Training Adaptability in Digital Skills

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This paper reports on a project that addresses a critical need for tomorrow's Army: Training in the ability to adapt digital skills to the ever-changing evolution of technology. As outlined in this Phase I report, Aptima and the Group for Organizational Effectiveness (gOE) have lain the groundwork for an innovative, computer-based, digital-skills training package designed to increase the adaptability of digital skills. The key innovative idea is a modular training package that links fundamental digital knowledge to device-specific knowledge and to the specific tasks that soldiers are trained to perform. Generalizable, transferable digital skills are not taught in a vacuum, but instead are learned in the context of device- and job-specific goals. As the digitization of the battlefield progresses, tomorrow's soldiers must be able to adapt, innovate, and rapidly transfer digital knowledge and skills to new software and new equipment. Soldiers need training in transferable digital skills in addition to training in setting-up, using, and maintaining specific digital equipment. The training being developed – the prototype of which is described in this report – will have general applicability to any domain requiring general digital skills, and will be easily customized to provide maximum learning regardless of the digital system targeted.

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for the Behavioral and Social Sciences**

TRAINING ADAPTABILITY IN DIGITAL SKILLS

Contractor Report No.____

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Executive Summary

The concept of Network-Centric Warfare is rapidly becoming a reality for today's modern military. In practically every operational context—from simulation-based training, to digital collaborative planning, to real-time video conferencing on the battlefield—the tools used by the modern "digital warrior" are networked and software based. As the digitization of the battlefield progresses, tomorrow's soldiers must be able to adapt, to innovate, and to rapidly transfer digital knowledge and skills to new software and new equipment. Soldiers need training in transferable digital skills in addition to training in setting-up, using, and maintaining specific digital equipment. This paper reports on a project that addresses a critical need for tomorrow's Army: Training in the ability to adapt digital skills to the ever-changing evolution of technology.

Digital equipment and communication evolve rapidly – the shortened supplier design/production cycles and uniquely fast improvements in software and computer components mean that new equipment and techniques are fielded with unprecedented speed. The stability of the military environment, and the concomitant predictability of tasks and equipment, has become a thing of the past. This means that the "half-life" of equipment training is short, so that a soldier may face the need to master new equipment in the field. In addition, Army personnel may have to work under an intense optempo, under which learning conditions are not optimal. It is not sufficient for soldiers simply to learn how to operate today's digital equipment; there is a need for adaptability in learning to use equipment requiring digital skills under difficult conditions. The successful warfighters are those who possess a solid foundation of adaptive digital-literacy that goes beyond abilities to utilize specific tools and applications, and includes deep knowledge of digital concepts that are relevant in every context of use.

Ensuring this level of knowledge transfer will require new approaches to training, focused on providing a deep foundation of digital skills and knowledge, and a set of "tools" and strategies that the warfighters can use to apply what they already know to actively engage and learn new tools. In fact, one of the major drivers for the Objective Force, Task Force TLS (the "Training," "Leadership," and "Soldier" parts of DTLOMS), recognizes that the role of the soldier will change dramatically because of changes in technology, and that this will result in the need for an increase in adaptive skills.

As outlined in this Phase I report, Aptima and the Group for Organizational Effectiveness (gOE) have lain the groundwork for an innovative digital-skills training package designed to increase the adaptability of digital skills. The key innovative idea, developed and demonstrated in Phase I, is a modular training package that links fundamental digital knowledge to device-specific knowledge and to the specific tasks that soldiers are trained to perform. Generalizable, transferable digital skills are not taught in a vacuum, but instead are learned in the context of device- and job-specific goals. This approach was developed based on the literature on learning and transfer of training in procedural domains, which suggests that linking "how to" knowledge to domain goals and subgoals helps learners to adapt parts of solutions to new problems.

Specifically, the training package has two "modules," one module covers general device knowledge and procedures—such as general computer skills, or knowledge, skills, and abilities

required for networking computers together—that can be used for any domain in which general device knowledge is needed, and the other module trains how to map this general device knowledge onto a specific computer system—which requires training focused on a specific system. In Phase I, we selected the AFATDS system used by the Army Field Artillery as the focus of our training. The general device knowledge training will ensure true adaptability when going from one computer system to another, while the device-specific training will allow the trainees to take full advantage of the general training in a specific situation.

This report also outlines the plans for Phase II, where we will expand the training program to include all basic digital skills, and improve upon it significantly. Like the Phase I prototype, we envision a web-based system that enables both remote hosting and, if required, client or stand-alone platform installation. It is also anticipated that, unlike the Phase I prototype, the final system will be database capable, with administrative capabilities to enable non-HTML proficient users to tailor Skills Bridge information for systems other than AFATDS. That is, we expect to specify and create a product that has general applicability and is easily customized to provide maximum learning regardless of the digital system targeted.

Concerted commercialization will occur throughout the entire Phase II period. Within the Army, the most immediate application is for the Intell school, where soldiers must stay current with frequently changing software. For non-DoD government applications, we see the digital skill adaptability training supporting the Department of Education's lifelong learning programs and the Department of Labor's programs designed to improve technology skills among adults. Outside the government, this training could be used in any job environment that requires the use of technology to ensure the ability of workers to keep up with quickly changing systems. Industry is currently facing a severe problem as workers must be retrained after the insertion of technological updates—the digital skill adaptability training could mitigate or alleviate this problem altogether.

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Acknowledgments

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1. Introduction

This SBIR project addresses a critical need for tomorrow's Army: Training in the ability to *adapt* digital skills to the ever-changing evolution of technology. It is not sufficient for soldiers simply to learn how to operate today's digital equipment. As the digitization of the battlefield progresses, tomorrow's soldiers must be able to adapt, to innovate, and to rapidly transfer digital knowledge and skills to new software and new equipment. Soldiers need training in *transferable digital skills* in addition to training in setting-up, using, and maintaining specific digital equipment.

In Phase I, Aptima and the Group for Organizational Effectiveness (gOE) laid the groundwork for an innovative digital-skills training package designed to increase the adaptability of digital skills. Our key innovative idea, developed and demonstrated in Phase I, is a modular training package that links fundamental digital knowledge to device-specific knowledge and to the specific tasks that soldiers are trained to perform. Generalizable, transferable digital skills are not taught in a vacuum, but instead are learned in the context of device- and job-specific goals. This approach was developed based on the literature on learning and transfer of training in procedural domains, which suggests that linking "how to" knowledge to domain goals and subgoals helps learners to adapt parts of solutions to new problems.

Specifically, the training package has two "modules," one module covers general device knowledge and procedures—such as general computer skills, or knowledge, skills, and abilities required for networking computers together—that can be used for any domain in which general device knowledge is needed, and the other module trains how to map this general device knowledge onto a specific computer system—which requires training focused on a specific system. In Phase I, we selected the AFATDS system used by the Army Field Artillery as the focus of our training. The general device knowledge training will ensure true adaptability when going from one computer system to another, while the device-specific training will allow the trainees to take full advantage of the general training in a specific situation.

Training in adaptive digital skills is critical for tomorrow's Army

The concept of **Network-Centric Warfare** is rapidly becoming a reality for today's modern military. In practically every operational context—from simulation-based training, to digital collaborative planning, to real-time video conferencing on the battlefield—the tools used by the modern **"digital warrior"** are networked and software based. Digital equipment and communication evolve rapidly – the shortened supplier design/production cycles and uniquely fast improvements in software and computer components mean that new equipment and techniques are fielded with unprecedented speed. The stability of the military environment, and the concomitant predictability of tasks and equipment, has become a thing of the past. This means that the "half-life" of equipment training is short, so that a soldier may face the need to master new equipment in the field. In addition, Army personnel may have to work under an intense optempo, under which learning conditions are not optimal. Thus there is a need for adaptability in learning to use equipment requiring digital skills under difficult conditions.

In such digital environments, the **successful warfighters are those who possess a solid foundation of adaptive digital-literacy** that goes beyond abilities to utilize specific tools and applications, and includes deep knowledge of digital concepts that are relevant in every context of use. Whether faced with new tools, incremental improvements of familiar tools, or the same

tools in new contexts (e.g., from a CONUS simulation setting, to a theater of war, or drug ops application), the digital warrior will be expected to apply what he or she already knows to quickly come up to speed on new tools, often with "just-in-time" rapidity. Ensuring this level of knowledge transfer will require new approaches to training, focused on providing a deep foundation of digital skills and knowledge, and a set of "tools" and strategies that the warfighters can use to apply what they already know to actively engage and learn new tools. In fact, one of the major drivers for the Objective Force, Task Force TLS (the "Training," "Leadership," and "Soldier" parts of DTLOMS), recognizes that the role of the soldier will change dramatically because of changes in technology, and that this will result in the need for an increase in adaptive skills.

The U.S. Army Research Institute (ARI) currently has a research program focusing on how to best train the digital skills necessary for this battlefield digitization. ARI argues that one of the best ways to maximize the benefits of digitization for all personnel is through improved training. Training that will help personnel benefit from the full potential of the improved technology instead of allowing these personnel to use the new technology simply to do things the same old way is needed before the benefits of improved technology can be fully realized (Moses, 2000). The framework ARI chose to organize their plan of attacking this problem consists of five topics (see Figure 1), each emphasizing a different area in need of research.

Strategies for Training on Demand

What training should be done how, when and where using soldier-centered distributed/digital environments?

Determine Digital Task Training Requirements

How should training requirements analyses change for digital tasks and for hybrid digital-conventional environments to determine the training needed for producing and sustaining high performance soldiers?

Certify Required Digital Skill Levels of Soldiers

What assessment and feedback tools are needed to ensure that required skill levels are attained and retained?

Train Adaptability

What training methods work best to prepare soldiers for frequent software/equipment changes combined with ad hoc and varied missions (including combat and special assignments)?

Prepare Digitally-Linked Teams

What methods work best to prepare leaders and to train widely dispersed soldiers linked as teams and units through digital networks?

Figure 1. Five research topics for training the digital soldier (Moses, 2000) [emphasis added]

As highlighted in Figure 1, ARI believes that training adaptability is a key aspect of training for successful battlefield digitization. Moses (2000) suggests that "Soldiers will have to go beyond minimal operation of digital workstations to be effective" and that training must shift its perspective from training in "what to think" to training in "how to think." A key goal identified

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in Moses (2000) for digital skills training is to "develop training methods and strategies that promote adaptive/flexible and innovative behavior." The purpose of the Aptima/gOE two phase research and development is to meet this goal.

A survey conducted on a class of soldiers training on the AFATDS system highlights the correctness of ARI's belief that digital skills is an important arena for training at the dawn of this century. In general students reported a broad range of previous experience with computerized systems. As indicated in the figure below, some students reported no or very little experience with computers, and a larger percentage reported no experience with computer networks. This is significant because the kind of adaptable behavior that is desirable in recruits will come in part from substantial experience with computer technologies. When asked "What most helped them in their training," many responded that previous experience with computers was key. Yet it is clear that this experience is by no means the norm among recruits. Detailed results from all questions are available in Appendix A: Results of AFATDS Training Student Survey Administered Week of 10.16.00 at Net Team Training, Fort Sill. Some highlights can be found in Figure 2.

Reported AFATDS student experience with PC-type operating systems

Reported AFATDS student experience with computer networks
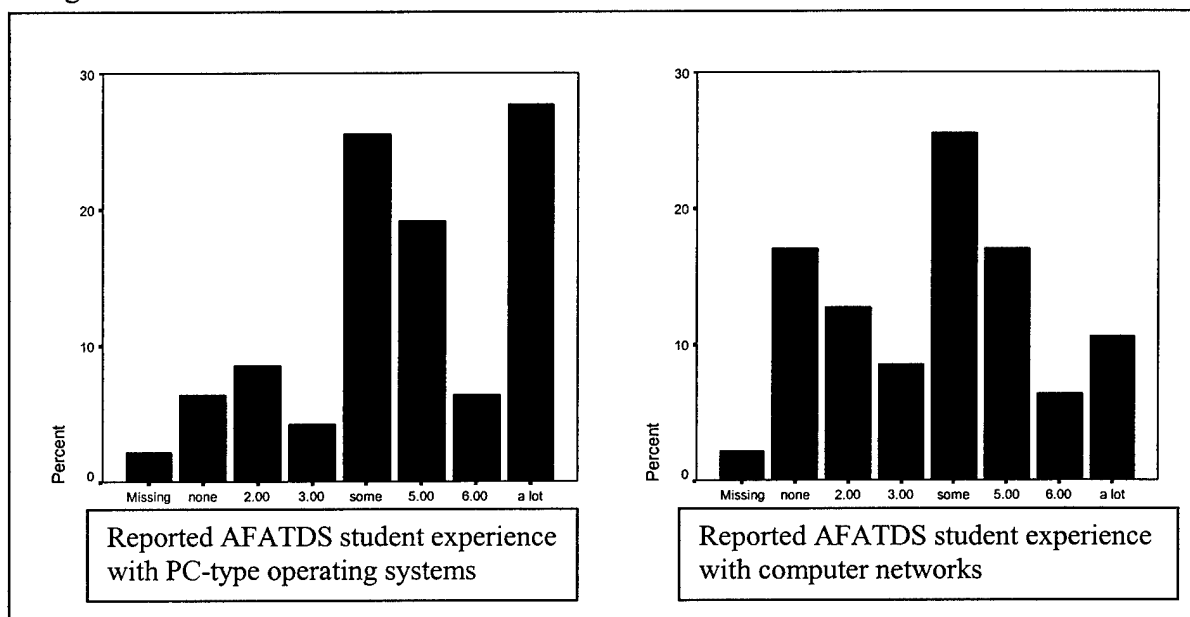
Figure 2: Responses of a sample of AFATDS students to two survey questions

The challenge of adaptive digital skills training

The idea of "training adaptability in digital skills" is, on the surface, an appealing and intuitive one. To make it a reality, however, requires addressing fundamental and challenging issues in training design and training effectiveness measurement. The major challenges are:

- **Identifying a "core" set of digital skills that transfer across tools.**

    While there are a multitude of organizations that focus on developing tool-specific training and documentation, there is little prior work on defining cross-tool digital skills. Defining this core skill set requires an open mind, experience in the various military domains in which the digital warrior operates, expertise in knowledge elicitation using techniques such as cognitive task analysis, and expertise in structuring knowledge and identifying skill commonalties across different environments and tasks.

- **Developing training that teaches adaptable, flexible knowledge bases and strategies for exploiting them** rather than quickly outdated knowledge and skills about specific tools.

  Most training packages focus on teaching specific skills to be used in specific contexts, for the very good reason that training developers have expertise and experience in designing and delivering this type of training. Developing instructional content that permits learners to re-use and re-apply it in new contexts is a significant, but achievable goal for training developers. Training individuals to adapt, change, and learn—as opposed to fit square-peg knowledge into a round-hole problem—in response to a changing environment is a much more difficult task than imparting specific knowledge.

- **Measuring the effectiveness of adaptability training** in preparing learners to cope with new, unfamiliar environments and problems.

  Most measures of training effectiveness assess the ability of learners to perform those specific tasks for which they have been trained. Measuring transfer of training to new environments is much more challenging, and requires, for example, an underlying model of the relationships between latent constructs such as skills and performance in order to predict which skills *should* transfer to new tasks and to predict the expected measurable effects of training on new-task performance.

We have begun to develop a **digital-skills training package** that is based on contemporary cognitive theory and training practice, provides today's warfighter with a deep foundation of digital skills and knowledge, provides opportunities for practice in multiple contexts of use, teaches focused learning strategies to maximize the transfer of prior knowledge, and delivers training content directly to operational settings using modern distance-learning methods. Our approach is based on the fundamental premise that failures of digital-skills transfer are often failures of shallow, tool-specific knowledge to transfer to new contexts in which—despite similarities in the tools and operations involved—contextual or tool related changes make it difficult for learners to leverage what they already know to support new learning. There are several sources of evidence for this premise in the psychological literature (detailed below). In response to this, we propose that training be designed to provide a *foundation of general digital-tool concepts* and *strategies for mapping these concepts to new applications* will provide a deeper base of knowledge and cognitive learning strategies to insure rapid transfer.

1.1 Phase I Objectives and Results

The goal of Phase I was to show how a training program designed to increase adaptability in a subset of digital skills could be developed. Our team for Phase I—Aptima and gOE—began its Phase I effort with a strong background in both training and digital skill use. Aptima has expertise in digital skill use and training development; gOE has expertise in training development and training validation.

Our overall objective in Phase I was to provide a proof of concept that shows the feasibility of developing an adaptive digital skills training package. Our challenge in Phase I was to create an example of a training program that is both general enough to train for adaptability in digital skills regardless of the context, yet specific enough that its effectiveness could be observable when used for a specific digital device.

To do this, we needed to focus on a specific Army training need and a specific type of digital device for which soldiers need to be trained. Using an example allows us to show how the device-specific tasks and actions that are currently being trained can be linked to underlying principles, knowledge, and generalizable digital skills.

In Phase I, we made progress in addressing each of three major challenges identified above:

- *Identify core underlying digital skills for a selected domain.*

  In Phase I, we focused our effort on US Army field artillery digitization and learned what digital tools are used, how they are updated, and how soldiers are currently taught about these tools. This domain was selected because it is currently a focus of ARI research on training for digitization and because one of the Aptima team members has extensive experience in this area.

- *Develop an innovative method to teach these skills in such a way that they can be transferred to other problems and situations.*

  In Phase I, we conducted an extensive review of the literature on training for adaptability and developed an instructional design approach based on learning theory. The *subgoal learning model* provides a framework for designing instructional materials that help learners adapt old procedures to new problems.

- *Develop a plan for measuring the effectiveness of transfer of training.*

  The final product of Phase I is a design for a validation study, coordinated with ongoing device-specific training for field artillery units, that will allow us to test the effectiveness of our training-for-adaptability approach.

To accomplish these objectives, we had five technical goals in Phase I: 1) Gain an **understanding of the capabilities and context of use** of existing and soon-to-be-deployed digital tools, 2) Determine what **fundamental knowledge** is necessary to use these digital tools, 3) Draw on human learning theory to determine the best approaches to **maximize learning** and **knowledge transfer** across domains, 4) Develop and demonstrate a **proof of concept training program** to facilitate human learning of digital tools, 5) Design a **validation study** to evaluate the training program. These goals resulted in a proof of concept for a training program and a plan for its validation. Following is a brief explanation of how these objectives were achieved. A more in-depth description can be found in sections 2-6.

Phase I, Objective 1: Gain an understanding of the current and future digital tools

Accomplishment: Identified US Army Field Artillery as the focus for Phase I, and learned what digital tools they use, how they are updated, how soldiers are taught about tools.

The domain of Artillery was chosen as the focus of our Phase I effort for a number of reasons including a) on-going ARI research on training in this domain, b) the availability of in-house expertise in this area, and c) access to local experts. By taking advantage of a local Army Reserve Artillery Unit, we have gained access to experts trained in the use of two iterations of Artillery-support software: AFATDS and IFSAS. We were also able to visit SFC James O'Connor of the CECOM NET (the team that, until recently, was responsible for training delivered to soldiers receiving an updated version of AFATDS) and Mr. Roger Baker of Engineering and Professional Services (EPS; the organization currently responsible for AFATDS

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update training), as well as other EPS personnel and AFATDS instructors. These opportunities have helped us develop an understanding of the domain, the ways that these tools get used to support the work done in the field, and the vision of the digital tools of the future.

> **Phase I, Objective 2: Determine what fundamental knowledge is necessary to use these tools**
>
> Accomplishment: We interviewed AFATDS trainers and IFSAS users, worked with our in-house expert to identify the digital skills and knowledge that underlie AFATDS and IFSAS use, and we observed AFATDS training delivered by EPS.

Once we had a general understanding of the Field Artillery domain, we began to investigate more deeply the specific tasks performed by Field Artillery soldiers, focusing on those digital skills exercised when using the computer systems. To do this, we were fortunate enough to be able to sit in on some AFATDS training performed by EPS at Fort Sill, OK. During our observations we concluded that, although the training received by the soldiers comprehensively covers specific behaviors necessary to perform the requisite AFATDS operations, the soldiers did not receive training that covered 1) fundamental computer background important for understanding AFATDS components and operations, 2) troubleshooting and problem solving skills, and 3) how this AFATDS training really relates to the soldier's job as a Field Artillery personnel (e.g., why is this training so important; how does the training map onto the soldier's assigned tasks). Without the background and base-knowledge that these three areas afford, the trainee will have a difficult time comprehending and retaining the AFATDS training. After thoroughly reviewing the training literature, we felt that the soldiers would most benefit from training that addresses these areas.

> **Phase I, Objective 3: Develop a sound training approach to maximize learning and knowledge transfer**
>
> Accomplishment: Developed training-for-transfer approach based on the training and learning literature.

Our goal was to develop a general training approach that is inspired by current theory and practice in the training and learning literatures, and is flexible enough for use in any context where learners use digital tools in service of their domain tasks. We went to this literature with the goal of developing an approach to training that helps learners to see relationships between the tools they use and the structure of the domain tasks which they presumably know well (although, we recognize the potential weakness of this assumption, and plan to build in reinforcement training that makes this structure explicit). Using the domain task structure as a learning *scaffold,* we additionally teach fundamental digital principles that help learners to understand, given the context of tool use, the kinds of tool interaction that are possible to get the job done, and thus the kinds of expectations they can have for software given the task at hand. This two-layered approach (that maps domain tasks to tools, and tools to digital implementation) has been implemented in Phase I for one digital skill found to be crucial for the AFATDS – building and operating an electronic network.

> **Phase I, Objective 4: Deliver proof-of-concept training program.**
>
> Accomplishment: We have developed a training program to illustrate our idea of linking domain specific knowledge to fundamental digital skills for computer networks.

At the conclusion of Phase I, we demonstrated how our theory-based approach can be applied to training for the fundamental digital skills that are associated with the selected AFATDS task, computer networks. The self-paced training program is written in HTML and can be delivered on a CD.

Phase I, Objective 5: Design validation study

Accomplishment: We designed a validation study to test the effectiveness of the training in promoting the ability of learners to transfer what they have learned to new problems.

At the conclusion of Phase I we developed an Experiment Plan that details how we plan to evaluate both degree of learning and transfer success for the training package. Because our training on fundamental digital knowledge and skills is complementary to detailed training on the specifics of operating a digital device, we plan to closely coordinate our data collection in Phase II with AFATDS training delivery.

1.2. Task Selection for Demonstration

As stated earlier, we chose Field Artillery as the domain of focus for our Phase I effort. The rationale for this decision was based on on-going ARI research on training in this domain, the availability of in-house expertise in this area, and access to local experts. By taking advantage of ARI contacts at Fort Sill, OK, we were able to visit AFATDS trainers at Fort Sill, as well as sit in some of the training designed to introduce Field Artillery Soldiers to updated versions of the AFATDS system. Our in-house expert, a 15 year member of the National Guard, works in the Battalion and Battery levels of the Fire Direction Center. He has expertise in AFATDS' precursor, IFSAS, and has been able to provide names and contact information for soldiers with both AFATDS and IFSAS experience. These opportunities have afforded us occasion to develop an understanding of the domain, the ways that these tools get used to support the work done in the field, and the vision of the digital tools of the future.

One of the first conclusions we were able to draw from our observations and conversations is that the entire field of Artillery is quite massive and the AFATDS system is consequently rather complex, the capabilities of which are described in more detail below. A training program that will address the entire AFATDS system will be equally complex, so to successfully complete this first phase of the project we chose to focus our proof of concept training on just one of the many aspects of the AFATDS system, network communications. Our choice was guided by the consideration of the importance of the various system aspects, and how those aspects overlap with our in-house expertise.

1.3. Document Overview

The remainder of this document will elaborate on the introductory presentation of the Training Adaptability for Digital Skills effort. The following are brief descriptions of the remaining sections of this document.

2. *Understanding current and future required digital skills*: Describes how we gathered the information to understand current and future digital skills, and outlines our findings.

3. *Determining fundamental knowledge necessary to use these tools*: Contains an overview of the base knowledge that is needed to effectively use the digital tools.

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4. *Developing sound training approach*: Illustrates how the training approach was developed.

5. *Developing proof of concept training program*: Describes the proof-of-concept training program.

6. *Designing a validation approach*: Presents an overview of the validation approach.

7. *Technical Objectives for TADS*: Presents an overview of the plans for accomplishing Phase II.

8. *Plan for TADS*: Describes the tasking schedule we will follow to implement Phase II

9. *Commercialization Plan*: Contains our assessment of potential post Phase II TADS application and a plan to achieve these goals.

2. Understanding current and future required digital skills

The first task for the Aptima/gOE team was to gain a better understanding of current and future required digital skills. Ideally, this would be done for all domains requiring digital skill knowledge; however, to keep the task manageable we chose to focus on Field Artillery. The domain of Artillery was chosen for a number of reasons, including on-going ARI research on training in this domain, the availability of in-house expertise in this area, and access to local experts. By taking advantage of a local Army Reserve Artillery Unit, we have gained access to experts trained in the use of two iterations of Artillery-support software: AFATDS and IFSAS. We were also able to visit SFC James O'Connor of the CECOM NET Team (the team that, until recently, was responsible for all AFATDS update training) and Mr. Roger Baker of Engineering and Professional Services (EPS; the organization currently responsible for all AFATDS update training). These opportunities have allowed us to develop an understanding of the domain, the ways that these tools get used to support the work done in the field, and the vision of the digital tools of the future.

To familiarize ourselves with the chosen domain (i.e., Field Artillery), we tapped into several different sources[1] and performed a high-level task analysis. From this initial task analysis it was established that the United States Army Field Artillery is a combat arms branch whose units engage enemy forces with cannon, rocket, and missile fires and acquire targets for combined arms operations to accomplish the mission. The Field Artillery team is divided into four major components: 1) the Fire Support Team (FIST) that works within each company to develop fire support plans that protect the company; 2) The Target Acquisition team that uses radar to acquire deep targets; 3) the Firing Battery who deliver the right type of artillery fire at the right time and place on the battlefield; and 4) The Fire Direction Center (FDC) who translates the FIST's call for artillery fire into information used by the Firing Battery. To accomplish their part of the overall mission, the field artillery units use advanced computer and communications systems to do a number of things including produce calls for fires, process calls for fire, and plan the fire mission – and it is this reliance on advanced technology to accomplish their part of the mission that made the Field Artillery team ideal for the purposes of the current project. The digital skills we have chosen to focus on are those necessary to operate the IFSAS and the AFATDS, two versions of a computerized support system that allow Field Artillery leaders to gather

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[1] Much of this information was acquired through personal correspondences with Field Artillery personnel, a visit to CECOM NET Team and EPS personnel at Fort Sill, observations of AFATDS update training at Fort Sill in October, 2000, and from Fort Sill and other relevant internet sites.

information, pass orders and compute data. IFSAS is an older system still in use by certain facets of Field Artillery, whereas AFATDS – a newer system that is continually being upgraded – is used more globally in the Field Artillery because of its increased versatility. During the interviews and observations we learned about the problems experienced by soldiers because of the frequent changes in AFATDS, including both problems with remembering the old version and problems with learning the new version. Digital skills training will be applicable to these systems as they change in the future, as well as to any other military and non-military computer-based systems.

AFATDS is a totally integrated fire support Command and Control (C2) system that processes fire mission and other related information to coordinate and optimize the use of all fire support assets, including mortars, field artillery, cannon, missile, attack helicopters, air support, and naval gunfire (e.g., see Boutelle and Filak, 1996). AFATDS supports the five Fire Support functional areas:

- **Fire Support Planning**; providing integration of field artillery, mortars, naval gunfire, and air support into the force commander's scheme of maneuver. AFATDS helps create a Fire Support annex to the commander's Operation Plan (OPLAN) and a Field Artillery Support Plan.

- **Fire Support Execution**; guided by fire support and field artillery support plans, it performs sensor employment, target processing, attack systems analysis, and target damage assessment.

- **Movement Control**; managing and coordinating the movement of field artillery units and sensors and coordinating the movement of fire support units and sensors.

- **Field Artillery Mission Support**; including functions logistically supporting the field artillery system, it creates and maintains supply inventory files, supply requests, and supply reports.

- **Field Artillery Fire Direction Operations**; including the collection and maintenance of weapon, fire unit, and ammunition status data required for day-to-day operations. This information is provided in either detailed or aggregate form to appropriate Operations Centers in support of both planning and execution requirements.

As AFATDS is upgraded over the next decade, the plan is not for substantial change but rather for improvements that build on the system as it is today. Specifically, the plan is for it to become more automated, have more software modules incorporated into it (to enhance AFATDS joint capabilities), and ultimately become fully interoperable with the automated systems of all services.

3. Determining what fundamental knowledge is necessary to use these tools

Once we had a general understanding of the Field Artillery domain, we began to investigate more deeply the specific tasks performed by Field Artillery soldiers, focusing on those digital skills exercised when using the computer systems. For example, some of the tasks performed by Field Artillery units while using the computer support systems are as follows: fire support

planning and coordination, fire support execution, Field Artillery movement control, and Field Artillery mission support. Each of these tasks can be broken down into smaller (i.e., more specific) tasks; for example, fire support planning and coordination consists of a number of smaller tasks including the following: plan target list, edit target list, pre-coordinate targets, create a group of targets, and create a series of targets. These smaller tasks can, in turn, be divided into even more specific subtasks that are unique to the particular computer system being used, one example being the task "create a group of targets" – in IFSAS the operator first selects "FIRE PLANNING" from the main menu, then selects "INST," and then goes through a series of selections to specify the fire plan name, the specific targets, a group name, a phase, etc.; whereas in AFATDS the operator first selects "Targets/Groups/New…" and a new window opens, the operator then creates the new group, and clicks "OK." For our purposes, we are focusing on the top and middle levels of tasks – those that decouple the operator's task from the specific computer system – because we want our training to be useful regardless of the details of the computer system being used[2].

Basic digital skills and knowledge used by the IFSAS and AFATDS users include networking knowledge (e.g., host name, IP address, SCSI,), communication and planning skills, geometry computation skills, data analysis, data base management, visualization/mapping, software installation, and trouble shooting skills.

The general digital knowledge and skills that have been identified in Phase I include:

- Knowledge of computer networks
- Knowledge of computer components
- Knowledge of computer operating systems

- Understanding of electronic communications
- Computer experience
- General intelligence
- General mechanical efficacy

- Computer efficacy
- Planning
- Decision making
- Geometry
- Mapping skills

Although the soldiers are comprehensively trained in many of these areas in AFATDS training, three areas the training does not cover thoroughly are 1) fundamental computer background important for understanding AFATDS components and operations, 2) troubleshooting and problem solving skills, and 3) how this AFATDS training really relates to the soldier's job as a Field Artillery personnel (e.g., why is this training so important; how does the training map onto the soldier's assigned tasks). Without the background and base-knowledge that these three areas afford, the trainee will have a difficult time comprehending and retaining the AFATDS training. After thoroughly reviewing the training literature, we felt that the soldiers would most benefit from training that addresses these areas.

Integration with AFATDS Training

Figure 3 represents the current training need for AFATDS specialists. Currently, the soldiers receive extensive training in their Military Occupational Specialty (MOS) and in the tools that they will use in performing the duties required of their MOS. For example, for the new MOS

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[2] It is important to note that current computer training generally focuses on the lowest level (i.e., computer system specific) subtasks.

13D (the
AFATDS
specialist), the
soldiers receive
extensive
training
regarding the
specific tasks
expected of
them (see
Table 1). Once
they have had
sufficient time
to learn what
tasks are
expected of them, they are taught how to use the computer system (the AFATDS) designed to let
them do their tasks. During AFATDS training, the soldiers are thoroughly trained in the specific
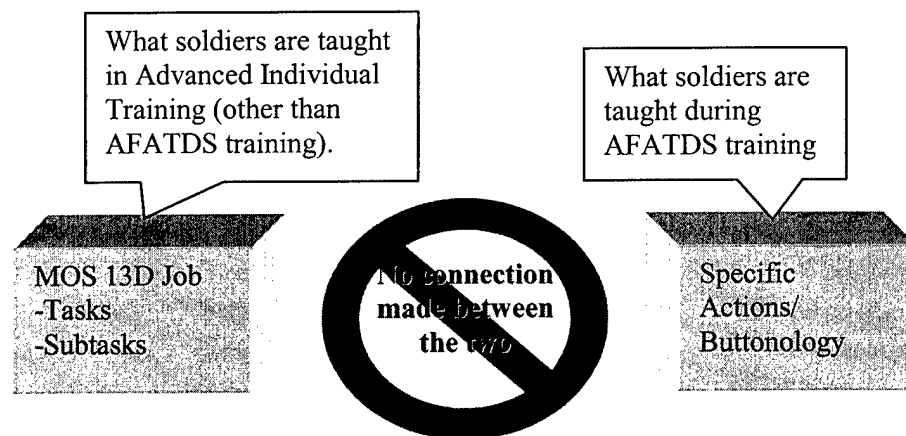actions necessary to successfully operate the system.

What soldiers are taught in Advanced Individual Training (other than AFATDS training).

What soldiers are taught during AFATDS training

MOS 13D Job
-Tasks
-Subtasks

No connection made between the two

Specific Actions/ Buttonology

Figure 3. Current training of the US Army Field Artillery AFATDS specialist

Table 1. Sample Tasks from the MOS13D Task List

TASK NUMBER	TASK TITLE
061-275-2001	Employ Field Artillery communications systems
061-275-8010	Use field wire laying techniques
061-279-5017	Maintain operational graphs on a map
061-280-5005	Perform manual safety procedures
061-299-5005	Process meteorological data
061-299-5017	Decide to attack a target
061-299-5019	Direct the massing of artillery fires
061-299-5109	Prepare a situation map
061-300-0006	Develop routing for target indicators
061-300-0007	Develop automatic purging for target indicators and suspect targets
061-300-0008	Manually input suspect targets and target indicators.
061-300-0025	Load initial vector map to AFATDS workstation
061-300-5002	Establish TAFCS communication configurations (AFATDS units)
061-300-5003	Incorporate the printer into the TAFCS (AFATDS units)
061-300-5006	Process geometry data in the TAFCS (AFATDS units)
061-300-5007	Up data unit data in TAFCS (AFATDS units)
061-300-5008	Enter the field artillery support plan text (AFATDS units)
061-300-5009	Perform trouble shooting procedures on the TAFCS (AFATDS units)
061-300-5010	Configure received message types (AFATDS units)
061-300-5011	Process message for transmission (AFATDS units)
061-300-5012	Disseminate information via data distribution (AFATDS units)
061-300-5015	Process target information (AFATDS units)
061-300-P001	Initialize the AFATDS
061-300-P002	Shutdown the AFATDS workstation operations

Currently, these two sessions are taught as being somewhat unrelated so the soldiers often experience great difficulty when trying to learn the AFATDS system, and they find it extremely difficult to learn the new system as the AFATDS progresses. We think our training can help soldiers adapt more easily to the computer system designed (e.g., the AFATDS for MOS 13D soldiers) to let them do their job as well as prepare the soldiers to learn the new system more easily as AFATDS updates.

A graphic representation of where our training program will fit into the education currently experienced by the Field Artillery soldiers can be found in Figure 4. The training that we propose to develop will bridge the gap between these two aspects of the curriculum to make the AFATDS training—both current and future—more effective. Our training will help remedy these problems by forming a bridge between the specific MOS knowledge and the detailed AFATDS instructions by training the soldiers to focus on bigger picture knowledge associated with tasks. We will help soldiers map job tasks and subtasks that they learn comprise their MOS onto specific actions they are trained to perform with the computer software.
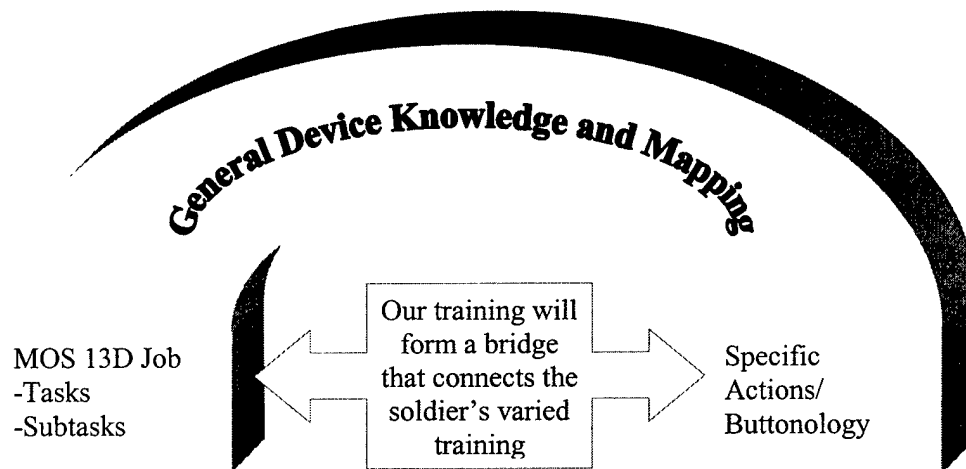
Figure 4. Relationship between current and proposed training

Following are some real-life experiences illustrating not only that soldiers, in this case Personnel from the National Guard, have a difficult time learning the necessary digital skills but also that the ramifications of this faulty learning can be quite detrimental. The following story is from Mr. Paul Titus; a member of the Aptima team who is also a member of the National Guard.

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We are not suggesting that our training will solve all the problems and roadblocks experienced by computer users; however, it could give computer users more knowledge and understanding that can be used as tools with which they can attempt to solve problems as they emerge. Mr. Titus is well trained in computers, so if he had not been around to point out the importance of IP addresses the soldiers may never have realized the cause of their problems. Our training will introduce novice computer users to the topics that are most important and thus the first to consider when experiencing difficulties.

4. Developing a sound training approach to maximize learning and knowledge transfer

Our ultimate goal for this two phase SBIR program is to develop a general training approach inspired by current theory and practice in the training and learning literatures that is flexible enough for use in any context where learners use digital tools in service of their domain tasks. We went to the learning literature with the goal of developing an approach to training that helps learners see relationships between the tools they use and the structure of the domain tasks which they presumably know well (although, we recognize the potential weakness of this assumption, and plan to build in reinforcement training that makes this structure explicit). Using the domain task structure as a learning scaffold, we teach fundamental digital principles that help learners understand, given the context of tool use, the kinds of tool interaction that are possible to get the job done, and thus the kinds of expectations they can have for software given the task at hand. To do this we use a "two-layered" approach that maps domain tasks to tools, and tools to digital implementation, a prototype of which was implemented in Phase I for one digital skill found to be crucial for the AFATDS – building and operating an electronic network.

Theory-Based Approach to Training for Adaptability

During Phase I, our investigations of the army's artillery fire support system revealed several issues that the proposed training package must address to be successful. First, a system like AFATDS is complex, and for a novice in computer systems, its interface is un-intuitive. Experts in AFATDS note that not only must trainees understand tactical operations very well to use AFATDS, but they must have a very good mental model of the system and its functionality in order to trouble-shoot in the system. For example, there are a number of functions for which the user cannot check the accuracy of recently inputted data and must test a long list of possible trouble-spots to find the cause of error. Second, the current training targets a user who is perhaps already somewhat knowledgeable about computer systems and understands the inner workings of the internet. For example, to set up communications within AFATDS, the trainee must understand the components of an electronic network, which is far more than simply typing in every host's address correctly. Even when all members of a network-in-the-making know each other's host addresses, the network may fail because of a long list of other requirements, any one of which may not have been met.

In a training situation such as this, with complex material to teach quickly to novices in computer systems, it is very difficult to avoid teaching "buttonology" and lists of procedures. That is, one eventually *must* train specific steps and procedures. Unfortunately, procedures learned in long lists inevitably become a kind of "inert" or un-usable knowledge if the learner lacks a conceptual framework for mentally storing, organizing, and accessing that much complex information. The

proposed training package delivers a **conceptual framework** plus a way of guiding students to **apply that framework** in learning the specific buttonology of a particular system like AFATDS. The package serves as a "prelude" or a bridge to procedural training in a specific system to make it the most effective it can be.

Teaching "Expert Models" of Complex Conceptual Knowledge

The training solution for teaching complex and unintuitive material to novices is instruction in the expert mental models for organizing that material. There are two types of mental models that individuals need for learning to operate complex devices. One type of model is known as a **device model** (Kieras & Bovair; 1984; Folz, Davies, Polson, & Kieras, 1988); for example, the expert's mental model of the electronic device known as an internet. Particularly with a complex system such as a network, the trainee might have a mental picture of a diagram of such a device showing the major components and the information flows in a network. With basic conceptual knowledge of what makes a network, database, visualization tool, or data analysis package work—for example, its components, resources, backup capabilities, power and information flows—the AFATDS trainee could trouble-shoot in a system and apply his or her knowledge to learning a new system or software version. A low-level example is that with a good device model, trainees "know that" computer systems have backup power capabilities (e.g., an Uninterruptible Power Supply). This factual, conceptual knowledge supports the trainee in understanding not only such basic features as where the system gets power, but the implications of shutting down or turning off the system. The trainee who believes data is **always** lost when the system is not properly shut down is a trainee with brittle, inflexible, and even somewhat superstitious knowledge. She or he is willing to use only one method—the "recommended" one—for shutting down the computer, when in fact, different methods (turning the system off, cutting the power supply) exist for different situations (e.g., protect data by destroying it when under attack). The trainee's belief is rational, but based on an erroneous, possibly nonexistent, mental model of the device.

> **Training design.** In the instructional module of our training package, students are presented with hyperlinked lessons on a **device model**. Students see diagrams representing a comprehensive but also **generalizable device** (e.g., for a generalizable network). Text describes the components and functions; interactive highlighting (balloons-style) further illuminate important issues and topics. Structure in the lessons guide students to navigate the pages of content from overviews of the device to more detailed information about sub-components and their inner workings. Special targets of instruction are terminology, the functions of components, the links between components, and communication tasks (e.g., building a network, sending data, receiving messages) that are served by different sections of the device.

A device model is only part of the knowledge needed to support expert performance with a complicated device. This is because the steps and procedures for interacting with the device may also be complex and counter-intuitive, especially when the device is a computer system with a fairly un-instructive interface. Thus, the second mental model that the expert has is a **procedural model**, or a set of goal structures for the practical "how to" knowledge of interacting with a system (Catrambone & Holyoak, 1990; Catrambone, 1998). For example, the expert user knows that there are steps associated with the goal "shut down the system." Some of the steps are further organized into sub-goals such as "shut down in an attack" or "shut down so as not to lose

data." In an attack, the expert executes steps that turn off the system the most quickly and keep data from falling into enemy hands. In another situation, however, the expert executes a different set of steps for carefully preserving data while shutting down. Each sub-goal is a mental category for remembering a group of unintuitive steps or procedures such as arcane keystroke combinations and navigations through different menus together in a meaningful way. When a trainee is presented with procedural instruction that explicitly groups and labels steps according to the relevant goals and subgoals, she or he can not only learn a system well, but apply that learning to new versions of software (Novick, 1988; Catrambone, Experiment 1, 1998). Having these mental groupings for steps, a learner will be better prepared to remember information about steps. Additionally, when faced with a new version of software to learn, the learner will remember the various "shut-down" goals from the previous system and look for steps and procedures in the new system that accomplish those goals. Aided by this well-organized knowledge of goals and steps, learners may even analogize about individual steps from the old system to the new one. For example, if in the old system the learner had to use menu options to shut down the system without losing data, then in the new system the learner would analogize that group of menu steps to the new system, searching for and trying out menu-driven shut-down procedures.

> **Training design.** Currently in the instructional module of our proposed training package, students are presented with brief lessons on a **procedural model**. Students see diagrams representing the generalizable device in question, as well as diagrams representing a process they are more familiar with (e.g., the USPS) and similarities between the procedures are pointed out. The availability of the device diagrams will help students integrate information from the device model with the procedural model.

Guiding Application of Knowledge

With knowledge of a type of device (e.g., an electronic network) and the general procedural goals for interacting with it (e.g., steps for building a network), learners must **be shown how this critical information applies to a specific system**. While device and procedural models are powerful concepts that guide the trainee to learn new systems, they are also general models that must be adapted to the specific buttonology of a system. Some guidance must be given initially in applying those concepts as this kind of learning-transfer activity is traditionally a stumbling block for learners and training packages alike (for a review of this issue, see Singley & Anderson, 1989). Our solution to this issue is to guide students through a module that acts as a **Skills Bridge** between the conceptual instruction in device and procedural models and the systems-operator instruction (e.g., for AFATDS) currently delivered by the Army. Practice in such a module results in more refined understanding of the device and procedural models and in mental rules for analogizing one set of procedures to a goal in a new system. Just because learners are asked to draw on old knowledge to solve a similar but new problem does not mean that the learner will know what to do first in that situation. Practice in the Skills Bridge module will give students practice using analogy heuristics such as thinking about the general goals of a device first, putting off thinking about superficial features like key-stroke combinations, and modifying an old procedure several ways rather than trying to use it identically in the new system.

Training design. After they have received training in a generalizable device model and a procedure model , students are presented with lessons in a **Skills Bridge** that links what they have learned in the TADS training to the specific system they are preparing to learn about (in our prototype – the AFATDS system). This Skills Bridge will assist the student in building a mental model, or schema (e.g., see Wyer and Srull, 1989), of the AFATDS system so that future association with that system, or similar systems, can be more efficient and productive. To create the Skills Bridge we used material supplied by AFATDS trainers as well as material in the AFATDS manual and leveraged the structure of the generalizable device and procedural models as well as principles of instructional design (e.g., how to sequence instruction; how to present information effectively; how and when to evaluate). The Skills Bridge will help the student understand how the general training will be useful in the system training and thus increase motivation; it will also increase the probability of training transfer by using the terminology and illustrating the basic device and procedural models that students have learned so far in the new context of a new system.

Gauging Students' Progress Continually

In a training package for teaching complicated cognitive skills, one must ensure that all learners are keeping up with the instruction. The device model, procedural model, and Skills Bridge are modules of instruction that build, module by module, an integrated body of knowledge. Regular assessment will be necessary to assure that students can remember, for example, the components of an internet device and the procedural goals and sub-goals that must be met in building a network, before students attempt to apply this knowledge in a Skills Bridge module.

Regular testing is also an opportunity to select the next level of informational complexity and instructional content to present to students. For example, early exercises in a module would give students practice in retrieving overview information about the general functions of a device. Later, when students show mastery of the earlier material, exercises would lead students to refine that knowledge further by solving "de-bugging" problems and testing hypotheses about the location of errors and the best ways to resolve them. The general plan of instruction flow from module to module also implements an instructional design from the simple to the more complex. For instance, students learn overview information about general devices before attempting to apply the knowledge to procedural goals. Once students have mastered general device and procedural models, they refine and deepen their knowledge by applying it in limited examples during the Skills Bridge module. After students have completed the proposed modules, they will be ready to again deepen their knowledge of devices and learn the complex workings of a specific system like AFATDS.

To get the full benefit of the regular assessment, the student must receive timely and constructive feedback (Latham, 1989) for both correct and incorrect answers. Without such feedback, learning is unlikely to take place and the students will become unmotivated and frustrated.

Training design. Each student begins the training with assessment questions to gauge their mastery level of the concept being trained. Assessment for each topic begins with simple, or basic, questions that gradually progress to more difficult, or complex issues. Each time they answer a question, they receive immediate feedback

about the correctness of their answer. If they answer it correctly they go on to the next harder assessment question; if they answer it incorrectly, they go to instruction focused on the specific construct of interest.

Summary of Adaptability Training Approach

Figure 5 summarizes the components of our approach, as discussed above. We will train learners to develop a general device model (e.g., a model of the components of a network) and a general procedures model (e.g., how one sets up a network). Then we provide a "Skills Bridge" that links this general knowledge to the specific training that soldiers receive on the AFATDS system.
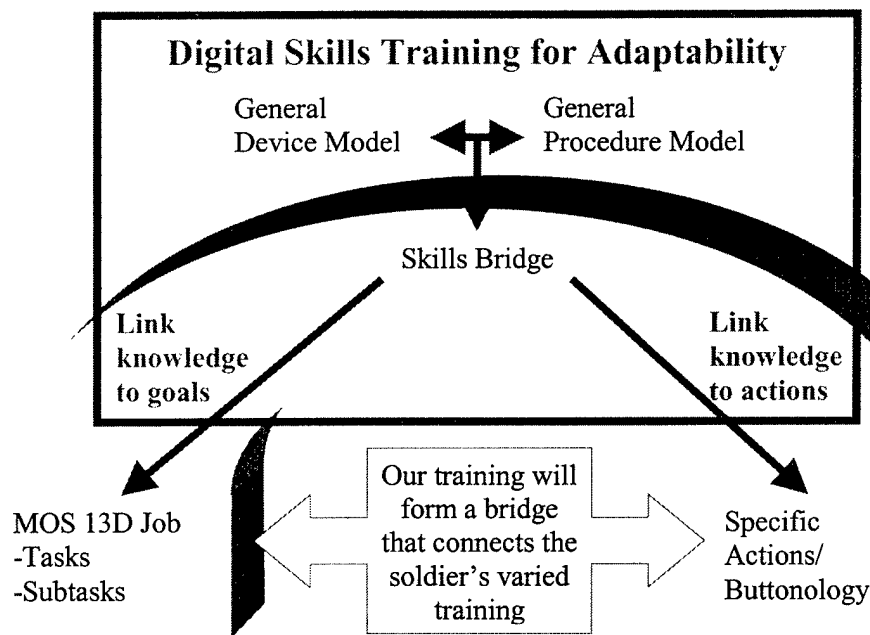
Figure 5. Components of Proposed Training Approach

Both the general device model training and the general procedure model training take place through progressively more difficult assessment and focused instruction for each topic (e.g., computer components, computer networks, electronic communications). Feedback is given after each assessment question is answered, and the Skills Bridges occur after each specific knowledge or skill (e.g., understanding Wide Area Networks) has been successfully mastered (i.e., the student correctly answered all questions for that training segment). Figure 6 depicts the flow of the TADS training program.
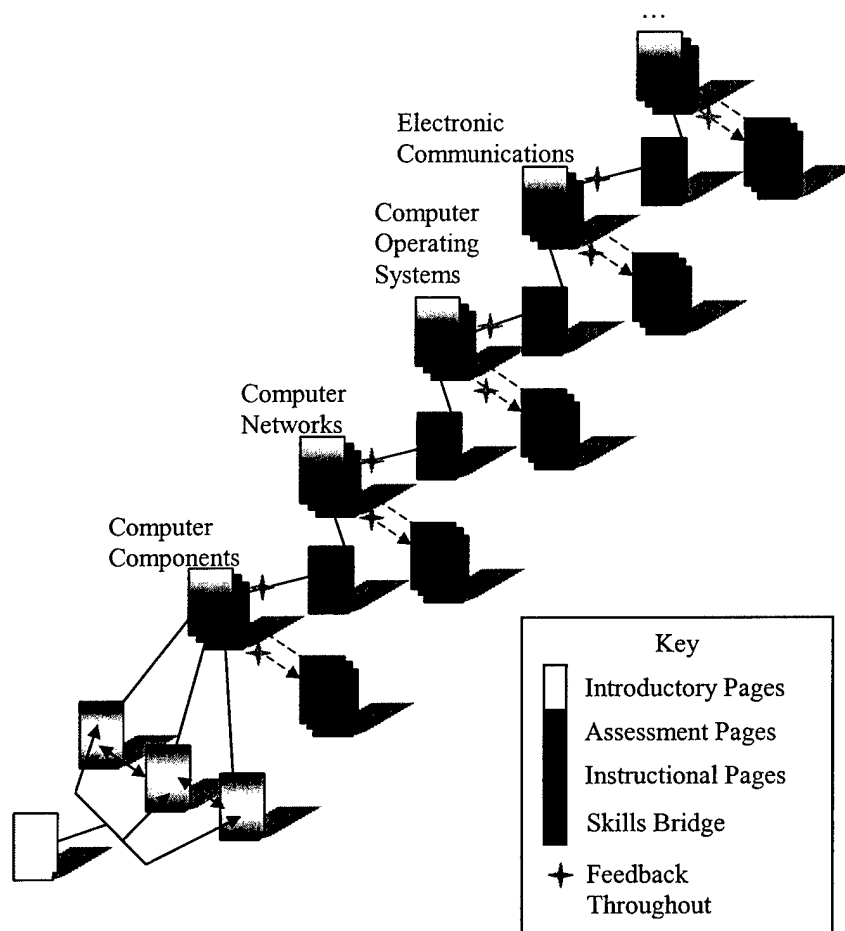
Figure 6: Flow of the TADS Training Program

5. Deliver proof of concept training program.

At the conclusion of Phase I, we have demonstrated how our theory-based approach can be applied to training for the fundamental digital skills that are associated with a selected AFATDS task – computer networks. The proof-of-concept training is written in HTML and uses JavaScript, so the students could theoretically take this training over the internet, or the training can be used from a CD, or it can be copied onto the hard drive of any computer so students can receive the training at their convenience. Figure 7 portrays the flow of this section of the TADS training program. Following is a description of the training program developed for the Phase I project.

Basic/Advanced Network Device concepts

Basic/Advanced WAN concepts

Basic/Advanced LAN concepts

Basic/Advanced Networking concepts

Key
☐ Introductory Pages
▮ Assessment Pages
▮ Instructional Pages
▮ Skills Bridge
✦ Feedback Throughout
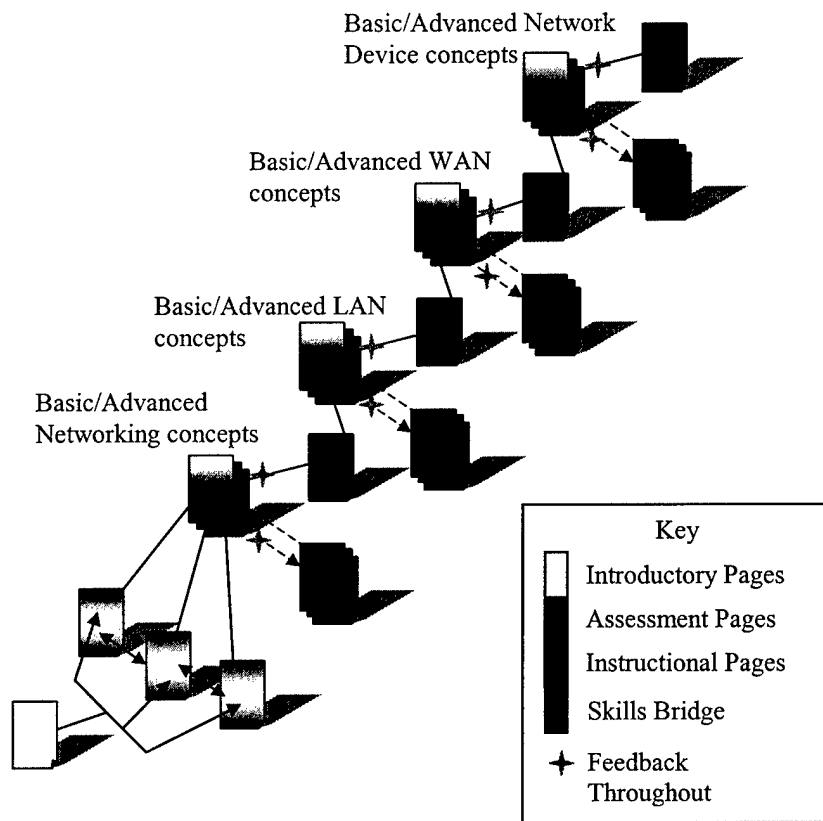
Figure 7: Flow of the Computer Networks Section of the Training Program

The training program begins with an introduction to the entire training program (See figure 8). In this general introduction, the training program is described and the student is told what they should expect as they continue with the program. When the entire training program is completed at the end of the second phase, the student will be able to choose any of the topics in the outline on the left to get further training; however, in this initial prototype, only computer networks training is available.

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Preparation for AFATDS Training

This program is a self-training tool designed to help you prepare for the AFATDS training, and should be considered a supplement to the actual training course provided for AFATDS. This preparation consists of multiple training levels nested from most broad to very detailed - your specific level of expertise determines how deep into the nested levels you will go. First, you are asked very broad questions to gauge your level of expertise, then you are asked questions and given examples appropriate for your expert level. Throughout the training, you will learn how programs like the AFATDS work when everything goes well, then you will learn how things may go wrong and what can be done about that, finally you will learn how this training connects to your AFATDS training. The goal of this training is to ensure that you have a good solid base of knowledge upon which you can build while learning about the AFATDS system.

Continue

Figure 8. General Introduction page

Because it is assumed that this training will be delivered with minimal instructor contact, the initial instruction is quite detailed. When a student clicks on the "continue" button at the bottom of the initial instruction page, they will see another instruction page that introduces the three types of pages the student will encounter throughout the training program (see Figure 9).

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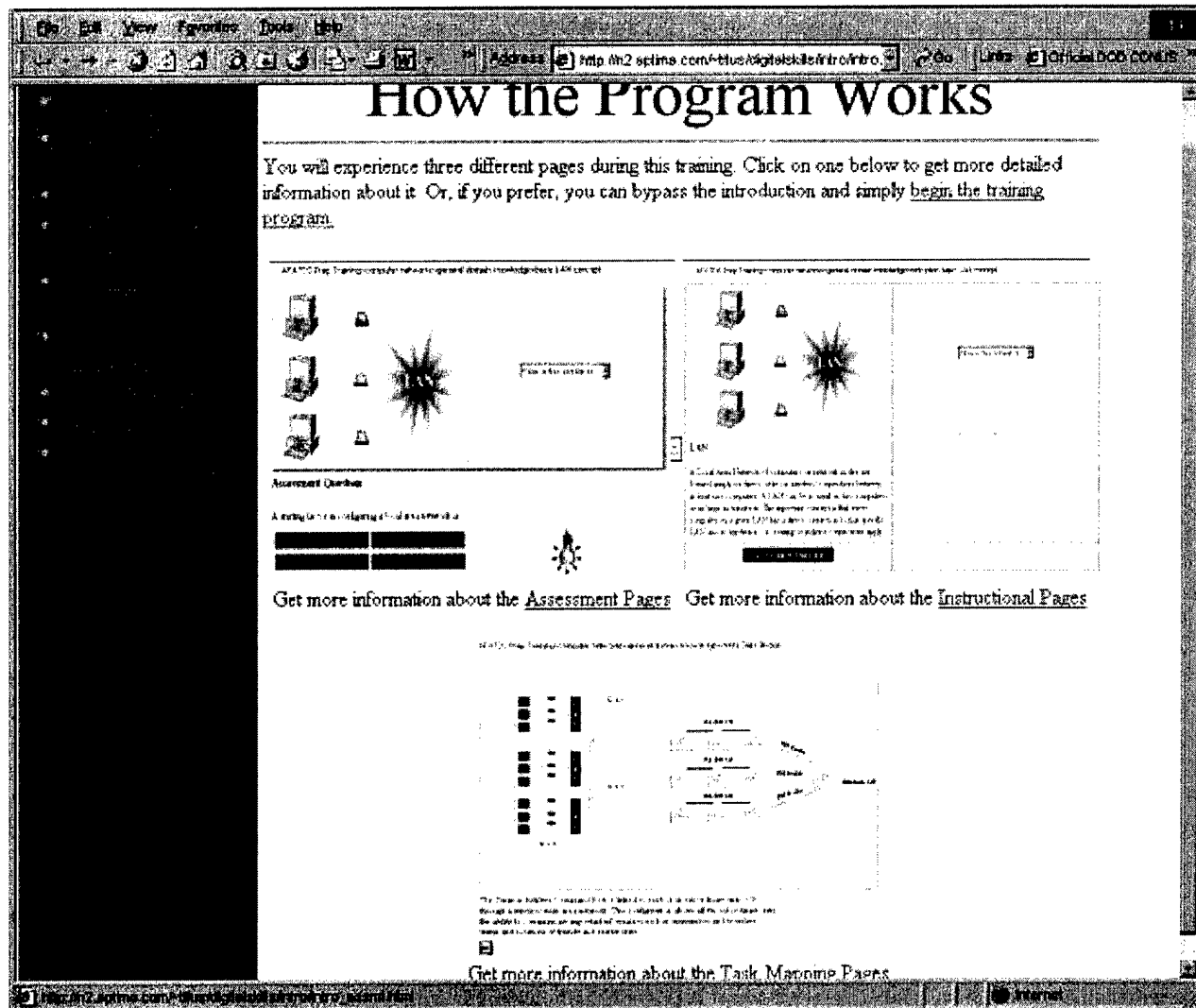
Figure 9. Introduction to the Three Types of Instructional Pages.

By clicking on the specific page, a student can get a more detailed introduction of the Assessment, Instructional, or Task Mapping (i.e., the Skills Bridge) pages where each part of the page is explained in detail. Figure 10 presents the three introductory pages for the instruction pages.
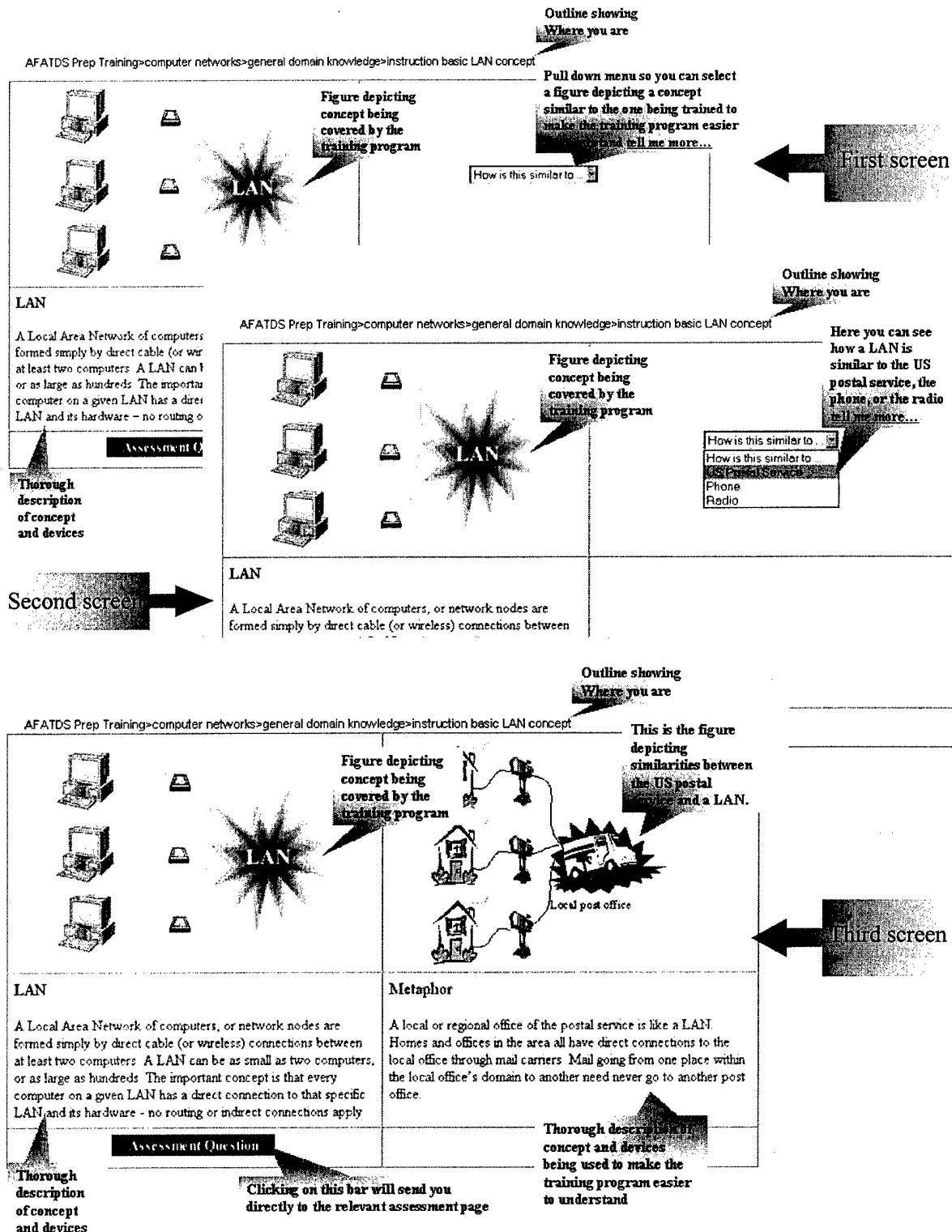
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Figure 10. Sequence of 3 screens describing the instruction page

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Both the assessment and instructional pages have three introductory pages to illustrate the pull-down menu for the metaphor. In discussions with AFATDS instructors and students at Fort Sill, it was decided that no one metaphor would be perfect for all students, because of different backgrounds and different ways of thinking about the topic, so students should have a choice of metaphors from which to choose. To illustrate how to choose a metaphor from the pull-down menu, the introductory pages walks the student through selecting the USPS metaphor.

When the student has completed the introductory pages, he can then begin the training program. The first screen the student will then see for the computer network module is the introduction to the computer network module (See Figure 11). Like the assessment and instruction pages, the student can choose from a list of metaphors included to help them better understand the topic. If they click on "Continue", they are sent to the first assessment question (see Figure 12); if they click on "To Instructional Information", they go to the first instructional page (See figure 13).
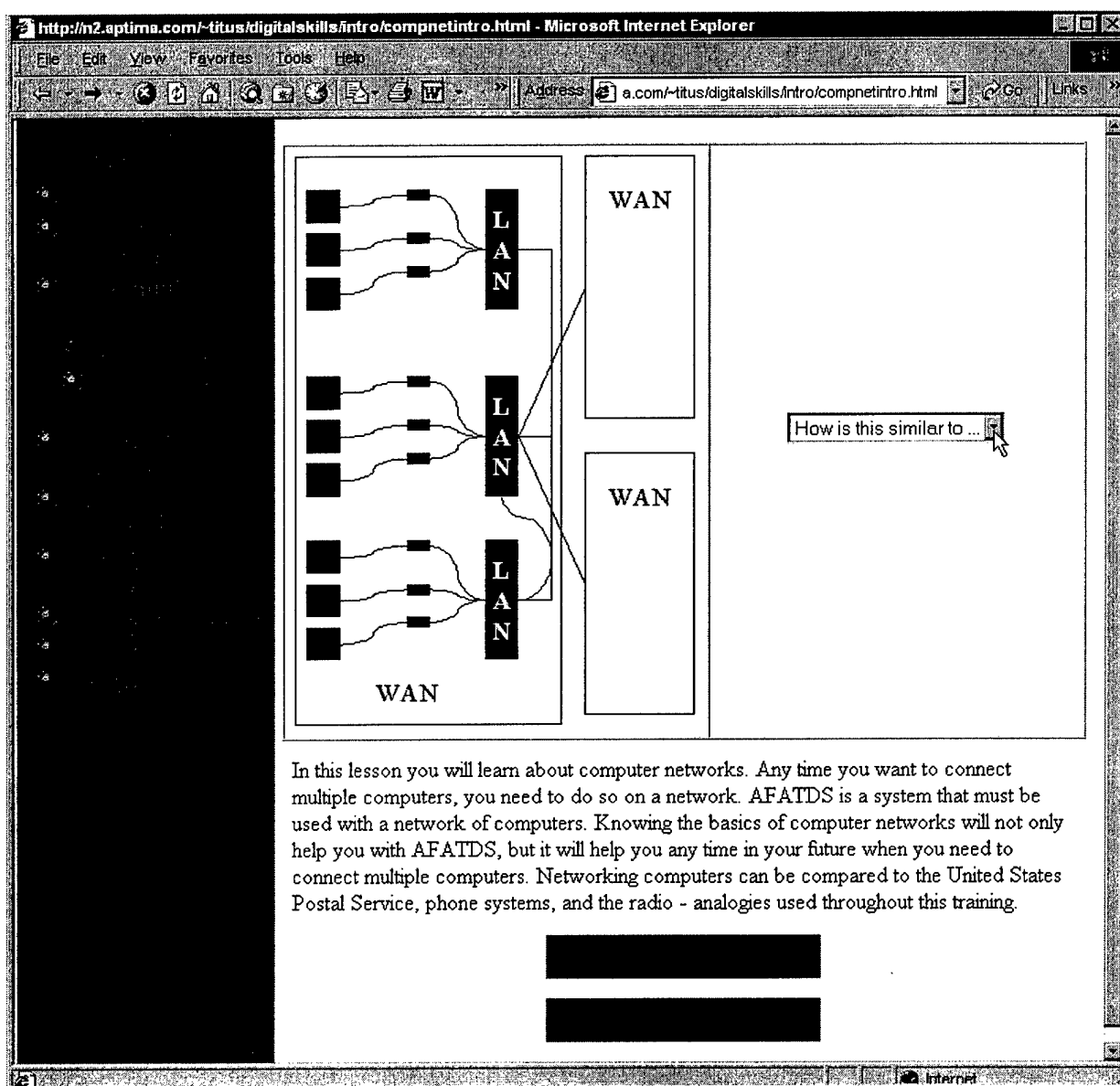
Figure 11. Introduction to Computer Network Module
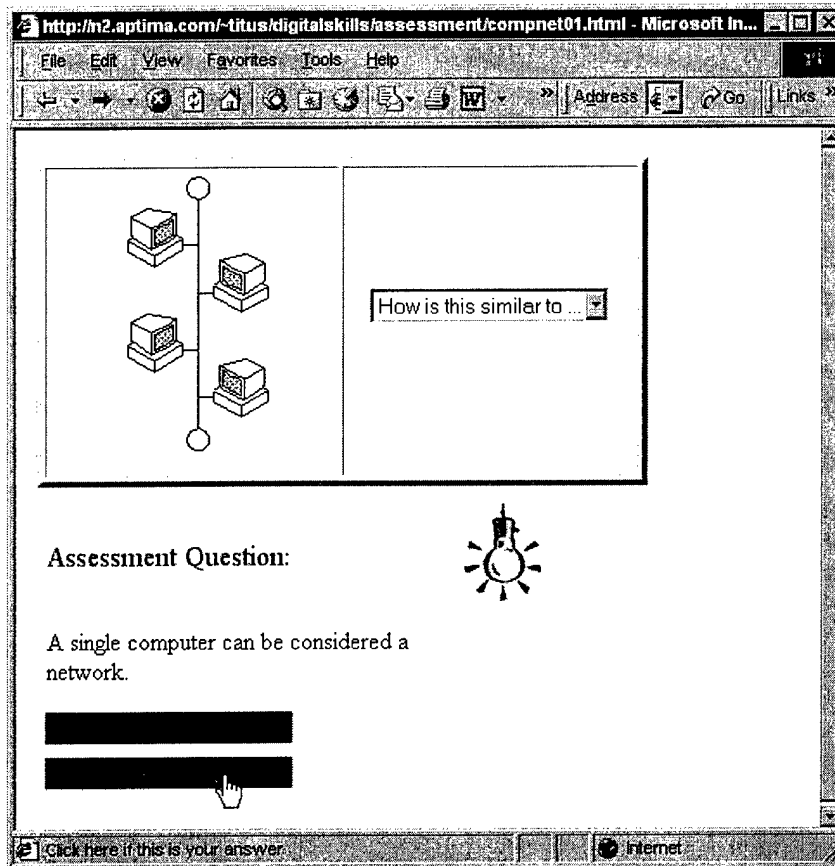
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Figure 12. The initial assessment page
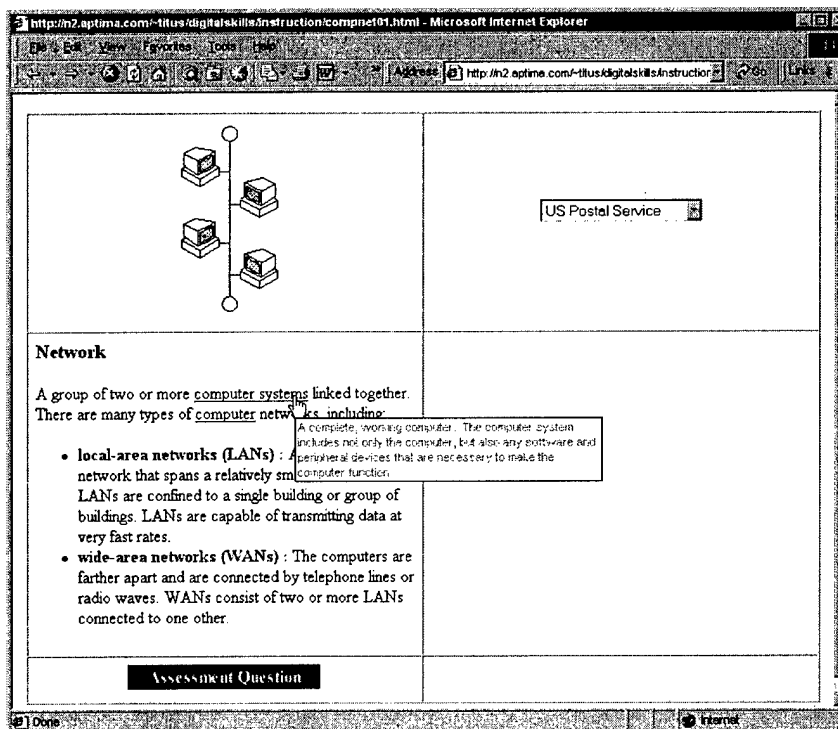
Figure 13. The initial instructional page illustrating pop-up vocabulary

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As the student navigates through the assessment and instructional pages, the training program is designed to give instantaneous feedback for the student's answers to the assessment questions. If an answer is incorrect, a dialog box pops up stating that the answer was incorrect and the student is being sent to the appropriate instructional page (see Figure 14). The student must click on the "OK" button to make the dialog box disappear, and the student is then sent directly to the instruction page.
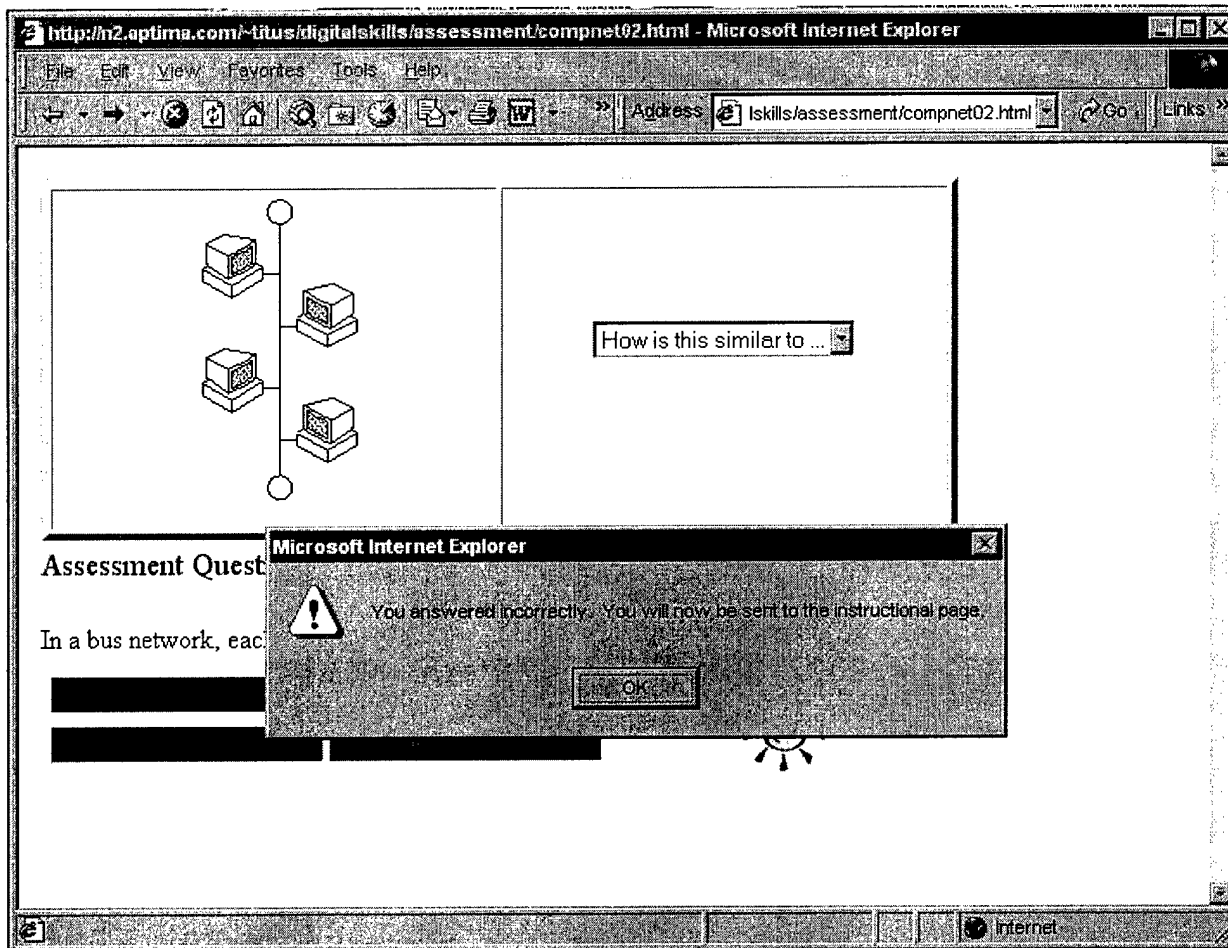
Figure 14. Students get immediate feedback for incorrect answers and are sent to the instruction pages.

If the student answers correctly, another dialog box pops up explaining that they are correct and can either continue with the assessment questions (See Figure 15) or go on to the Task Mapping screen (see Figure 16).

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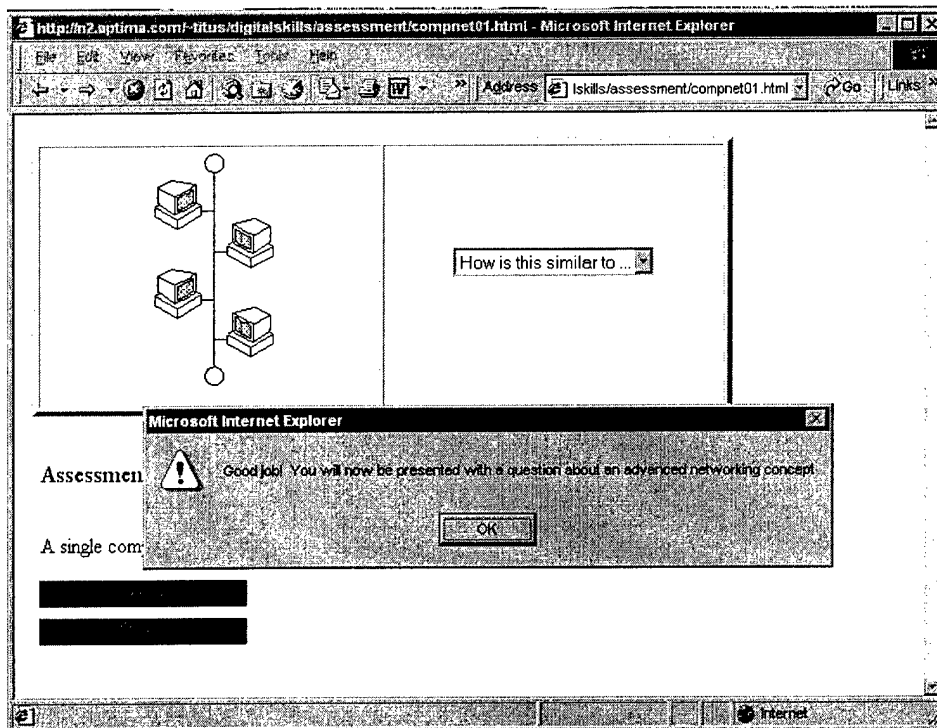
Figure 15. Correct answers are acknowledged immediately
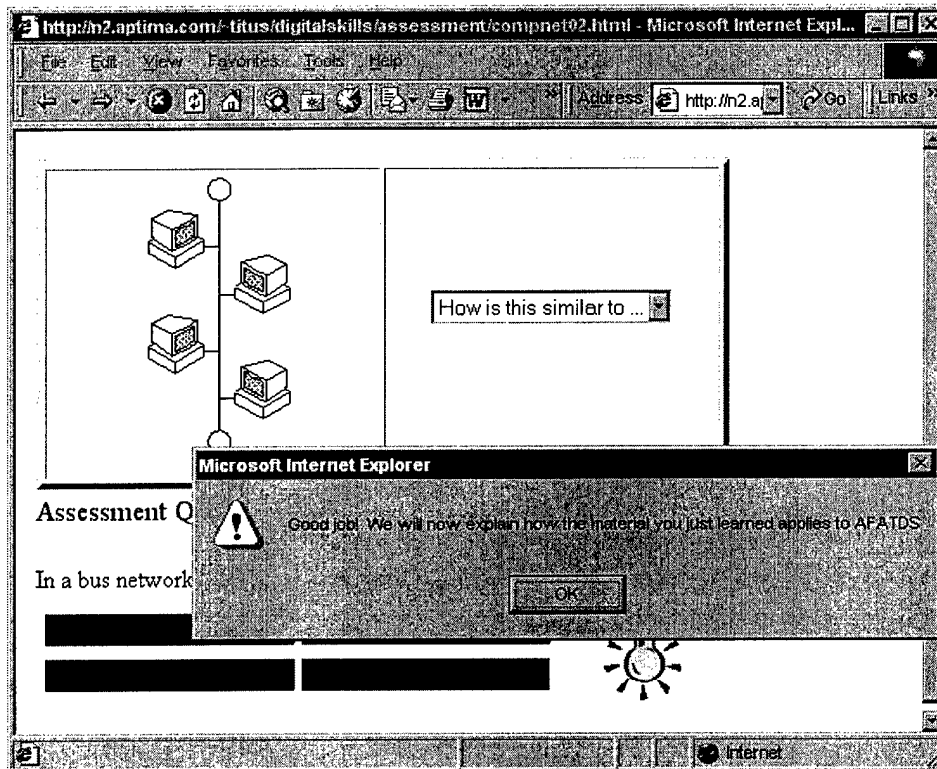
Figure 16. Students answering the most difficult assessment questions correctly are sent to the appropriate Task Mapping page.

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For our Phase I and option product, we have developed a proof-of-concept training program for computer networks. For Phase II we will continue to develop and expand the training program to include all topics necessary for a solid base knowledge of digital skills.

6. Design validation study

Following is an Experiment Plan that details how we plan to evaluate both degree of learning and transfer success for the training package. Because our training on fundamental digital knowledge and skills is complementary to detailed training on the specifics of operating a digital device, we plan to closely coordinate our data collection in Phase II with AFATDS training delivery.

Experimental Plan

To deliver a valid training program at the end of Phase II, we have determined that a two-stage validation plan is called for. For the first stage, we will conduct an initial usability test and content validation study on the training as it was developed in Phase I. After further developing the training program, we will conduct a full validation study to ensure that the entire training program is valid. Both of these studies is explained in more detail below.

Initial Validation

For the initial validation we want to make sure the training we developed in Phase I is appropriate before expanding it to the full training package. This initial validation study will have 2 parts a) Conduct initial usability testing, and b) Conduct initial content validation study.

A. <u>Usability testing</u>. The goal of usability testing is to determine how users who have not previously encountered the TADS system react to it. Specifically, what problems or difficulties do naïve users encounter in proceeding through the training? What recommendations for improving the system do such users have?

Typically, usability of a web site or web application is conducted in several different ways. These include "cognitive walkthrough" (e.g., Spencer, 2000), "heuristic evaluation," (e.g., Neilsen, 1994), "thinking aloud protocol" (e.g., Rubin, 1994), focus groups, questionnaires, and feature and consistency evaluation. We propose usability testing of three types: cognitive walkthrough, thinking aloud protocol, and heuristic evaluation. Usability testing will be conducted on both the prototype and during the creation of the actual Phase II deliverable. Each of the planned usability evaluations are discussed briefly below.

Heuristic evaluation (Molich & Neilsen, 1990; Neilsen, 1994) consists of designing and reviewing a system in order to assure that certain fundamental usability good practices are followed. That is, various criteria for success in this area are stipulated and examined in regard to a particular project. After Molich & Neilsen (1990 – note that some of the wording in the numbered points directly below is theirs), we list below some of the usability heuristics to be used in the design and review of the TADS system.

1. *Visibility of system status* – The system should always keep users informed about what is going on, through appropriate feedback within reasonable time.

2. *Match between system and the real world* – The system should speak the users' language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order.

3. *User control and freedom* – Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Support undo and redo.

4. *Consistency and standards* – Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.

5. *Error prevention* – Even better than good error messages is a careful design which prevents a problem from occurring in the first place.

6. *Recognition rather than recall* – Make objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate. For the TADS system, this has implications on limiting the amount of screen scrolling that is required.

7. *Aesthetic and minimalist design* – Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.

8. *Help users recognize, diagnose, and recover from errors* – Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution.

9. *Help and documentation* – Any help should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large. It is anticipated that the TADS system, after a brief orientation, will have minimal need for additional help documentation. Nonetheless, where required as determined by good design and results of other usability testing, help will be made available.

A second kind of usability testing that will be used in the TADS development is what can be called expert cognitive walkthrough (ECW, Spencer, 2000). Best for the earliest stages of product development, the ECW consists of designers "storyboarding" a process in the sense of anticipating the sequence and nature of the actions required of a user, and identifying any problems that the user might encounter in accomplishing the goals of the system.

A third kind of usability testing is the so-called "thinking aloud" method (e.g., Rubin, 1994), which is a kind of observational technique. In this method, users are asked to complete a task (in this case, to proceed through the TADS system), and further asked to voice their thoughts as they complete it. This method is ideal for identification of any aspects of a system that a user finds confusing, ambiguous in purpose, or difficult in

execution. In addition, the users will complete a post-use interview protocol that further elicits both specific and general reactions and comments.

At the conclusion of usability testing, user comments and observer notes will be organized and reduced to a final set of identified problems and recommended solutions.

Note that in addition to standard usability testing, the content of the materials will be analyzed for reading level. This analysis will use a standard computer program utilizing a broadly agreed-upon heuristic (such as the Gunning or Flesch) to assess reading level. The target is to developed TADS with a reading level not above high school graduate (excluding computer/technology specific words, which are necessary in training digital skills).

B. <u>Content validation</u>. The goal of content validation is to determine whether the content of the TADS system reflects accurately and completely the knowledge and skill domains that it was designed to reflect. Thus, content validation is structured process that requires the judgment of subject matter experts as to appropriateness of content, given a particular domain. While the content validation process can be quantified, typically a qualitative approach is used, whereby reactions and judgments by experts are used to expose knowledge/skill content gaps, and domain-extraneous content. The degree of successful content development is then known, and shortcomings or errors can be addressed.

TADS will be content validated for both the generic digital skills content, and for the Skills Bridge content. The generic digital skills content will be validated on the basis of input from digital skills trainers/teachers. These experts will enable us to verify that the general categories within the digital skills domain identified in Phase I (e.g., knowledge of computer system components, knowledge of operating systems) are complete and accurate. The second part of TADS content validation involves assuring that the AFATDS-specific information present in the Phase I prototype is accurate and complete. The experts required here will have expertise in the AFATDS system. Note that this second level of content validation will continue throughout the full program development.

Full Validation Study

Although the training program development will include recurrent content validation throughout, it is still necessary that the entire training program be fully validated once it is complete. Below we explain why we feel that the training must be evaluated, then we discuss the proposed evaluation criteria and the evaluation design.

<u>Why digital skills training for AFATDS is a high priority for evaluation</u>

We are proposing an evaluation/validation of the digital skills training. Whenever an evaluation of training is considered, it is important first to understand **whether** an evaluation is feasible and appropriate. gOE (1998) surveyed people from over 100 organizations about "high priority evaluation" projects. Survey results showed that in projects where evaluation are considered critical: a) there is at least one clear **reason** or **purpose** for conducting the evaluation, b) the **potential impact** or scope of the service, program or initiative in question is high, and c) **conditions that support** the collection of evaluation data are favorable.

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Each of these three conditions holds for the digital skills training for AFATDS. First, there are a number of clear reasons to conduct an evaluation of such training, including: a) its validation – to learn whether and why the training did or did not work, including gathering strong evidence regarding effectiveness (i.e., to collect evidence credible to the scientific community within the Army, b) to decide whether to continue/expand such digital skills training for all AFATDS trainees now in and the foreseeable future, c) to obtain diagnostic data in order to evolve digital skills training into its optimum form. Second, the potential impact of digital skills training is high, because a) the individuals participating in the training (soldiers) are critical to the nation's defense readiness, b) there are large numbers of soldiers both within the AFATDS program and in other programs where digital skills are important, and c) the programs, such as AFATDS, that digital skills training might affect are expensive to develop, deliver, and maintain. Third, the conditions that support the collection of evaluation data are favorable because customers' expectations for the success of the service, program, or initiative are clear, the customer is interested in supporting evaluation, and the feasibility of gathering evaluation data in the military is high.

Proposed Evaluation Criteria

In order to best determine what criteria should be assessed, the general expectations of training should first be identified. We believe that, if digital skills training, combined with AFATDS training, is successful, then:

- Trainees will increase their understanding of what is required of them to succeed

- Trainees will be more ready to take on additional roles or rotate roles as required

- Trainees' job performance will improve

- Trainees' knowledge and skills will improve as a result of the training

- Trainees will feel more confident in their ability to perform the job

- Trainees' attitude toward digital jobs will improve

- Trainees will feel training is meaningful

- Trainees will be more able to learn other digital skills (the digital skills training will transfer to new situations)

These expectations for what successful digital skills training will accomplish, along with the purposes of the evaluation (to collect credible scientific evidence relative to the training's effectiveness, to help determine whether to continue/expand digital skills training, and to provide diagnostic information that will improve digital skills training) help define the appropriate training evaluation criteria. Table 2 provides an overview of planned evaluation criteria. Both the general nature of the criteria and the proposed collection method is specified. The rationale for some of these criteria, such as confidence (digital efficacy) was described in the discussion of Task 1.

Table 2: Proposed Evaluation Criteria

Survey Supervisors, to assess:
Whether unit **retention/morale/attitude** has improved.
If trainees are ready to take on **additional roles or rotate roles** as required.
If trainee **performance** has improved.
Whether trainees have become **more knowledgeable and skilled**.
Survey Trainees, to assess:
If trainees have increased their **understanding of what is required of them** to succeed.
If trainees feel ready to take on **additional roles or rotate roles** as required.
If trainee **job performance** has improved.
Whether they have become **more knowledgeable and skilled**.
If trainee **confidence** about ability to perform job has improved.
If trainee **attitudes toward digital tasks** have changed.
Interview Supervisors, to assess:
If trainees have increased **understanding of what is required of them to succeed**.
If trainees are ready to take on **additional roles or rotate roles** as required.
If trainee **job performance** has improved.
Whether trainees have become **more knowledgeable and skilled**.
Interview Trainees, to assess:
If trainees have increased their **understanding of what is required of them to succeed**.
If trainees are ready to take on **additional roles or rotate roles** as required.
If trainee **job performance** has improved.
Whether trainees have become **more knowledgeable and skilled**.
If trainee **confidence** about ability to perform has improved.
If trainee **attitudes toward digital tasks** have changed.
Test Trainees, to assess:
Whether trainees have developed **digital skills**.

From the above table, it can be seen that Phase II will require the development of interview protocol, surveys, and tests.

Evaluation Design

The design for the proposed evaluation study is a pre, post, delayed-post treatment/ control group design. A design of this type does much to obviate a number of the so-called "threats to validity" (Cook & Campbell, 1979). The fact that a control group is included permits relatively strong conclusions about the unique effectiveness of differential treatment, which in this case is the digital skills training preceding the AFATDS training. Table 3 provides a summary of the planned design:

Table 3: Evaluation Study Design

	Pre-Measures	Digital Skills Training	AFATDS Training	Post-Measures	Field Experience	Delayed Post-Measures
Digital Skills Group	Surveys and Tests of Trainees	YES	YES	Surveys and Tests of Trainees	Surveys of Trainees in Field	Surveys and interviews of trainees and interviews of supervisors
Control Group	Surveys and Tests of Trainees	NO	YES	Surveys and Tests of Trainees	Surveys of Trainees in Field	Surveys and interviews of trainees and interviews of supervisors

Control Variables. There are a number of variables which it will be important to assess, in order that a) statistical control can be done if necessary (i.e., if the control group and the digital skills group differ systematically), and b) pre-existing differences among trainees may be tracked to see effects on training. These variables include g, general intelligence, and computer skills/experience. These variables will be assessed prior to training, using efficient group measures of each.

Validation Sample. Part of this fourth task will be determining where we will get the sample of personnel to participate in the validation study. To minimize duplication of efforts, we will capitalize on the current AFATDS training as it presently occurs. At present, there are two ways that Field Artillery personnel gain the needed training on the AFATDS system: they either receive training as a part of their coursework while at Fort Sill or they receive training in the field with their entire battalion—we will pursue both venues as possible samples for the validation study. Beginning in September 2000, all field training for the AFATDS will be performed by Engineering and Professional Services, Inc. (EPS), an engineering firm that provides expert services in system communications technology. These field training exercises occur at multiple Army Bases multiple times throughout the year. They take place over a four week period, where the first week is set-up, and the second and third weeks are AFATDS training and the fourth week is "unit validation" where the soldiers do an exercise to make sure they can set up and use AFATDS in the field. EPS has agreed to support our Phase II effort by a variety of supporting activities such as helping us arrange access to the soldiers who will participate in the study, helping us choose a representative sample of the available personnel, helping us make the necessary arrangements to perform the validation study, and helping us remain in contact with the soldiers for follow-up data if needed. Another possible test bed is the US Army Reserve. With the split training option, recruits begin training during one summer (basic training) and finish it (specialization) the next. This would allow digital skills training to be given one summer, followed by IFSAS/AFATDS training the following summer.

It is assumed that sufficient numbers of trainees will be available to allow for stable estimates of training effect size and other statistics such as correlation. A optimum sample size would exceed thirty trainees in each of the digital skills and control groups.

Work Environment Readiness. In order to attain maximal understanding of the impact of digital skills training, it is necessary to understand the transfer environment. Conditions in the

field will support transfer of training to a certain degree and in certain ways. Similarly, various constraints on transfer will operate in any given training situation. Accordingly, in addition to the various effectiveness measures which will be developed and administered during Phase II, we will administer the **Work Environment Readiness Survey,** a validated diagnostic tool that can be distributed to trainees to determine their perceptions of the supportiveness of the learning environment (Tannenbaum, 1997). This survey includes items addressing such factors as "Learning Conditions" (factors that influence whether employees can successfully engage in continuous learning), and "Learning Sources" (trainees can learn and gain competence from a number of different sources). For example, the survey can identify whether a trainee has learned more from trial and error than any other single source. Similarly, the survey will be adapted to indicate the extent to which digital skills training influenced field success.

A Measurement Model of Digital Skills Transfer for Phase II. Although we are examining one particular instantiation of the U.S. Army's wide variety of tools demanding digital skills (AFATDS), and not measuring what might be termed the far transfer to an additional platform, the concept behind general digital skills training includes generalization to different tools. Figure 10 illustrates this concept.

The ovals in Figure 17 represent latent constructs which can be measured, with some degree of error, by visible or recordable indicators represented by rectangles. Arrows between latent variables signify influence while arrows between latent constructs and indicators represent measurement opportunities. The training interventions are shown as parallelograms.
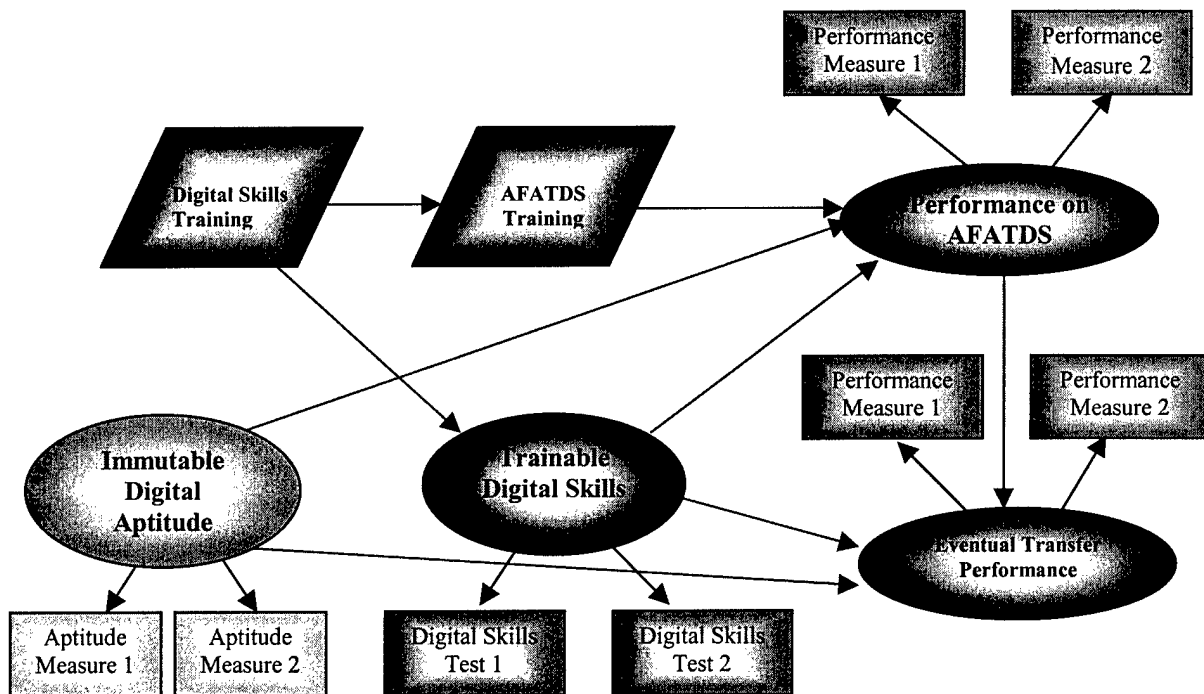
Figure 17: A Measurement Model for Digital Skills Training

There are several points illustrated in the model. First, digital skills are considered a latent trait, observable through indicators or tests of performance. This suggests that it is desirable to measure digital skills in an abstract or general way, separate or separable from any specific tool. Second, digital skills training has an impact on both the trainable digital skills and on AFATDS training. Third, trainable digital skills influences field performance. Fourth, it is possible that there will be a relationship between level of performance on one task and that of another. Fifth, there are hypothesized immutable personal characteristics (such as *g*) which affect performance on digital tasks. These are skills which will need to be "held constant" or "controlled" in the proposed studies. Not shown are trainable personal characteristics, such as self-efficacy or self-regulation, which can affect mastery and transfer of digital skills, but they can be seen as having the same influences (arrows) as trainable digital skills.

7. Technical Objectives for TADS

In Phase I we demonstrated the feasibility of developing a training program to increase adaptability in digital skills. In Phase II, we will develop the full training program and show evidence of its validity for training digital adaptability with the AFATDS system.

Our goal in Phase II will be to develop a full training package that can be used to ensure that trainees get the background skills necessary to take full advantage of the digital revolution. We will design the training to prepare trainees to use a specific digital tool, the AFATDS. The general device knowledge module of the training will focus on that general knowledge needed to understand the AFATDS and other similar digital systems (e.g., computer systems in general, networking systems, data management systems); the device specific module will train the soldiers on how to map this general device knowledge to the specific AFATDS system. In addition to the training package, a related product of the second phase will be a description of the protocol necessary to revise this system-specific training module for other digital tools and situations.

Phase II Objectives

We have established four specific objectives to meet the Phase II challenge of developing a training program to increase adaptability in digital skills. The details of our approach for meeting each of these objectives are provided in Section 8, the Phase II Work Plan.

Phase II – Objective 1: Completely map device knowledge to MOS specific tasks

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The core of our approach to training in adaptability, as developed in Phase I, is establishing links between generalizable knowledge about digital devices (e.g., the components of a network and the steps needed to set up a network) with information about a specific system (e.g., what networks are used in AFATDS and what steps are needed to set them up) and the specific goals to be accomplished (e.g., why an MOS 13D needs to set up an AFATDS network). Our review of the literature on transfer of training in Phase I suggested that establishing this type of linkage

between general knowledge, specific knowledge, and task goals is the best way to promote learning of adaptable skills. In Phase I, we selected the networking knowledge and skills required for AFATDS to demonstrate our training approach. The first step in Phase II will be to expand the approach demonstrated in Phase I to include additional aspects of AFATDS and additional MOS tasks. The product of this activity will be a mapping of basic digital skills and knowledge to device-specific AFATDS actions and to MOS 13D tasks. This mapping will be the foundation for Phase II training development.

Phase II – Objective 2: Develop program to train adaptability in digital skills

The majority of our activity in Phase II will focus on the design and development of the Adaptive Digital Skills Training package. We will follow the approach used in Phase I to develop storyboards for the training package, prepare a flowchart of the relationships between the training topics being covered, generate paper prototypes of the screens for review, develop electronic prototypes of the screens that can be reviewed on line, and prepare the final training package based on the prototype. The mode for delivering the training can be either CD or web-based, depending on the preferences of the Army. The advantage of CD delivery is that students can use the training without the need for an internet connection. The advantage of web-based delivery is that it is easily modified and updated at one central location.

Phase II – Objective 3: Guarantee the validity of the training program

The delivery of training that transfers from one problem or situation to another is a challenging task, and a critical objective for Phase II will be to conduct an evaluation study to assess the success of the adaptability training. The proposed innovative training approach has almost unlimited potential for use in other Army systems, other military services, and commercial environments, but, first, evidence is needed that it is effective. Considerable effort was focused in Phase I on the design of an evaluation study that will yield valid results. We have developed a set of proposed evaluation criteria, and will spend time during Phase II developing the measures necessary to determine the validity of the training program. The validation study we are proposing is a pre, post, delayed-post treatment/control group design.

Phase II – Objective 4: Commercialize the digital skill training program

The central goal of Phase II is to create a training program to increase adaptability in digital skills. While we plan to concentrate this effort on the MOS13D and their use of the AFATDS, a portion of our efforts will be aimed at ensuring that the training to increase adaptability in digital skills has widespread applications for both military and commercial users. To enable this application diversity, we will solicit input from potential post application users early in the needs analysis, design, and validation process. In addition we will develop a demonstration methodology (via the Web) that can be used to cultivate a commercialization success. We will leverage both Aptima's and gOE's prior success in marketing the benefits of SBIR research for application in real world systems (gOE's history of developing and successfully marketing

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commercial products and the details of Aptima's most recent success in obtaining Phase III SBIR funding are discussed in the Section 9).

The proposed commercialization will commence following the project kickoff meeting and continue throughout the entire Phase II period. Within the Army, the most immediate application is for the Intell school, where soldiers must stay current with frequently changing software. For non-DoD government applications, we see the digital skill adaptability training supporting the Department of Education's lifelong learning programs and the Department of Labor's programs designed to improve technology skills among adults. Outside the government, this training could be used in any job environment that requires the use of technology to ensure the ability of workers to keep up with quickly changing systems. Industry is currently facing a severe problem as workers must be retrained after the insertion of technological updates—the digital skill adaptability training could mitigate or alleviate this problem altogether.

8. Plan for TADS

We plan four interrelated tasks to develop the digital skill adaptability training and to collect validation data in Phase II. Figure 18 shows the planned schedule. The major tasks for Year 1 will be the initial validation study of the training program developed in Phase I and the further development of the training program to begin in quarter 2 and to conclude by the end of the year. In Year 2 we will collect performance data to validate the training program in quarters 1 and 2. The final product, at the end of two years, will be 1) a program to train the general digital skills, knowledge, and procedures needed to understand the AFATDS system, and 2) written procedures for how to develop system-specific training for future training in different systems for different jobs. Plans for each of the four tasks, including a description of the technical approach for each task, are discussed in detail below.
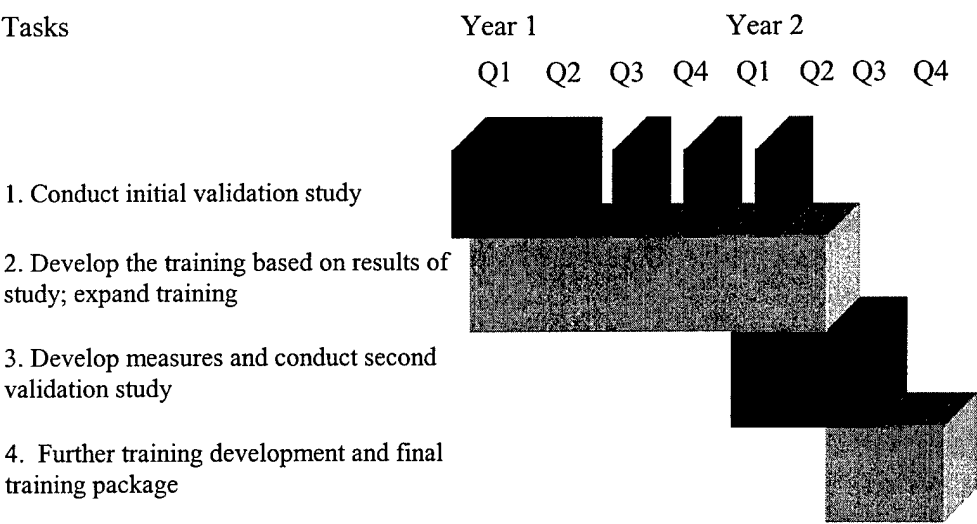
Figure 18. Training Adaptability in Digital Skills Schedule for Phase II

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Phase II Task 1: Conduct initial validation study

This task has three parts: a) Conduct initial usability testing, b) Conduct initial content validation study, and c) Complete specifications for deliverable Digital Skills training system. The first two parts are described in detail in Section 6 of this report ("Design Validation Study"). The third is described below:

> Specification development. In addition to the initial validation studies, Task 1 requires that we complete specifications for the TADS system.
>
> In Phase I, we completed a simple prototype of the TADS system. In order for TADS to be scalable and possess sufficient flexibility, a number of factors additional to those considered for Phase I will be required of the final deliverable. Consequently, a most important step is the full specification of that deliverable.
>
> Some high-level requirements of the final TADS system include: extent and nature of database requirements, extent and nature of administrative capabilities, platform and computer system requirements, and design requirements such as color palette and visual/graphic themes. Note that, like the Phase I prototype, we envision a web-based system that enables both remote hosting and, if required, client or stand-alone platform installation. It is also anticipated that, unlike the Phase I prototype, the final system will be database capable, with administrative capabilities to enable non-HTML proficient users to tailor Skills Bridge information for systems other than AFATDS. That is, we expect to specify and create a product that has general applicability and is easily customized to provide maximum learning regardless of the digital system targeted.
>
> Below we identify in more detail the some of the work that will need to be done to complete the specifications for the Phase II deliverable.
>
> 1.   *Administration.* There should be at least two levels of administrative capability. First, local administrators should be able to log on and determine nature and extent of use of the TADS system. Information available to this administrator level could include user name, length of use, and user path/performance (e.g., number of assessment questions correct). A more complete user profile could be available that would include results of a pretest assessing initial level of digital skills. This kind of local administration capability would provide the ability to track who has completed TADS successfully, who has begun but not completed it, and who has not yet logged on to TADS. This facilitates local training management. In addition, individuals whose performance is problematic can be identified for remediation.
>
>   A second level of administration would be available to those in charge of altering the content of the TADS system itself. This could include modifying the content of the basic digital skills training, and also adapting TADS with a new Skills Bridge for a new transfer environment. The figure below illustrated a mock-up of an administrative screen for adapting Skills Bridge content from AFATDS to a different environment (Radar).
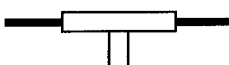
Figure 19: An administrative interface for Skills Bridge adaptation

These kinds of administrative capabilities are crucial in producing a deliverable that has the greatest value to the widest number of possible transfer environments. As explained elsewhere, the Skills Bridge integrates the general digital skills content into a specific application.

2.   *Database and Information Processing Systems*. Because of the desirability for make TADS to be a dyanamic, database-driven system with administrative capabilities, it is necessary to specify the nature of that system. In its simplest term, TADS will be a web-based application. In such a system, the browser sends a request to the internet information server, which processes the request, obtains any information required from the database, and then serves out the final information (in the form of a web-page) to the browser. This is illustrated in the picture below.
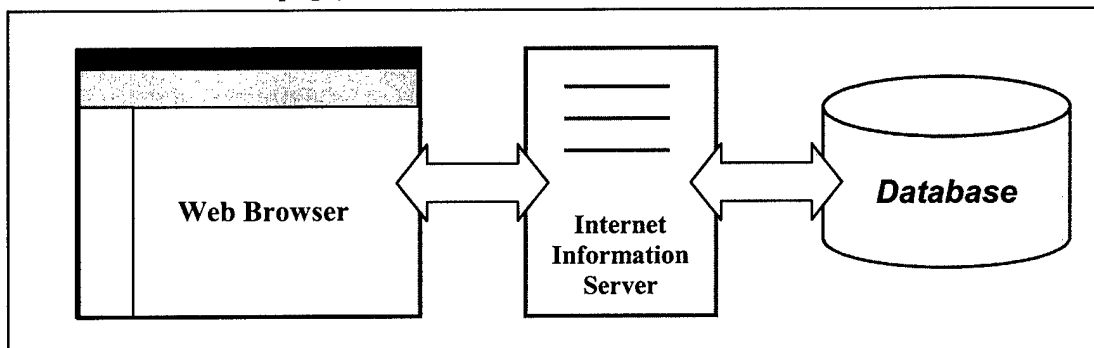
Figure 20: How data is transferred to browser

For example, the administrative capabilities already mentioned are made possible through the access of database-stored information, and operate via special administrative pages (like the one illustrated in Figure 19) that send the appropriate information and requests to the server.

Thus, another critical set of specifications relate to the nature and structure of the system databases. Also required is a final determination of the systems (e.g., Oracle or SQL Server) and languages (e.g., Java or ASP/VBScript) used for developing the active pages of the TADS system.

Task 2. Develop and expand training based on the results of the validation study

Based on the results of the initial validation study, we will develop and expand our training program. This will entail mapping general digital knowledge and skills to the AFATDS tasks; Designing the training for general device knowledge; and Developing the training for general device knowledge.

Map general digital knowledge and skills to AFATDS tasks

We will expand the approach demonstrated in Phase I (i.e., mapping general digital knowledge to setting up computer networks in the AFATDS system) to include additional aspects of AFATDS and additional MOS tasks. The product of this activity will be a mapping of basic digital skills and knowledge to device-specific AFATDS actions and to MOS13D tasks. This mapping, which will be the foundation for Phase II training development, will take place in the following two subtasks.

Subtask 2.1: Continued identification of general knowledge, skills, and human characteristics that underlie both successful adaptation to and learning of digital tasks in general.

Phase I work in identification of knowledge, skills, and human characteristics relating to digital performance will be augmented and extended. In particular, the goal will be to identify and specify two domains: a) **general** digital knowledge and skills, and b) **specific** human characteristics related to success in learning and performing digital tasks.

This first domain, **general** digital knowledge and skills, was partially identified in Phase I work. In essence, the idea of general digital knowledge and skills is simple. There are basic general concepts and skills a) that can be taught, and, b) that once learned can improve further learning on specific tasks that load heavily on digital skills. For example, advance organizers, device knowledge, and schema/prototypes are all related, overlapping descriptions for learning preparation as researched by cognitive and learning psychologists. The literature is replete with references to models of human learning that include components of learning "readiness". This literature will continue to be mined in the early stages of Phase II.

Other general skills that are important to AFATDS in particular will be identified. For example, AFATDS performance requires some understanding of maps and mapping and artillery geometry. These are general skills that, while not critical to the training of many digital skills, are important in this instance. It seems important to identify such other general skills so that they can receive the same instructional design treatment as general digital skills and be included in

training. The identification of such other general skills will then be part of the final delivered process for adapting digital skills training for any particular situation.

Also in the early part of Phase II, the second identified domain will be further specified to assist in completing Phase II goals. This domain is that of **specific** human characteristics related to success in learning and performing digital tasks that can be influenced by training. Most important among these characteristics is what we term "digital efficacy" – a generalized sense of competence that *predicts* learning digital skills. Research has shown repeatedly that confidence in a task relates to performance. Self-efficacy (Bandura 1977, 1984) is a domain-specific, focused belief in the ability to perform a specific task or in a specific arena of activity. Self-efficacy can be critical for good performance – Bandura has even suggested that self-efficacy will "usurp the lion's share of the variance in human conduct" (Bandura, 1984, p. 252). The practical implication is that in digital skills training, it will be important to foster digital skills self-efficacy. Other research has confirmed that self-efficacy has a strong influence on many aspects of individual performance, both in and out of the classroom.

In a field study of USAF aircraft technician ("Mission Ready Technician" or MRT) training, Alliger, Bennett, Eddy, & Tannenbaum (in press) found that task self-efficacy (as reported by the technician) strongly predicted task performance (as reported by the supervisor). These were field measures. Although self-efficacy was somewhat more restricted in range for F-16 MRTs than for C-141 MRTs, the same general relationship between performance and confidence held. This relationship in both cases was a remarkably strong one (r's = .68, .86). Gist (1989) demonstrates that the method of training can be critical to the degree of trainee self-efficacy. There also research that training method is related to self-efficacy in the specific area of digital skills (e.g., Gist, Schwoerer, & Rosen, 1989). Accordingly, the successful inculcation of "digital efficacy" is one critical goal of the proposed digital skills training.

In Phase I we focused our training development on Computer Networks. Other general digital knowledge and skills that are candidates for the full training program include:

- **File Management:** Copying Directories, Copying Files, Creating Directories, Deleting Directories, Deleting Files, Directory Tree, Moving Directories, Moving Files, Renaming Directories, Renaming Files, Root

- **GUI:** Cursor, Desktop, Double-Click, Drag And Drop, Hot Keys/Shortcut Keys, Icons, Multi-Tasking, Point And Click, Right-Click

- **Hardware:** Cd-Rom, Keyboard, Modem, Monitor, Motherboard –CPU, Mouse, Powering Up, Printer, Scanner

- **Memory:** RAM, ROM

- **Software:** Database, E-Mail, Graphics, Other, Spreadsheet, Web Browsers, Word Processing

- **Storage:** Cd-Rom, Floppy, Hard Drive, Sizes (Bits, Bytes, KB And MB), Zip

- **Operating System:** Control/Utility Panels, Find/Search, Help, Menus, Reboot, Recycle Bin, Shutdown, Starting, Managing Tasks, Troubleshooting Tools

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Part of this Phase II subtask will be accomplished through completion of the literature review work started in Phase I. It is also foreseen that interviews with both expert and below-average-performing AFATDS operators will help us understand what digital knowledge, skills, and other characteristics differentiate the experts from the inferior-performing soldiers. In other words, if we can identify what base knowledge is possessed by an individual who succeeds in training (becomes an expert), and if there are clear differences in this regard between experts and those that fail to become good AFATDS performers, then those differences should provide guidance in terms of the skills and knowledge that are important pre-requisites to successful training. This could be called **expert profiling**.

Subtask 1.2: Mapping of Digital Skills and Device Knowledge to AFATDS tasks.

This task requires the general digital skills and device knowledge identified in subtask 1.1 to be mapped to tasks learned in AFATDS training. In a sense, this is a content-validation strategy. Subtask 1.1 completed the identification of general digital skills. Not all of these will apply to any specific training program, including AFATDS. Nor, even in AFATDS, will general digital skills underlie all aspects of performance. Consequently, it will be necessary to understand in detail how general digital skills map onto AFATDS tasks. Figure 21 illustrates the expected outcome.
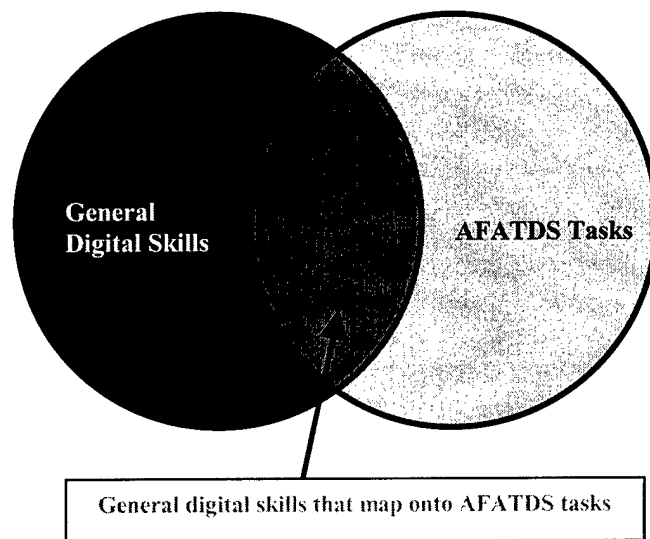
Figure 21: How general skills underlie AFATDS tasks

Therefore, given that many trainees do not have a background in computers or the kind of digital skills that would prepare them to face the potentially intimidating topics included in AFATDS training, we believe, as outlined in the introduction of this proposal, that a preliminary training in digital skills will benefit trainees. However, given the vast area of digital knowledge that could be trained, the question is: how to correctly specify which topics will be most appropriate for AFATDS training?

Like many modern military systems AFATDS is highly computerized. Consider some of the terms and concepts that trainees face in mastering AFATDS (AFATDS Operator's Notebook, 1999):

- 10 Base 2
- 15-pin Receptacle
- 40-pin Port
- AC/DC Power
- Accelerator Keys
- Access Privileges
- Bandwidth
- Boot/Reboot
- Byte
- CD, CD-ROM, CD-Caddy
- Coax, Coaxial
- Database, Database Backup, Database Utilities

- Debugging
- Distributed
- Domain Name Server
- Drive, Drive Access Door
- Hostname
- Initializing
- Internal LAN, External LAN, WAN
- IP Address
- LAN Dust Cover, LAN Terminator, LAN Tee
- Login, Password, Password Confirmation
- Menus, Menu Options
- Optical Disk

- Parallel, Parallel Port
- Router
- SCSI
- String
- Subnet, Subnet masking
- System Administration
- TCP/IP
- Unix, Xterm
- UPS Power Strip
- Workstation, Multi-Workstation

A number of general areas of knowledge can be perceived when the above list is studied. "Knowledge of computer networks, including hardware and configuration" for example, is one; another is "Knowledge of databases." A third is "Knowledge of computer components." We propose a two-step process for the task of understanding how to map these general areas onto AFATDS training: a) SME content-validation, and b) mapping of knowledge and skills to AFATDS domain.

The content validation and mapping will occur as follows. In Phase I, we identified several potential AFATDS instructors who expressed a willingness to participate as subject matter experts to assist in the mapping task described in this section. These individual will be requested, via proper US Army channels, to participate in a content validation exercise, possibly in a facilitated workshop that will be held at Ft. Sill. This SME exercise will accomplish much of the content validation identified in Task 1 B. In addition and as a parallel process, the subject matter experts will assist us in mapping general digital skills onto AFATDS tasks.

Content validation by AFATDS SMEs. Using the domain of digital skills which we have defined in Phase I, we will present the AFATDS SMEs with of a master list of digital skills, and obtain agreement on which of these skills load (and to what degree they load) onto these AFATDS instructional components. In this way, it will be possible to correctly identify and prioritize the general digital knowledge and skills that underlie successful learning of AFATDS skills. This assures content validation of the digital skills training via standard content validation techniques.

Content-Validation Survey/Interview of AFATDS SMEs. A survey-type protocol will be developed that will list all components of AFATDS instruction (e.g., Preparing AFATDS for Operation, Implementing AFATDS Unit Database), and that will request respondents to indicate

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which of a master list of digital skills load (and to what degree they load) onto these AFATDS instructional components. In this way, it will be possible to correctly identify and prioritize the general digital knowledge and skills that underlie successful learning of AFATDS skills. The AFATDS Subject Matter Experts (SMEs) that will be asked to participate in this survey may include both civilian and U.S. Army AFATDS experts, such as instructors and supervisors. Analysis of the survey results will proceed in a straightforward manner: computation of average SME general skill ratings for each instructional component.

Map General Digital Knowledge and Skills to AFATDS Tasks. The data from subtask 1.1 will result in a prioritized list of general digital skills, mapped onto the AFATDS curriculum. For example, something like the following might result:

Table 4: Example of Mapping

AFATDS Training Component	Important Aspects of Digital Skills Training (in order of importance)	Other Important General Knowledge and Skills
Identify and Cable AFATDS Components	General Network Knowledge, Cabling, Cabling Connectors, Distributed Systems	
Prepare AFATDS for Operation	General Network Knowledge, Cabling, Cabling Connectors	
Implement AFATDS Mapping	Displays, Menus	Mapping Knowledge (e.g., Coordinates, Scales)
Implement AFATDS Battlefield Geometry	Displays, Menus	Artillery Geometry
Hardware and Software Communications Configuration	Communications Hardware and Software, Distributed Systems	Communications Protocol
Implement AFATDS Data Distribution	Databases, Distributed Systems, General Network Knowledge	
Database Trouble-shooting	Databases, Digital System Troubleshooting	Troubleshooting

To consider a single example in more detail, the concept of networks is addressed. AFATDS operates as a 10 Base 2 configured Local Area Network (LAN). It operates over coaxial cables with BNC connectors, achieving transmission rates of 10 millions bytes per second. In AFATDS training, users are taught how to set up the hardware for such a network, including cabling and connectors. However, a LAN is a general concept; the current AFATDS is simply one instantiation a LAN, just as a LAN is a particular type of network. Therefore, we can say that the general concept of a computer network "maps" onto AFATDS, as Figure 22 indicates:

Networks
- WANs (wide area networks)
- MANs (metropolitan area networks)
- **LANs** (local area networks)
  - Components (e.g., router, computers/workstations, hub, server)
  - Characteristics (e.g., reliability, throughput, security, access)
  - Protocol (e.g., TCP/IP, SMTP)
  - Operating System (e.g., Unix, Linux, Windows)

AFATDS as particular example of a **LAN**
- Components: Ethernet hub/routers, workstations
- Characteristics: Reliable, very secure, fast
- Protocol: TCP/IP
- Operating System: Unix

Figure 22: How the general concept of networks is instantiated in AFATDS

It is planned to systematize this content-validation survey approach for the final, portable digital skills training process which is envisioned as a central outcome of Phase II.

Design the training for general device knowledge

In an extension of our Phase I effort to understand the training requirements for digital mastery, we will gather more detailed information about how EPS trains soldiers to use AFATDS and what complex skills are being addressed. Specifically, a team of two psychologists will participate in one of the AFATDS training regimens alongside soldiers receiving the instruction for the first time. For two weeks, our team will gather data on the content of the AFATDS instruction, the methods used, and the responses of students to the training. We will focus on questions such as "What units are the most difficult for students?" and "What are some useful exercises we can draw from the material"? and "Are there particular student groups emerging during the training as a result of the demands placed on them? For example, can you tell by the teacher-student interactions or student conversations which students are already skilled and which have no internet experience?" This data will give us invaluable and otherwise inaccessible information about the cognitive skills we need to train and the most relevant, instructive examples to import into our training. The data will heavily influence the development of all three training modules—the device model, procedural model, and Skills Bridge.

It is also during this second task of our SBIR Phase II that we will determine what the overall appearance of the training will be and how the entire training package will flow. These two

aspects of the training may seem trivial, but they are actually integral parts of the training that have a great affect on the overall effectiveness of the program itself. If the flow of the training program is counterintuitive, trainees will get lost in the maze of the training screens, become frustrated, and will gain nothing from the training program. Likewise, if the appearance of the training screens is inappropriate for the intended audience, or if the screens are too cluttered or too sparse (e.g., lack important information), the trainees will not get the full benefits of the training. To ensure the proper development of the training program, we will begin with storyboarding, graduate to detailed flowcharts and paper prototyping, then do actual electronic prototyping before developing the final product.

Storyboarding. This initial phase of web-based training development is similar to brainstorming to generate ideas about how to develop the training. In this stage of the training development, suggestions are made about the design of the training package, these suggestions are discussed, and ideas for the training program are sketched out to prepare for further development.

Flowchart. The flowchart is similar to a road map for the training program that illustrates how the multiple screens will be linked together in the final product. By creating a flowchart before developing the final product, the designer is forced to think of all the many implications of the product design and therefore make best use of the links to maximize training effectiveness. An example of a simplified flowchart developed for the Phase I Network Training program can be found in Figure 23.
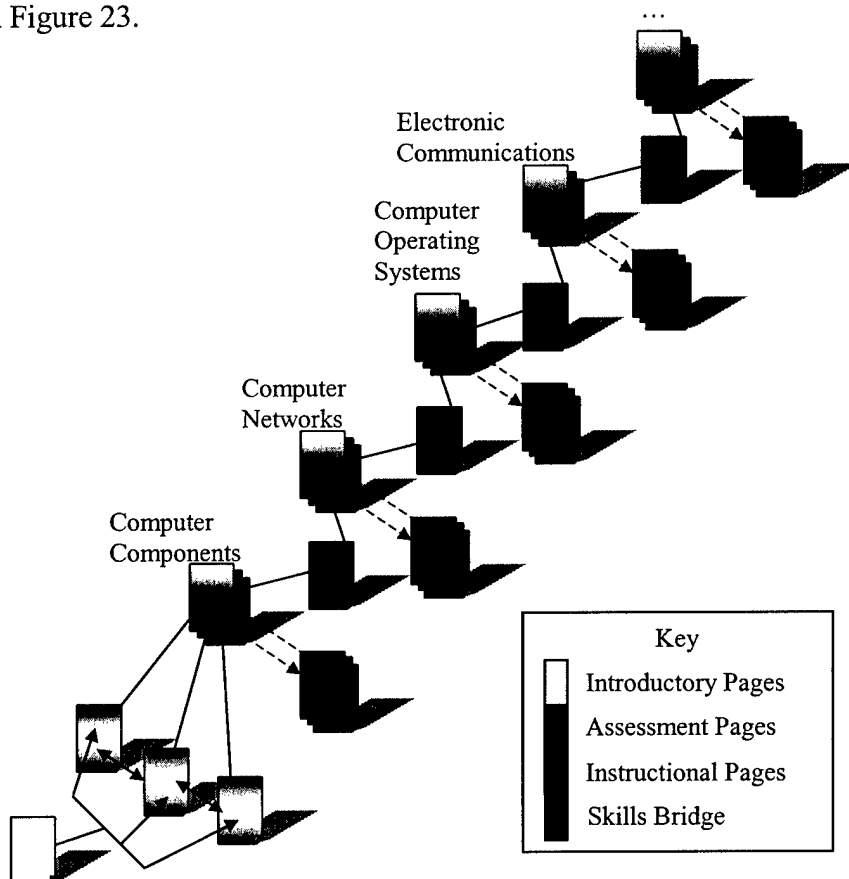
Figure 23: Flow of the TADS Training Program

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Paper Prototyping. As the flowchart is being prepared, paper prototypes of each screen will also be generated so that people can use both the paper prototypes and the flowchart to become familiar with the plan for the training program and make suggestions for improvement.

Electronic Prototyping. Once a satisfactory design has resulted from the paper prototyping stage, an electronic prototype will be assembled to allow people to sit at a computer screen and progress through a sample of links. This stage of the training design will overlap with the actual coding of the training program so advice resulting from people navigating through the electronic prototype can be fed directly into the final product code.

These processes will enable us to get input and advice from training experts, developers, and potential trainees before spending the extensive hours needed to fully develop the training program.

Develop the training for general device knowledge

There are several optional mechanisms for delivering the instruction and the evaluation, any of which we can implement based on the Army's preferences. One method is server-side delivery in the form of a web-based instructional program. The advantage of web-based instruction is the control that trainers have over the content and its accessibility. When instruction is server-side, the developers control which version of instruction is available and can update or de-bug instruction for all students at once without the sometimes difficult-to-get involvement of the students. Another method is for the instruction and evaluation to be client-side in the form of a CD-ROM. The advantages of a CD are that students who do not have access to the internet can still access the instruction on their own PC anytime. Regardless of the manner in which the training is delivered, it will likely be written in HTML (looking something like the screen shots in Section 5 above) so the students can learn at their own pace and with minimal trainer input.

In addition to the self-paced web-based or CD-ROM training, text-based lesson plans for classroom presentations may be useful for the Skills Bridge module and for some testing situations, such as late post-testing after a student has completed comprehensive instruction in a particular system. Lesson plans that instructors can print out and use in their classrooms are useful whenever the instructor needs to have control of the class. This is why the Skills Bridge module may be presented to students as a classroom-based lecture and exercise unit. In this case, a large part of the content is information about a specific system—information that the instructor or training developer controls. In cases where an evaluation is needed to assess the impact of the device and procedural training, a post-test could be developed by the instructor with guidance from the proposed training package.

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Task 3. Conduct second validation study

Once we have fully developed the training program, we will conduct a validation study to determine how effective the program is in increasing a trainees adaptability in digital skills. This validation study is fully detailed in Section 6 of this report ("Design Validation Study").

Task 4. Further training development and final training package

Based on the results of the validation study, we will refine the general digital skills training program and deliver a final package that can be used to train general digital skills for any number of computer systems. It is in this final task that we will make sure the program works smoothly and that no special training or knowledge is needed to operate it.

In addition to the digital skills training program, we propose to provide a manual explaining the procedure used to develop the system specific training. The true benefit of the training program proposed in this SBIR is the way that it uses the general device knowledge and general procedure knowledge to bridge the gap between the job's tasks and the specific actions necessary to perform those tasks. Most of this training involves the general knowledge found in the general digital skills training program, however it also requires specific knowledge to link the general skills with the specific job tasks and behaviors—this part of the training must be developed each time the training is to be implemented in a new job or system. The process for developing this part of the training will remain the same regardless of the specific job tasks or behaviors; so part of our final product will be a well documented process, in the form of an electronic manual, that will walk training developers through the procedures necessary to develop this part of the training program for any job or system.

9. Commercialization of TADS

A growing market: According to Business Week (August 3, 2000), the corporate e-learning market in the U.S. topped $550 million in revenue in the year 2000, and is expected to grow to $11.4 billion by 2003. The technology for a program to develop adaptive digital skills that the Aptima/gOE team is developing under this SBIR project has the potential to tap this quickly expanding market. Although, initially, the content and training strategies will be tailored for ARI's military customers, the sound underlying pedagogical principles, basic technology, and unique construct of the training package make it an ideal candidate for commercialization in several technology/market pairs in the general training market.

A commitment to transition and commercialization: Both Daniel Serfaty, Aptima's principal founder and Chief Scientist, and Scott Tannenbaum, gOE's founder, have a proven record of spinning off and marketing the technological ideas, methods, and products emerging from the R&D activities in both their companies. Daniel Serfaty is personally committed to apply his entrepreneurial skills to lead the project team in pursuing an aggressive commercialization strategy for the Training Adaptability in Digital Skills product. For example, working from a current SBIR Phase II project for AFRL, Aptima has been able to add almost $1.5 M of additional funding ($500K in supplementary funds from the Air Force and other customers interested in supporting the technology, as well as an additional $1,000K in Phase III funding directly from the AWACS program manager's office.) This vision, combining technical excellence with a focused marketing approach, is what has allowed Aptima to grow exponentially over the last four years into a $4M/year human-centered engineering company for

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both commercial and government customers. This market orientation has also enabled gOE to develop into a market leader in training programs for a very wide range of clients. Both founders are taking it upon themselves to collaborate in developing and implementing a strategy for Phase III transition and commercialization.

There are numerous commercialization opportunities in both government and industry for a training program that trains general principles of digital skills. We intend to target the Training Adaptability in Digital Skills tool to both government and commercial customers in both a horizontal and a vertical market expansion.

Horizontal Commercialization: Similar Technology-Wider Markets: First we are focusing on the horizontal marketing of the Training Adaptability in Digital Skills technology. By horizontal market expansion, we mean expansion into different markets that require few changes in the overall technology. Some examples of horizontal expansion are:

- Training Adaptability in Digital Skills for the Army intelligence community. Soldiers in this area must constantly learn to use new versions of digital tools

- Training Adaptability in Digital Skills for TRADOC in the Army XXI and the Objective Force. One of the changes in the Army for the Objective Force is an increase in digital tool use, as well as quicker transitions from one digital tool to the next as upgrades occur more quickly. This necessitates the need for training in adaptability. The Training Adaptability in Digital Skills tool could very easily be used to train soldiers to guarantee that the Army of today will be ready for tomorrow.

- Training Adaptability in Digital Skills for civilian safety personnel (e.g., fire and police officers, disaster relief personnel) to ensure they are prepared for the future. The Military is not the only profession faced with rapid change in the near future as a result of the influx of technology. Civilian jobs such as the job of police officer are experiencing similar changes, and they must be prepared to deal with the changes as they occur. The Training Adaptability in Digital Skills tool could easily be modified to ensure that our civilian safety personnel are prepared for the future.

- Training Adaptability in Digital Skills in other civilian jobs that will be increasingly impacted by technology such as manufacturing and clerical work. Technology is not confined to military and safety personnel, all vocations will be affected by it. The Department of Labor forecasts the skills that will be required over the next 20 years in order to plan its programs for adult education and retraining, and the insertion of new technology into the workplace is a large driver of changing skill demands. The Department of Education is also interested in forecasting the demand for adult education driven by changing jobs. Because the Training Adaptability in Digital Skills tool is a training program that focuses on general principles of technological skills, it could be used to train the employees in manufacturing and clerical jobs to prepare them for the quickly changing future.

Vertical Commercialization: Diversified Technology-Similar Market: We are also exploring possible vertical expansion of the Training Adaptability in Digital Skills technology (i.e., we are looking into ways that we can expand Training Adaptability in Digital Skills by adding different technologies). Some possible vertical expansion opportunities are:

- Expanding from training to selection tests. The Training Adaptability in Digital Skills tool could very easily be modified in such a way that it could be used to select employees who are

adaptable. Companies are realizing that adaptability is a skill crucial to the organization's success. If organizations could select individuals who are able to adapt quickly, they could ensure success in a constantly changing environment.

- Expanding from training to training assessment. The Training Adaptability in Digital Skills tool could also be modified to assess training needs. Individuals could be tested to determine their "adaptability quotient," and training could be recommended for those individuals who score below some acceptable threshold.

In Summary, we see a rapidly expanding market for the Training Adaptability in Digital Skills tool. It fills a gap created by the swiftly increasing technology-based market. It is no longer possible to keep up with technological changes in a reactive way – implementing training after the technology has been introduced. Now the only way to succeed is to prepare pro-actively for technological change before it occurs. Training Adaptability in Digital Skills is a tool that will allow military and civilian organizations to prepare for the future.

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Appendix A:
Results of AFATDS Training Student Survey Administered Week of
10.16.00 at Net Team Training, Fort Sill

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AFATDS Training Student Survey

This survey will allow researchers from Aptima, Inc to gather information needed to develop supplemental AFATDS training – it will NOT be used to evaluate the AFATDS students, trainers, or the training program. Please do not put your name on the survey; all answers will be held in the strictest of confidence and the information will be used only in the development of supplemental training.

Please answer the following questions:

Rank/MOS/DMOS _____

How many months/years of experience do you have with each of the following? (If none, leave blank)

____years _____months with IFSAS   ____years _____months with FDS

____years _____months with TACFIRE   ____years _____months with DMD

____years _____months with BCS   ____years _____months with a Personal
                                            Computer
____years _____months with AFATDS

How much experience have you had with a windows-type computer operating environment (such as Microsoft windows)? (circle appropriate number)

1----------------2----------------3----------------4----------------5----------------6----------------7
None   some   a lot

How much experience have you had with computer networks?

1----------------2----------------3----------------4----------------5----------------6----------------7
None   some   a lot

How much experience have you had with data input and manipulation?

1----------------2----------------3----------------4----------------5----------------6----------------7
None   some   a lot

How much experience have you had with computer games?

1----------------2----------------3----------------4----------------5----------------6----------------7
None   some   a lot

Before the AFATDS training, how comfortable were you with computer systems?

1----------------2----------------3----------------4----------------5----------------6----------------7
Not at all   moderate   very comfortable
(I had very little   (I had an email address   (I had experience
exposure to computers)   and surfed the web)   programming computers)

In your opinion what most helped you learn from the training? (examples: understanding the terminology, understanding Field Artillery)

What do you think might help you learn more from the training? (examples: better understanding of the terminology, better understanding of Field Artillery)

Other comments or questions that could help us develop supplemental training:

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Administered Week of 10.16.00 at Net Team Training, Fort Sill

RANK

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		3	6.4	6.4	6.4
	13P10	1	2.1	2.1	8.5
	E-3	1	2.1	2.1	10.6
	E-4	2	4.3	4.3	14.9
	E-5	1	2.1	2.1	17.0
	E4	5	10.6	10.6	27.7
	PFC	6	12.8	12.8	40.4
	PVT	1	2.1	2.1	42.6
	SFC	1	2.1	2.1	44.7
	SGT	8	17.0	17.0	61.7
	SPC	9	19.1	19.1	80.9
	SSG	8	17.0	17.0	97.9
	SST	1	2.1	2.1	100.0
	Total	47	100.0	100.0	

MOS

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		4	8.5	8.5	8.5
	13	1	2.1	2.1	10.6
	1310	1	2.1	2.1	12.8
	13P	30	63.8	63.8	76.6
	13P10	1	2.1	2.1	78.7
	13P20	2	4.3	4.3	83.0
	13P2P	1	2.1	2.1	85.1
	13P30	2	4.3	4.3	89.4
	13P4H	1	2.1	2.1	91.5
	13PAPA	1	2.1	2.1	93.6
	E5	1	2.1	2.1	95.7
	SPC	2	4.3	4.3	100.0
	Total	47	100.0	100.0	

DMOS

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	35	74.5	74.5	74.5
13P	3	6.4	6.4	80.9
13P10	2	4.3	4.3	85.1
13P20	1	2.1	2.1	87.2
13P30	2	4.3	4.3	91.5
13P40	1	2.1	2.1	93.6
13PAPA	1	2.1	2.1	95.7
30	1	2.1	2.1	97.9
35309	1	2.1	2.1	100.0
Total	47	100.0	100.0	

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Experience on IFSAS (yr.mo format)	10	.10	4.00	1.0900	1.3345
Experience on TACFIRE (yr.mo format)	5	1.00	5.00	3.4000	1.6733
Experience on BCS (yr.mo format)	8	.10	13.00	5.1375	4.6577
Experience on AFATDS (yr.mo format)	11	.10	.60	.1909	.1814
Experience on FDS (yr.mo format)	40	.10	12.00	3.6962	3.1256
Experience on DMD (yr.mo format)	3	.90	2.00	1.3000	.6083
Experience on Personal Computer (yr.mo format)	36	.10	15.00	5.1667	4.0029
Valid N (listwise)	0				

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How much experience have you had with a windows-type computer operating environment (such as Microsoft windows)?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	none	3	6.4	6.5	6.5
	2.00	4	8.5	8.7	15.2
	3.00	2	4.3	4.3	19.6
	some	12	25.5	26.1	45.7
	5.00	9	19.1	19.6	65.2
	6.00	3	6.4	6.5	71.7
	a lot	13	27.7	28.3	100.0
	Total	46	97.9	100.0	
Missing	System	1	2.1		
Total		47	100.0		

How much experience have you had with computer networks?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	none	8	17.0	17.4	17.4
	2.00	6	12.8	13.0	30.4
	3.00	4	8.5	8.7	39.1
	some	12	25.5	26.1	65.2
	5.00	8	17.0	17.4	82.6
	6.00	3	6.4	6.5	89.1
	a lot	5	10.6	10.9	100.0
	Total	46	97.9	100.0	
Missing	System	1	2.1		
Total		47	100.0		

How much experience have you had with data input and manipulation?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	none	6	12.8	13.0	13.0
	2.00	8	17.0	17.4	30.4
	3.00	10	21.3	21.7	52.2
	some	8	17.0	17.4	69.6
	5.00	3	6.4	6.5	76.1
	6.00	4	8.5	8.7	84.8
	a lot	7	14.9	15.2	100.0
	Total	46	97.9	100.0	
Missing	System	1	2.1		
Total		47	100.0		

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How much experience have you had with computer games?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	none	4	8.5	8.7	8.7
	2.00	5	10.6	10.9	19.6
	3.00	1	2.1	2.2	21.7
	some	10	21.3	21.7	43.5
	5.00	11	23.4	23.9	67.4
	6.00	5	10.6	10.9	78.3
	a lot	10	21.3	21.7	100.0
	Total	46	97.9	100.0	
Missing	System	1	2.1		
Total		47	100.0		

Before the AFATDS training, how comfortable were you with computer systems?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not at all (I had very little exposure to computers	3	6.4	6.5	6.5
	2.00	2	4.3	4.3	10.9
	3.00	7	14.9	15.2	26.1
	moderate (I had an email address and surfed the web)	17	36.2	37.0	63.0
	5.00	5	10.6	10.9	73.9
	5.50	1	2.1	2.2	76.1
	6.00	6	12.8	13.0	89.1
	very comfortable (I had experience programming computers)	5	10.6	10.9	100.0
	Total	46	97.9	100.0	
Missing	System	1	2.1		
Total		47	100.0		

Descriptive Statistics: Rating Questions

	N	Minimum	Maximum	Mean	Std. Deviation
How much experience have you had with a windows-type computer operating environment (such as Microsoft windows)?	46	1.00	7.00	4.7609	1.8641
How much experience have you had with computer networks?	46	1.00	7.00	3.7609	1.8995
How much experience have you had with data input and manipulation?	46	1.00	7.00	3.7391	1.9713
How much experience have you had with computer games?	46	1.00	7.00	4.6087	1.8912
Before the AFATDS training, how comfortable were you with computer systems?	46	1.00	7.00	4.2935	1.5937
Valid N (listwise)	46				

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Case Summaries, Comment 1

	In your opinion what most helped you learn from the training? (examples: understanding the terminology, understanding Field Artillery)
1	Having previous experience w/MS Windows & the operating style.
2	I have previous training w/Windows.
3	More detailed computer system classes/understanding
4	Field problems, war fighter exercise.
5	Practical exercise.
6	The hands on PE's.
7	Trying to understand AFATDS how it runs.
8	PE
9	Understanding Field Artillery & training I have had.
10	Terminology
11	Understanding terms, FA working w/FCS & MS Win.
12	Hands on training.
13	The PE's were very helpful in my learning of AFATDS.
14	Hands on.
15	Understanding Field Artillery.
16	Understanding FA.
17	The system itself.
18	
19	Understanding FA.
20	Photographic memory.
21	PE
22	The PE's .
23	How confusing AFATDS is/don't think I learned anything new, just more windows.
24	Neither, understanding how to use a PC.
25	Being familiar with FA and having computer experience.
26	Hands on.
27	In depth of mission planning and strategies.
28	Understanding Field Artillery.
29	Hands on during class.
30	I understand that there is a lot more to it than what I thought.
31	I've been it the Field Artillery for over 2 years (experience of Fire Direction).
32	
33	Already having experience in fire direction.
34	Hands-on exercises.
35	The hands-on experience.
36	The exercises the class had to complete.
37	Understanding basic computers and understanding Field Artillery.
38	Training exercises, hands on training.
39	The terminology and the window setups.
40	Practical exercises.
41	Understanding Field Artillery, computer skills.
42	Understanding how this s/w applies to F.A.
43	Doing the P.E.
44	
45	Hands on training.
46	All in doing. I now have a better understanding of my job as 13P.
47	Hands on working w/the system.

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Case Summaries, Comment 2

	What do you think might help you learn more from the training? (examples: better understanding of the terminology, better understanding of Field Artillery)
1	Slower training
2	Need a looser environment.
3	More about computer terminology, structure, terms.
4	More class time (i.e.) simulate FA mission processing.
5	Better understanding of terminology & F.A.
6	Going more detail on communications.
7	How every window operates.
8	Information with more PE.
9	Making the PE questions easier to understand.
10	Terminology
11	None
12	
13	Some of the classes were really boring. I don't think there is any solution.
14	Hands on.
15	Same as above.
16	Understanding FA.
17	Strippers, or some entertainment.
18	
19	Experience/on the job training/ fielding.
20	No suggestions.
21	Specialized training for where we work at.
22	Better visual aids.
23	I think it might help if they showed us just our MOS areas.
24	Better understanding of cannon. We are MLRS, lost many of us.
25	More interesting classes.
26	Time & experience/hands on.
27	Better understanding of Field Artillery.
28	It has a good set up.
29	Better understanding of the system.
30	
31	
32	
33	Maybe a smaller group to work with.
34	More hand-on work.
35	Nothing.
36	If each individual had their own computer.
37	More hand-on experience.
38	Getting more specified training on equipment dealing with my specific job and position.
39	Less window option.
40	Better understanding of how all of the different jobs in the Army work together.
41	Better understanding of Field Artillery.
42	Better understanding/more friendlier s/w with better prompts to continue.
43	
44	
45	More hands on training.
46	Windows that automatically go to next or corresponding windows.
47	Extend training on certain things and explain why it works and happens.

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Case Summaries, Comment 3

	Other comments or questions that could help us develop supplemental training
1	
2	
3	
4	More comfortable working environments; air conditioner/seats that don't hurt your !!
5	
6	
7	
8	
9	
10	More P. E. time.
11	
12	
13	N/E
14	Ask me at the end of the course.
15	
16	AFATDS has too many windows, unnecessary windows.
17	
18	
19	
20	None.
21	Can you make the questions more clearly stated next time.
22	
23	
24	Need class geared towards MLRS, do not care about the cannon piece. Sometimes it seems people get cocky about the system, know it alls, thank you, 1st time these SM's have seen this equipment.
25	Why do the teachers teach primarily toward cannon artillery when the students are all MLRS? We will never use most of the fields that are being reviewed.
26	Train only in specific areas of concern.
27	
28	
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38	
39	
40	
41	
42	Should be a separate window showing "required entries" for each type of mission or action. Required entries should be color coded.
43	
44	
45	
46	
47	Before leaving classroom, do a complete set up as it is in the field and simulate an exercise so we can completely understand the program and how it works on our level and not a made up unit that we are not.

Training Adaptability in Digital Skills