APPLICATION OF SITUATED COGNITION STRATEGIES IN A MAINTENANCE TRAINING CURRICULUM

Donna Carroll
JIL Information Systems, Inc. Training Services Division
Orlando, FL

ABSTRACT

The gap between learning something in the classroom and applying it in the real-world may well be a byproduct of the Navy training system. Current methods of schoolhouse instruction decontextualize learning by treating it as independent from the situation in which it will be used. Instruction has become classroom tasks, not authentic activities. Proponents of situated cognition argue that knowledge remains inert and unused if taught in contexts that separate knowing from doing (Driscoll 2000; Whitehead, 1932). Investigations of traditional learning are challenging the separation of what is learned from how it is used (Brown, Collins, & Duguid 1989b) and are instead proposing that instruction situated in the context in which it will be used produces more usable and transferable knowledge.

This paper presents a proposal on how to incorporate situated cognition instructional strategies into the E2C maintenance training community. It discusses incorporating authentic context that reflects the way knowledge will be used in real life; inserting authentic activities into the training environment to provide multiple opportunities for practice; providing access to expert performance and the modeling of processes; furnishing the opportunity to experience multiple roles and perspectives; facilitating collaborative construction of knowledge; inserting opportunities for reflection, enabling abstractions to be formed; articulation activities to enable tacit knowledge to be made explicit; furnishing strategies for the instructor to provide coaching, scaffolding, and fading of support at critical times; and, integrating assessment within learning tasks.

AUTHOR'S BIOGRAPHY

Donna Carroll is a Program Manager for JIL Information Systems, Inc. s Training Services Division in Orlando, FL. She has over seven years experience supporting courseware development initiatives and is currently managing development of Interactive Multimedia Instruction for the E2C and C2A maintenance training communities. She received her Bachelor of Science Degree in Education from George Mason University and is currently completing course requirements to achieve her Masters in Instructional Technology.

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INTRODUCTION

How do people learn? What is knowledge and how does the mind acquire it? The theory of constructivism professes that reality is constructed by the knower, the mind actively constructs this knowledge, and that knowledge is made up of our ideas and representations about reality (Driscoll, 2000). Behaviorists and cognitivists believe the world is real, external to the learner, and the goal of instruction is to map the structure of the world onto the learner (Jonassen, 1991b). Constructivists affirm the existence of the real world but contend that what we know of the world stems from how we interpret our experiences (Ertmer & Newby, 1993).

The theory of constructivism has grown due to a revolt among educators who are questioning the current emphasis on teaching using techniques such as rote memorization that is then repeated verbatim on a test or providing step-by-step procedures in order to solve a finite set of problems. Constructivists argue this type of schoolhouse instruction decontextualizes learning by treating it as independent from the situation in which it will be used. Thus, instruction becomes classroom tasks, not authentic activities and when this knowledge changes from learning to application, students can fail to transfer it from one context to another.

Constructivism is not a new approach to learning because it can trace its roots to the work of Jerome Bruner, John Dewey, Jean Piaget, and Lev Vygotsky. In constructivism, the focus on learning shifts from the instructor and moves to the learner because it is the learner who must ultimately construct their own meaning. Students build on prior knowledge by associating new information with what they already know to construct new meaning when what they are learning cognitively challenges previously held beliefs.

There are two major factions within the constructivist movement — cognitive constructivists and social constructivists. Cognitive constructivism is based on the work of Jean Piaget who proposed that humans cannot be given information that they immediately understand and use. Instead, they must construct their own knowledge through experience enabling them to create schemas that are subsequently changed, enlarged, and made more sophisticated through assimilation and accommodation (Chen 2002).

Social constructivism can be found in the works of Jerome Bruner and Lev Vygotsky. Bruner proposed that learning is an active, social process where students construct new ideas or concepts based on current knowledge. The student selects information, originates hypotheses, and makes decisions in the process of integrating experiences into their existing mental constructs. Vygotsky emphasized social interaction played a fundamental role in the development of cognition. He believed everything was learned on two levels. First, through interaction with others and second through integration into the persons mental structure. A more experienced partner (whether peer or teacher) is able to provide assistance (scaffolding) of the subject matter to support the student's evolving understanding. Another aspect of Vygotsky's theory is the idea that the potential for cognitive development is limited to a zone of proximal development. This "zone" is the area of exploration for which the student is cognitively prepared, but requires help and social interaction to fully develop.

WHAT, THEN, IS A CONSTRUCTIVIST LEARNING ENVIRONMENT?

A learning environment is a place where people can draw upon resources to make sense out of things and formulate meaningful solutions to problems. Adding the word constructivist before learning environment is a way of emphasizing the importance of meaningful, authentic activities that help the learner construct understandings and develop skills relevant to solving problems (Wilson, 1996). Therefore, learners within a constructivist environment would encounter strategies that address the following:

- Learning is an active process in which the learner constructs his own meaning. Students must not passively accept what is being communicated by the teacher but must, instead, become an active participant in the instructional process.

- Learning is also a social process. Learning is intimately connected to our involvement with other human beings where meaning is socially negotiated according to the terms of the culture in which we live.

- Learning is contextual. We do not learn isolated facts in abstraction, we learn in relation to what we know and what we believe.

THE NATURE OF SITUATED COGNITION

The theory of situated cognition is a subtheory that can be found within the constructivist continuum. The theory claims that every human thought is adapted to the environment, that is, *situated,* because what people *perceive,* how they *conceive of their activity,* and what they *physically do* develop together (Clancey, 1997, italics in original). A major goal of this approach is to create environments that permit sustained exploration by students to enable them to understand the kinds of problems and opportunities that experts encounter and the knowledge they use as tools (Cognition and Technology Group at Vanderbilt 1990).

The theory is also recognized under several other names (e.g., authentic learning, cognitive apprenticeship, cognitive flexibility, and situated learning); however, all forms share the same principles: learning and doing are inseparable and learning is a process of enculturation.

The situated cognition model is based on the following five tenets of constructivism:

1. The idea that knowledge results from complex social interaction is key to situated cognition. Brown et al. (1989b) referred to this as a process of enculturation and applied it not only to how craft apprentices learned their trade but also to how students learn. From childhood to adult, individuals continually adopt the behaviors and practices of the social groups with which they interact (Hendricks 2001). This interaction results in remarkably complex behavior that, some people believe, occurs only when individuals are allowed to observe members of a culture and practice relevant behaviors in situ (Brown, et al 1989b).

2. Learning occurs through sustained participation within a community (Brown et al., 1989b; Collins, Brown, & Newman, 1989; Lave, 1988, 1990; Lave & Wenger, 1991; Prawat & Floden, 1994). The learner interacts with the expert by working alongside them and learns to solve problems in the same way through guided experience.

3. Learning viewed as a situated activity has, as its central defining characteristic, a process called legitimate peripheral participation in a community of practice (Lave & Wenger 1991). To be more precise, by participating within a community of practice new members (newcomers) interact with older members (old timers) and artifacts (e.g., language, books, drawings, etc.) generated by the community and continuously engage in the socio-cultural process until they transition into old timers themselves. These practices are identified as the property of the community and their meaning is either sustained or further negotiated by participants over time. Wenger (1998) defined member s participation over time using the concept of learning trajectories. Depending on the actual involvement within the community, practitioners are either peripheral, inbound, insider, boundary, or outbound participants. There is also no fixed membership within the community. As long as membership changes (e.g., newcomers integrate into the community, engage in activities, and perpetuate its practice) the community is recognized as continuing. The distinction between historical cases of apprenticeship and a theory of situated cognition was strengthened as a more comprehensive view of different approaches to situatedness were developed (Lave & Wenger 1991).

4. The concept of problem-solving within a situated cognition environment is also known as anchored instruction. Students are able to immerse themselves within a setting that provides meaningful contexts and has been realistically simulated. These practice experiences are highly relevant, authentic to the user, and anchored in a familiar situation (Brown, et al 1989b).

5. Authentic assessment or assessment in-situ is another key tenet of this model. Proponents of situated cognition argue that assessment of the learner should be embedded within the learning experience and not conducted as a separate activity to validate student learning. The focus

is on acquiring problem-solving capabilities within authentic activities that can be transferred and applied to real-world situations.

SITUATED COGNITION DESIGN

Context and Parameters of the Situated Cognition Environment

General Knowledge Domain. The general knowledge domain focuses on maintaining aircraft systems onboard the E2C. The E2C is an all-weather, carrier-based, tactical Airborne Early Warning system and control platform designed to provide early warning, threat analysis, and control of counteraction against air and surface targets. There are three distinct versions of the E2C aircraft.° Each version is identified by its installed radar system.° Omnibus II aircraft have the AN/APS-138 radar installed.° Omnibus II Update Development Program (UDP) Group 1 has the AN/APS-139 radar installed and reached Initial Operating Capabilities (IOC) in December 1988 with delivery of aircraft A-125.° Omnibus II UDP Group 2* aircraft have the AN/APS-145 radar installed and reached IOC in April 1992 with delivery of aircraft A-145.

Engineering change proposals (ECPs) to the E2C provided increased capabilities in the areas of passive detection, fuel quantity accuracy, ultra high frequency (UHF) communications, cockpit lighting, advanced radar processing,°navigation systems, and the standard automatic flight control system (SAFCS). Additionally, installation of the T56-A-427 engine reduced fuel consumption, increased range, improved single-engine climb characteristics, and prolonged on-station time.

The newest configuration of the E2C is the Hawkeye 2000*, introduced in FY02.° ECP 418 will update the E2C to the new Hawkeye 2000 configuration. This will be accomplished during production line assembly and also via retrofit to Omnibus II UDP Group 2 aircraft.° ECP 418 incorporates the following changes: upgrades to satellite communications and the vapor cycle system, incorporation of a new mission computer and the advanced control indicator set (MCU/ACIS), and inclusion of a new cooperative engagement capability.

*° *It is important to note that E2C technicians must be prepared to maintain Group 2, NAV Upgrade, and/or Hawkeye 2000 configurations of the aircraft during deployment. The NAV Upgrade configuration updated UDP Group 2 aircraft by incorporating changes to the communications systems. The purpose was to test the capabilities of the new mission computer prior to incorporating the ACIS system into the Hawkeye 2000 configuration.*

Context of the Learning Environment. The gap between learning something in the classroom and applying it in the real-world may well be a byproduct of the Navy training system. As stated in the Executive Review of Navy Training (ERNT) the majority of core training processes, techniques, and procedures are more than 30 years old (Gunn 2001). These techniques are grounded in the objectivist approach to instruction that relies on rote memorization to teach declarative knowledge and is then repeated verbatim on a test. The ERNT also stated historical evidence indicated that if the training system did not send adequately trained sailors to the fleet, they would not catch up during actual warfighting (Gunn 2001). In a shipboard environment, aircraft maintenance technicians are required to make split second judgments on the air-worthiness of aircraft; therefore, the current training environment must be amended to include opportunities for the technician to think and perform like troubleshooters would in a real environment and build skills that will assist them deal with and respond to complex, troubleshooting events.

Target Audience. The target audience is comprised of Navy E2C aircraft maintenance technicians, rank E5 and above having a minimum of two years experience on the aircraft in one of the following rates: Avionics Technicians (ATs) responsible for avionics systems (e.g., radar, communication systems, computer and combat information group, and associated flight instruments); Aviation Electricians (AEs) responsible for electrical and instrumentation, navigation, and lighting systems; Aircraft Mechanics (AMs) responsible for hydraulic, flight control, and landing gear systems and aircraft structures; Aircraft Mechanic, Environmental (AMEs) responsible for environmental equipment (e.g., oxygen, heating and air conditioning, and pressurization systems), and Aircraft Mechanics (ADs) responsible for propulsion, fuel, and propeller systems. Enlisted pay grades for these personnel range from E1 through E9. E1 and E2 is equivalent to an entry-level technician, E3 and E4 would be considered apprentices, E5 and E6 have achieved journeyman level, and E7, E8, and E9 would be considered experts. Pay grades E8 and E9 duties and responsibilities are primarily involved with upper-level management decisions and the oversight of aircraft maintenance.

Work experience on the aircraft can range from two to ten or more years. Technicians may have many years experience maintaining either the E2C or other aircraft platforms but will be new to the Hawkeye 2000 configuration.

All technicians will have at least a high school education and are expected to read at the tenth grade level. Most have been through A school where they learned basic information appropriate to their track (for example, an AT would receive training in basic electronics) and may have attended C school where they would receive advanced training in their track (for example, they would learn more specific information about radar and communication systems).

Initial and career training is provided by Maintenance Training Unit (MTU) 1025, Naval Air Maintenance Training Group, Detachment (NAMTRAGRUDET) Pt. Mugu, CA and MTU 1026 NAMTRAGRUDET Norfolk, VA. Initial training is intended for pay grades E4 and below (for example, an AT would learn basic information about the radar — location and operation) with career training provided for pay grades E5 and above to enhance skills and knowledge within their specialty.

The average age of the technician is 23 years; however, this can vary from 21 to 45 years. Technicians are generally in good health and are evaluated according to military standards of physical fitness. Learners are highly motivated by training because new systems are constantly being fielded on this aircraft. Because this training is relevant to their job, it is anticipated that students will wish to become active participants in the learning process.

Learners will come from a variety of racial and ethnic backgrounds because selection by the military services is based on numerous factors. A basic tenet of the military is cooperation; therefore, strong relationships will have been built among peers. In addition, the new at war status of the military due to the events of September 11th have fostered an urgency among maintenance technicians to do everything possible to keep the planes in the air.

Learning Objectives

A learning objective is a statement that tells what learners should be able to do when they have completed a segment of instruction (Smith & Ragan, 1999). The types of learning objectives targeted by this design include domain-specific problem solving and cognitive objectives. Domain-specific problem solving objectives require the learner to assess the problem, determine which rule(s) to apply, and synthesize them to achieve a solution. Cognitive objectives require the learner to assess the learning task, select (or invent) an appropriate strategy, apply the strategy, assess its success, and modify it if unsuccessful. Strategies to achieve these objectives can be found in the design document along with their associated learning activity. Following is a list of objectives facilitated by this design:

- Increased knowledge of aircraft system theory of operation through identification of problems, analysis of cause and effect relationships, and prioritization of solutions.
- Development of domain-specific problem-solving skills to ensure learners are more able to respond to previously unencountered problems.
- The fostering of higher-level thinking skills, especially reflection, flexible thinking, and creativity.
- Experience with multiple perspectives facilitated by collaboration with other maintenance technicians (both within and out of their rate) to troubleshoot aircraft systems.
- Cognizance of the interrelationships between E2C aircraft systems.
- Transfer of troubleshooting knowledge and skills to real-world experiences.

Design Document

The primary purpose of this design is to accelerate development of E2C troubleshooting skills. Skill acceleration is a pressing need in the E2C community because troubleshooting experience takes years to develop.

A cognitive task analysis will be used to decompose novice, intermediate, and master technician s knowledge and skill bases. By contrasting their performance on problems of varying complexity, it will be possible to determine the relative learning difficulty of system components, functional areas, troubleshooting procedures, and strategic actions (Gott, Lesgold & Kane, 1996). These findings will help determine the point of delivery of more complex troubleshooting scenarios within the curriculum and the criterion performance levels to be met at each stage of the learning trajectory.

The acquisition of complex skills will occur incrementally as students work on a series of authentic scenarios that gradually become more complex. Because these scenarios simulate experiences that could be encountered in their actual work environment, the process of successive approximation will support achievement of learning objectives.

Basis for using scenarios

Anchoring instruction in realistic situations enhances the meaningfulness of the content (Wilson, 1996). Anchored instruction occurs within a realistic context that is both appealing and meaningful to students (Bransford, Sherwood, Hasselbring, Kinzer & Williams 1990). This guideline is based on the apprenticeship learning model proposed by Brown, Collins, and Duguid where students learn by doing because they work on realistic tasks. This does not mean that anchoring instruction in realistic situations requires 100% fidelity; however, complexity and detail is necessary to make learning activities meaningful.

Design Strategies and Activities

The following situated cognition strategies and associated learning activities have been chosen to cultivate technicians that think and perform as they would in the real world. The general principle of embedding authentic context that reflects the way knowledge will be used in real life forms the basis of this design.

Situated Cognition Strategy: Provide authentic context that reflects the way knowledge will be used in real life.

Learning Activity: To the degree possible, scenarios will situate learning within the environment in which it will ultimately be used. The design will preserve the complexity of a real-life setting and make no attempt to fragment or simplify the environment. All scenarios will have real-world relevance and will be structured to provide a single, complex task to be investigated by students. Content will come from subject matter experts making them valid, complete, and precise. Scenarios will encourage students to define tasks and sub-tasks needed to complete the activity with activities integrated across rates.

Situated Cognition Strategy: Provide multiple opportunities for practice.

Learning Activity: Multiple opportunities for practice will be facilitated by providing a series of scenarios that gradually increase the relative learning difficulty of E2C system components and functional areas, troubleshooting procedures, and strategic actions over a period of time. Embedded within the scenarios will be relevant versus irrelevant information and tasks inherent to multiple rates. Multiple modes of representation will also be provided within the learning environment to ensure student understanding of facts, concepts, procedures, and principles is rich and multi-faceted. Available media will include: maintenance instruction manuals, NATOPS manuals, schematics, wiring diagrams, interactive courseware, Custom Lesson Builder files, and access to trainers.

Situated Cognition Strategy: Provide access to expert performance and the modeling of processes.

Learning Activity: Opportunities to make use of expert thinking and modeling of processes will be provided by the instructor who will act as a mentor by reviewing the technician s work and providing feedback. Feedback will consist of a critique of the quality of the response, alternative ways of thinking about questions, and suggestions on where the student might find additional information to address maintenance tasks embedded in the scenarios.

Situated Cognition Strategy: Support collaborative construction of knowledge.

Learning Activity: The requirement to use collaboration to resolve problems posed within the scenarios will be extensive. In every learning activity, students will work with other technicians (both rate-specific and across rates) to accomplish tasks/sub-tasks and come up with a solution.

Situated Cognition Strategy: Promote articulation to enable tacit knowledge to be made explicit.

Learning Activity: This strategy will be manifested within the learning environment by setting up collaborative groups, making the problem complex enough to ensure articulation, not building cues into scenarios, and holding in-class debriefings.

Situated Cognition Strategy: Provide coaching, scaffolding, and fading of support at critical times during the investigation.

Learning Activity: The collaborative learning environment will pair more able with less able partners (e.g., an E5 with an E6) to facilitate scaffolding and coaching. The instructor will also act as an observer while students carry out tasks, intervene to provide scaffolding for learning to progress, but will otherwise fade into the background.

Situated Cognition Strategy: Provide for integrated assessment of learning within tasks.

Learning Activity: Students will be required to prepare a formal written response to the scenario and provide a public presentation of findings to the class during scheduled debriefs. Other class members will be encouraged to ask questions during debrief so presenters can defend their findings. Assessment of learning will be based on indicators within the written report and in-class presentation. Opportunities for peer-to-peer and within-group peer assessment will also be provided.

PROTOTYPE

As stated in the ERNT, sailors reported that their most positive learning experiences in the Navy were attributable to relevant content. In addition, the majority of sailors indicated they would improve Navy training by adding opportunities for practice (Gunn 2001).

Integrating situated cognition strategies into the curriculum will facilitate additional hands-on practice using relevant, real-world content. These activities will be particularly motivating because each scenario is representative of the types of problems students could be expected to face aboard ship or in the work center. Students will be investigating processes and procedures related to their specialty with embedded opportunities to practice troubleshooting skills.

Role of the Instructor

For the instructor, the challenge of implementing a situated cognition environment becomes one of integrating methodologies into the curriculum that support cooperative activities to reflect the complex interaction between what maintenance technicians already know and what they are expected to learn. Instructors are cautioned that meaning can only be established *by* and not *for* the learner (Harley, 1993).

While students are solving scenarios, the instructor s role changes from sage on the stage to guide on the side. They will now be expected to act as mentors by reviewing the technician s work and providing feedback. Feedback will consist of a critique of the quality of the response, alternative ways of thinking about questions, and suggestions on where the student might find additional information to address maintenance tasks embedded in the scenarios. When students are resolving scenarios, instructors are directed to make every attempt to pair a more able with a less able partner (e.g., an E5 with limited time on the platform with an E6 with several years experience on the platform) to assist with scaffolding and coaching.

When students are working in collaborative groups, instructors will assess how the group is functioning overall and focus on whether there are problems that he might help resolve without providing direct answers to questions. Instructors will evaluate scenario responses based on a pre-determined rubric.

During in-class debrief, the instructor will encourage class members to ask questions so presenters can defend their findings. Assessment of learning will be based on indicators within written reports and during in-class presentations. Following each debrief, the instructor will provide peer-to-peer and within-group peer assessment forms for the students to provide input to the evaluation.

Role of the Student

As situated learners in the classroom, students will create, either tacitly or implicitly, a personalized sense of situation that guides their determination of what is meaningful and how it is understood and incorporated into what is already known (Harley, 1991). New knowledge will come from a continuous process that builds upon existing structures. Situated cognition activities will be timed to follow specific units of instruction and will provide opportunities for students to build on what they have learned by solving a series of scenarios that gradually increase in difficulty over time. Scenarios will focus on E2C system components, functional areas, and troubleshooting procedures with collaborative groups tasked to resolve each scenario, justifying all decisions and conclusions reached. The learning of new materials is therefore facilitated by using existing knowledge as a foundation on which to build new cognitive structures.

Each scenario will provide embedded data along with a list of resources available to resolve it. The instructor will be available to review work in progress and provide suggestions on where to find additional information to address maintenance tasks posed in the scenarios. The instructor s role is that of a resource ONLY. He is not expected to instruct or dictate information. Students are totally responsible for resolving each scenario.

They are expected to:

- Collaborate with other maintenance technicians (both within and out of their rate) to troubleshoot aircraft systems.
- Identify problems and negotiate, within their group, a path to follow to resolve them.
- Analyze cause and effect relationships.
- Prioritize solutions.

- Prepare a formal written response to the scenario.
- Provide a public presentation of findings to the class during an in-class debrief.

When all scenarios presented during classroom instruction have been resolved, it is anticipated students will:

- Possess an increased knowledge of aircraft system theory of operation.
- Have experienced multiple perspectives because they will have collaborated with other maintenance technicians to troubleshoot aircraft systems.
- Display an increased understanding of the interrelationships between E2C aircraft systems.
- Be able to transfer this troubleshooting knowledge to real-world experiences.

Sample Scenario

The E2C has taxied out to cat #1, technicians have already turned on avionics systems prior to aircrew arrival, all systems were on and operating normally. The aircrew started the engines and where going through the pre-launch checklist when the radar operator noticed the radar had dropped off-line. He tried to re-start the radar but it would not come back up. At that point, he called troubleshooters to the aircraft to look into the problem.

Troubleshooters discovered that the prop de-ice switch had been bumped to the on position and, even though it was placed back in the off position, the radar would still not come back on-line. The vapor cycle system appeared to be functioning normally; however, the radar operator told one troubleshooter that he had turned it off, then back on, because an over temperature condition was recorded on the fault panel. That meant all avionics systems shutdown and had to be restarted.

A troubleshooter inside the aircraft turned the radar off, then back on. Just a few seconds later, sparks where seen on the starboard side of the aircraft by another troubleshooter on the deck of the carrier, who then notified the troubleshooter inside the aircraft of this event. The radar operator also noticed a B interlock condition during the time-out sequence.

With this information you must first decide if the aircraft should be downed, what was the cause of the sparks, and what caused the radar to shutdown.

Resources

A large number of resources are currently available to facilitate sustained examination from a variety of perspectives. These resources will add richness to the learning environment because they can be reviewed when questions come to mind and will provide the opportunity to detect relevant versus irrelevant information. The Custom Lesson Builder (CLB) tool will be particularly helpful as students will be able to build animations that graphically depict flow sequences and allow them to visualize responses to troubleshooting scenarios.

CLB was created for use by E2C maintenance instructors in conjunction with development of interactive multimedia instructional (IMI) materials. It is an embedded tool that allows instructors to create custom scripts that can be saved, edited, and replayed to demonstrate an infinite number of flow sequences or troubleshooting scenarios. The use of this tool can be further expanded by allowing access to students to resolve scenarios developed for this situated cognition design.

The interface is divided into two general areas of use: Create/Edit mode and Show Lesson mode. As indicated by the name, students will enter the Create/Edit mode to assemble new or alter existing scripts. The Show Lesson mode refers to the condition where the user can actually play the script.

A CLB script is the result of an interactive process initiated by selecting a control point to build a graphical response to the troubleshooting scenario. (See Figure 1 for an example of a CLB script with control points activated.)

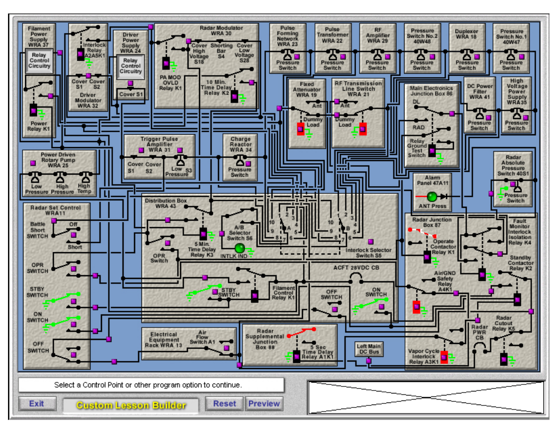

Figure 1. Sample CLB graphic with control points activated.

Students select control points to animate graphics. For example, if the associated signal flow for a line is an animated flow, students can send the signal to the right or left, up or down, back or forth. If the graphical element associated with a signal flow line is a still image (e.g., electrical signals or relay switches), an on button will display. If the initial setting for the relay, switch, or line is normally depicted as off or de-energized, selecting the control point associated with the line causes the circuit breaker, switch, or electrical flow to display as closed or energized respectively. (See Figure 2 for an example of a CLB graphic with signal flows activated.)

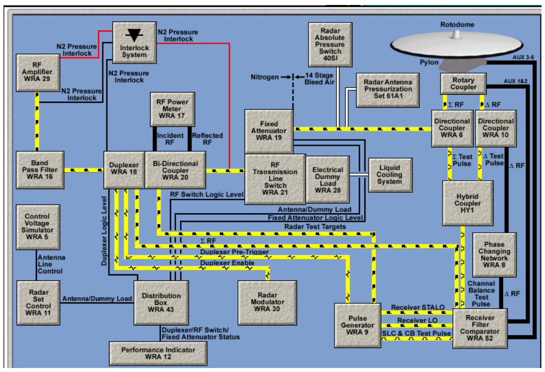

Figure 2. Sample CLB graphic with signal flows activated.

The CLB tool will support the learning environment by scaffolding responses to scenarios. Because the tool enables students to graphically depict sequences (i.e., how the system would look in a normal operational mode or what they believe might be the problem), they are then able to trace possible trouble spots within the system or hypothesize on the correct solution. Visual images created by CLB will also build embedded schema that support cognizance of the interrelationships between E2C aircraft systems, foster increased knowledge of aircraft system theory of operation, and enable analysis of cause and effect relationships.

Additional resources available for this learning environment include:

Maintenance instruction manuals. There are three types of Maintenance Instruction Manuals - Theory Manuals, Troubleshooting Manuals, and Removal and Replacement Manuals. Theory manuals provide information on how a selected system operates in a normal condition. Troubleshooting manuals provide the technicians with step-by-step procedures to isolate a specific fault within the system. Removal and replacement manuals provide step-by-step instructions on how to remove and replace specific components.

NATOPS manuals. The Naval Air Training and Operating Procedures Standardization (NATOPS) Manual is primarily used by aircrew; however, information contained in these manual provides additional system and component information and pre-start, pre-launch, and emergency procedures as seen from an operator s perspective.

Schematics and wiring diagrams. These resources provide specific information regarding wiring of systems to include relays, switches, and within-component tracing of wires to aid with troubleshooting.

Interactive courseware (ICW). Hundreds of ICW lessons have been developed for the E2C maintenance training community. The courseware was developed for organizational (O) level maintenance technicians and addresses location of system components as well as providing description and function (what the system does) and operational (how the system works) information.

Trainers located at NAMTRAGRUDET, Norfolk and NAMTRAGRUDET, Pt. Mugu are also available and offer potential for use in this design. Trainers are full-scale mockups of E-2C aircraft systems. They are used to train Navy personnel in initial and career maintenance skills and techniques by facilitating hands-on experience with actual systems and components.

CONCLUSION

This paper proposes that real world, problem-solving skills can be trained by incorporating situated cognition strategies into the E2C maintenance training curriculum. The goal was to present situated cognition as a detailed instructional model. Features of this environment stress the learner as actively engaged in tasks authentic to the community. The focus is on learners as constructors of their own knowledge in a context similar to one in which they would be expected to apply that knowledge. Students are expected to think at a critical level.

The design format is feasible but would require changes to the structure of the current learning environment. From an implementation standpoint, several events must occur before these strategies could be incorporated. These include review of or performance of a cognitive task analysis of novice, intermediate, and master technician s knowledge and skill bases, development of troubleshooting scenarios, conduct of field trials including evaluation, and restructuring of the training curriculum. Also, repurposing of existing resources is necessary but will minimalize implementation costs while increasing the richness of the learning environment.

This situated cognition environment can be expanded for use throughout the entire Navy maintenance training community. While this design focuses on the E2C maintenance training community, any Navy maintenance training community could implement it into their curriculum. Problem scenarios can easily be tailored for specific aircraft, ship, or tracked vehicles, CLB graphics can be developed, and ICW can be produced or repurposed. Scenarios could also be ported to a web environment accessed via the Navy/Marine Corps Intranet (NMCI) and used to satisfy on-the-job (OJT) training requirements by technicians aboard ship or in the work center.

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