response information not available from the current edition of the DOT Emergency Response Guidebook or an MSDS.
8.2.1.2 The incident commander shall be able to identify and interpret the types of hazard and response information available from each of the following resources and explain the advantages and disadvantages of each resource:
(1) Hazardous materials databases
(2) Monitoring equipment
(3) Reference manuals
(4) Technical information centers
(5) Technical information specialists
8.2.2 Estimating Potential Outcomes. Given scenarios involving hydrogen incidents, the surrounding conditions, and the predicted behavior of the container and its contents, the incident commander shall estimate the potential outcomes within the endangered area and shall complete the following tasks:
(1) Identify the steps for estimating the outcomes within an endangered area of hydrogen incidents.
(2) Describe the following toxicological terms and exposure values and explain their significance in the analysis process:
(b) Immediately dangerous to life and health (IDLH) value
(d) Lethal concentrations (LC50)
(e) Lethal dose (LD50)
(f) Parts per billion (ppb)
(g) Parts per million (ppm)
(h) Permissible exposure limit (PEL)
(k) Threshold limit value ceiling (TLV-C)
(l) Threshold limit value short-term exposure limit (TLV-STEL)
(m) Threshold limit value time-weighted average (TLV-TWA)
(3)*Identify two methods for predicting the areas of potential harm within the endangered area of a hydrogen incident.
(4) Identify the methods available to the organization for obtaining local weather conditions and predictions for short-term future weather changes.

(5) Explain the basic toxicological principles relative to assessment and treatment of personnel exposed to hydrogen, including the following:
(a) Acute and delayed toxicity (chronic)
(b) Dose response
(c) Local and systemic effects
(d) Routes of exposure
(e) Synergistic effects

8.3.1 Identifying Response Objectives. Given an analysis of a hydrogen incident, the incident commander shall be able to describe the steps for determining response objectives (defensive, offensive, and nonintervention).

8.3.2 Identifying the Potential Response Options. Given scenarios involving hydrogen, the incident commander shall identify the possible response options (defensive, offensive, and nonintervention) by response objective for each problem and shall complete the following tasks:
(1) Identify the possible response options to accomplish a given response objective.
(2) Identify the purpose of each of the following techniques for hazardous materials control:
(a) Absorption
(b) Adsorption
(c) Blanketing
(d) Covering
(e) Damming
(f) Diking
(g) Dilution
(h) Dispersion
(i) Diversion
(j) Fire suppression
(k) Neutralization
(l) Overpacking
(m) Patching
(n) Plugging
(o) Pressure isolation and reduction (flaring; venting; vent and burn; isolation of valves, pumps, or energy sources)
(p) Retention
(q) Solidification
(r) Transfer
(s) Vapor control (dispersion, suppression)

8.3.3 Approving the Level of Personal Protective Equipment. Given scenarios involving hydrogen, the incident commander shall approve the personal protective equipment for the response options specified in the incident action plan in each situation and shall complete the following tasks:
(1) Identify the four levels of chemical protection (EPA/OSHA) and describe the equipment required for each level and the conditions under which each level is used.
(2) Describe the following terms and explain their impact and significance on the selection of chemical-protective clothing:
(a) Degradation
(b) Penetration
(c) Permeation
(3) Describe three safety considerations for personnel working in vapor-protective, liquid splash–protective, and high temperature–protective clothing.

(4) Identify the physiological and psychological stresses that can affect users of personal protective equipment.

8.3.4 Developing an Incident Action Plan. Given scenarios involving hydrogen incidents, the incident commander shall develop an incident action plan, including site safety and control plan, consistent with the emergency response plan or standard operating procedures and within the capability of the available personnel, personal protective equipment, and control equipment, and shall complete the tasks in 8.3.4.1 through 8.3.4.5.5.

8.3.4.1 The incident commander shall identify the steps for developing an incident action plan.

8.3.4.2 The incident commander shall identify the factors to be evaluated in selecting public protective actions, including evacuation and sheltering-in-place.

8.3.4.3 Given the emergency response plan or standard operating procedures, the incident commander shall identify which agency will perform the following:

(1) Receive the initial notification.
(2) Provide secondary notification and activation of response agencies.
(3) Make ongoing assessments of the situation.
(4) Command on-scene personnel (incident management system).
(5) Coordinate support and mutual aid.
(6) Provide law enforcement and on-scene security (crowd control).
(7) Provide traffic control and rerouting.
(8) Provide resources for public safety protective action (evacuation or shelter in-place).
(9) Provide fire suppression services.
(10) Provide on-scene medical assistance (ambulance) and medical treatment (hospital).
(11) Provide public notification (warning).
(12) Provide public information (news media statements).
(13) Provide on-scene communications support.
(14) Provide emergency on-scene decontamination.
(15) Provide operations-level hazard control services.
(16) Provide technician-level hazard mitigation services.
(17) Provide environmental remedial action (cleanup) services.
(18) Provide environmental monitoring.
(19) Implement on-site accountability.
(20) Provide on-site responder identification.
(21) Provide incident command post security.
(22) Provide incident or crime scene investigation.
(23) Provide evidence collection and sampling.

8.3.4.4 The incident commander shall identify the process for determining the effectiveness of a response option based on the potential outcomes.

8.3.4.5 The incident commander shall identify the safe operating practices and procedures that are required to be followed at a hydrogen incident.

8.3.4.5.1 The incident commander shall identify the importance of pre-incident planning relating to safety during responses to specific sites.

8.3.4.5.2 The incident commander shall identify the procedures for presenting a safety briefing prior to allowing personnel to work on a hydrogen incident.

8.3.4.5.3* The incident commander shall identify at least three safety precautions associated with search and rescue missions at hydrogen incidents.

8.3.4.5.4 The incident commander shall identify the advantages and limitations of the following and describe an example where each decontamination method would be used:

(1) Absorption

(2) Adsorption
(3) Chemical degradation
(4) Dilution
(5) Disinfection
(6) Evaporation
(7) Isolation and disposal
(8) Neutralization
(9) Solidification
(10) Sterilization
(11) Vacuuming
(12) Washing

8.3.4.5.5* The incident commander shall identify the atmospheric and physical safety hazards associated with Hydrogen incidents involving confined spaces.

8.4.1 Implementing an Incident Command System. Given a copy of the emergency response plan and annexes related to hydrogen, the incident commander shall identify the requirements of the plan, including the procedures for notification and utilization of nonlocal resources (private, state, and federal government personnel), and shall meet the following requirements:

(1) Identify the role of the incident commander during a hydrogen incident.
(2) Describe the concept of unified command and its application and use at a hydrogen incident.
(3) Identify the duties and responsibilities of the following hazardous materials branch/group functions within the incident command system:
(a) Decontamination
(b) Entry (backup)
(c) Hazardous materials branch director or group supervisor
(d) Hazardous materials safety
(e) Information and research
(4) Identify the steps for implementing the emergency response plans required under Title III Emergency Planning and Community Right-to-Know Act (EPCRA) of the Superfund Amendments and Reauthorization Act (SARA) Section 303, or other state and emergency response planning legislation.
(5) Given the emergency response planning documents, identify the elements of each of the documents.
(6) Identify the elements of the incident management system necessary to coordinate response activities at hazardous materials/WMD incidents.
(7) Identify the primary government agencies and identify the scope of their regulatory authority (including the regulations) pertaining to the production, transportation, storage, and use of hydrogen and the disposal of hazardous wastes.
(8) Identify the governmental agencies and resources that can offer assistance during a hydrogen incident and identify their role and the type of assistance or resources that might be available.

8.4.2* Directing Resources (Private and Governmental). Given a scenario involving hydrogen and the necessary resources to implement the planned response, the incident commander shall demonstrate the ability to direct the resources in a safe and efficient manner consistent with the capabilities of those resources.

8.4.3 Providing a Focal Point for Information Transfer to the Media and Elected Officials. Given a scenario involving hydrogen, the incident commander shall identify information to be provided to the media and local, state, and federal officials and shall complete the following tasks:

(1) Identify the local policy for providing information to the media.

(2) Identify the responsibilities of the public information officer at a hydrogen incident.
(3) Describe the concept of a joint information center (JIC) and its application and use at a hydrogen incident.

8.5.1 Evaluating Progress of the Incident Action Plan. Given scenarios involving hydrogen, the incident commander shall evaluate the progress of the incident action plan to determine whether the efforts are accomplishing the response objectives and shall complete the following tasks:
(1) Identify the procedures for evaluating whether the response options are effective in accomplishing the objectives.
(2) Identify the steps for comparing actual behavior of the material and the container to that predicted in the analysis process.
(3) Determine the effectiveness of the following:
(a) Control, containment, or confinement operations
(b) Decontamination process
(c) Established control zones
(d) Personnel being used
(e) Personal protective equipment
(4) Make modifications to the incident action plan as necessary.

8.6.1* Transferring Command and Control. Given a scenario involving hydrogen, the emergency response plan, and standard operating procedures, the incident commander shall be able to identify the steps to be taken to transfer command and control of the incident and shall be able to demonstrate the transfer of command and control.

8.6.2 Conducting a Debriefing. Given scenarios involving hydrogen, the incident commander shall conduct a debriefing of the incident and shall complete the following tasks:
(1) Describe three components of an effective debriefing.
(2) Describe the key topics in an effective debriefing.
(3) Describe when a debriefing should take place.
(4) Describe who should be involved in a debriefing.
(5) Identify the procedures for conducting incident debriefings at a hydrogen incident.

8.6.3 Conducting a Critique. Given details of a scenario involving a multiagency hydrogen incident, the incident commander shall conduct a critique of the incident and shall complete the following tasks:
(1) Describe three components of an effective critique.
(2) Describe who should be involved in a critique.
(3) Describe why an effective critique is necessary after a hydrogen incident.
(4) Describe what written documents should be prepared as a result of the critique.
(5) Conducting a critique of the incident.

8.6.4 Reporting and Documenting the Hydrogen Incident. Given a scenario involving hydrogen, the incident commander shall demonstrate the ability to report and document the incident consistent with local, state, and federal requirements and shall complete the following tasks:
(1) Identify the reporting requirements of the federal, state, and local agencies.
(2) Identify the importance of the documentation for a hydrogen incident, including training records, exposure records, incident reports, and critique reports.
(3) Identify the steps in keeping an activity log and exposure records for hydrogen incidents.
(4) Identify the requirements for compiling hydrogen incident reports found in the emergency response plan or standard operating procedures.
(5) Identify the requirements for filing documents and maintaining records found in the emergency response plan or standard operating procedures.

(6) Identify the procedures required for legal documentation and chain of custody and continuity described in the standard operating procedures or the emergency response plan.

Appendix H

Final Competency Matrix

Final Competency Matrix

Competency	Knowledge	Skill	
Chapter 3 - Definitions			
Ch 4 Competencies for Awareness			
4.2.1	X		Analyzing the Incident - Detect the Presence
4.2.1 (2-13, 15, 20)	X		
4.2.2 (1-3)	X		
4.2.3 (1-2)	X		
4.4.1(1-12)	X		Implementing the Planned Response
4.4.2	X		
Ch 5 Competencies for Operations			
5.2.1	X		Analyzing the Incident - Surveying HM/WMD Incidents
5.2.1.1	X		
5.2.1.1.1	X		
5.2.1.1.2	X		
5.2.1.1.3	X		
5.2.1.1.4 (1 & 3)	X		
5.2.1.1.5 (3 & 5)	X		
5.2.1.2	X		
5.2.1.2.1 (1-3)	X		
5.2.1.2.2	X		
5.2.1.4	X		
5.2.1.5	X		
5.2.1.6	X		
5.2.2 (2-7)	X	5.2.2(3)	Collecting Hazard & Response Information
5.2.3 (1-8)	X		
5.2.4 (1-4)	X		
5.3.1 (1-4)	X		Planning the Response
5.3.2 (1-2)	X		
5.3.3 (1-2)	X		
5.3.4 (1-6)	X		
5.4.1 (1-6)	X	5.4.1 (4)	Implementing the Planned Response
5.4.2	X		
5.4.3 (1-7)	X		IC
5.4.4 (1-7)	X		
5.5.1 (1&2)	X		Evaluating Progress
5.5.2 (1&2)	X		
Mission Specific Operations			
6.2.3.1 (1-3)	X		
6.2.4.1 (1-5)	X	6.2.4.1 (3-4)	
6.4.3.1	X		Technical Documentation
6.4.3.2 (1-6)	X		
6.4.4.1 (1-2)	X		
6.4.4.2 (1-2)		X	

Competency	Knowledge	Skill	
6.4.5.1	X		
6.4.6.1 (1-4)	X		
6.6.3.1 (1-2)	X		Product Control
6.6.3.2	X		
6.6.4.1 (1-5)	X		
6.6.4.2	X		
6.7.3.1	X		Air Monitoring
6.7.3.2	X		
6.7.3.4	X		
6.7.4.1	X	X	
6.7.4.2	X		
6.8.3.1 (1-4)	X		Victim Rescue
6.8.3.2	X		
6.8.4.1 (1-5)	X	6.8.4.1 (3-4)	
Incident Command			
8.2.1.1	X		Analyzing the Incident
8.2.1.2 (1-5)	X		
8.2.2 (1)	X		
8.2.2 (2)(b, e, f, g, h, k, l, m)	X		
8.2.2 (3-4)(5a-e)	X		
8.3.1	X		Planning the Response
8.3.2 (1)(2a-s)	X		
8.3.3 (1-4)	X		
8.3.4.1 thru 8.3.4.5.5	X		
8.3.4.2	X		
8.3.4.3	X		
8.3.4.4	X		
8.3.4.5 thru 8.3.4.5.5	X		
8.4.1 (1-8)	X		Implementing the Planned Response
8.4.2	X		
8.4.3 (1-3)	X		
8.5.1 (1-4)	X		
8.6.1	X		Terminating the Incident
8.6.2 (1-5)		X	
8.6.3 (1-5)		8.6.3 (5)	Conducting a Critique
8.6.4 (1-6)		X	Reporting & Documentation

Appendix I

NFPA 472 Impact on H2 Project

NFPA 472 Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents

Impact on Hydrogen Project

1. A review of NFPA 472 illustrates there is a very clear statement of what volunteer first responders need to know at all levels of competency. Chapters 4.0 and 5.0 of NFPA 472 are the sections of the document addressing required core competencies for the Awareness and Operations levels of training. Section 4.1.1.2 states that "awareness level personnel shall be trained to meet all competencies of this chapter [4.0]. There is a similar statement for Operations Level in Chapter 5.0.

2. The levels of Hazardous Materials training we have chosen to support the Hydrogen Project are the Awareness and Operations.

3. We should assume that the target student audience for the program will have, at a minimum, Hazardous Materials Awareness level of training. Any active first responder will have this basic competency. Therefore, the Hydrogen Project must provide a curriculum at both the Awareness and Operations level. This training must ensure that this mission specific topic will complement all existing or future NFPA 472 online and classroom competency training programs. This training would not seek to duplicate current training efforts.

4. As it specifically refers to hydrogen gas, students should become knowledgeable with the following:

    a. Procedures for identification of hydrogen at the incident.
    b. The potential hazards for flammable gasses – Guide number 115
    c. The emergency response for flammable gasses – Guide number 115
    d. Properties of hydrogen as stated in the Emergency Response Guidebook
    e. For the Incident Commander level, identify and use multiple reference documents like the NIOSH Pocket Guide to Chemical Hazards to understand the properties of hydrogen gas or the NFPA Fire Protection Guide to Hazardous Materials to understand properties of hydrogen.

5. Both the Hazmat Awareness and Operations levels of competencies regarding a Hydrogen incident must be within a framework of safety. The foundation of an effective safety program will be the establishment of an incident management system.

    Being aware that even an awareness level first responder may potentially be an Incident Commander (IC), the topic of the Incident Command System (ICS) must be incorporated into the curriculum. All first responders should have already completed the basic Incident Command System (ICS) training before being allowed to respond to any emergency incidents. Therefore, as a refresher for these individuals, training refresher on "Competencies for Incident Commanders" described in Chapter 8.0 should be included.

6. Emergency Response Guidebook competencies specific to hydrogen that will be presented:

    a. Potential fire or explosion hazard – burns with an invisible flame
    b. Health hazard
    c. Immediate public safety actions by first responders
    d. Protective clothing
    e. Evacuation
    f. Emergency response actions suggested
    g. Spill or leak containment
    h. First Aid
    i. Emergency Response Guide number (115) and ID number (1049)

7. Additionally, the course should cover typical situations or applications where one would expect to find hydrogen as a first responder such as:
    a. Hybrid vehicle batteries
    b. Rail and highway emergencies
    c. Chemistry laboratories