UNIQUE STRATEGIES FOR DEVELOPING EMBEDDED INTERACTIVE COURSEWARE (ICW)

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ABSTRACT

Historical data has shown that effective and efficient simulator training depends largely on how students prepare for learning on the simulator. Typical preparation for simulator training consists of classroom and stand-alone computer-based training (CBT), which focus on individual objectives for learning facts, concepts, principles, or procedures. During simulator training, students are expected to develop the mental models and metaskills that will enable them to transfer their skills to new situations.

Because traditional pre-simulator training tasks are learned individually, students often have difficulty integrating multiple objectives in order to develop proficiency in complex tasks. Embedded interactive courseware (ICW) can improve the efficiency and effectiveness of the simulator by providing learning activities which specifically address (1) understanding the "big picture," (2) deriving meaning from visual and auditory cues, (3) understanding the three-dimensional environment, and (4) practicing procedures in which cues and responses are simplified but essentially the same as those in the simulator. Using a multidisciplinary team of instructional designers, software engineers, and subject matter experts to design simulator modes, capabilities, and feedback mechanisms to support the goals of skill building and transfer is the best approach to designing a simulator which integrates embedded ICW.

This paper describes the application of the new paradigm of instructional development to the analysis and design of embedded ICW and the unique strategies for developing embedded ICW as part of the total simulation training system. Recommendations for evaluation strategies are given, and considerations for future research areas are presented.

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INTRODUCTION

Integration of new technology such as embedded interactive courseware (ICW) within a total training system has the potential of improving overall instructional effectiveness and cost-efficiency (Bills, 1994). Design of total training systems requires a new paradigm of the Instructional System Development (ISD) model, one which is integrated with Systems Engineering, and which focuses on the overall goals of training and the integration of multiple objectives to achieve those goals. Embedded training, which was formerly applied only to development of training devices, should be developed in accordance with this new paradigm.

AF Handbook 36-2235, Volume 7, states that the ultimate value of aircrew training devices (ATD) depends on the extent to which skills learned during that training will transfer to the aircraft and that the three factors which affect this transfer are cue development, cue and response discrimination, and generalization. The designer of embedded ICW should focus on the goal of providing activities to foster the students' establishing meanings which transfer positively to the actual system such as the aircraft (Bills, 1994). Determining what should be incorporated into a simulator as embedded ICW requires an analysis of all of the training requirements. The instructional designer must look at the total training system to determine the mix of stand-alone instruction, embedded ICW, and simulator exercises which will provide the best opportunity for the student to learn the required skills. Embedded ICW is especially capable of training those skills in which the student uses visual and aural cue information to make decisions and perform procedures.

The question could be asked, Why embed ICW in the simulator? Could the same requirements be met by providing stand-alone level III ICW? There are a number of reasons to embed ICW in the simulator. Re-use of the hardware and software configuration developed for the simulator allows a cost saving both during development and during maintenance. Most simulator operating systems allow incorporation of animated 3-D graphics and speech recognition systems that would not be available on standard personal computers. Embedded ICW can re-use the actual software for displays from the simulator database, and incorporate that software into scenario-based ICW lessons. For procedural tasks, performance on the simulator allows the student to experience the "look and feel" of the simulator and the actual equipment. The ICW performance lessons will have the same functional fidelity as the simulator.

This paper describes the application of a new paradigm of instructional development to the analysis and design of embedded ICW and the unique strategies for developing ICW as part of the total training system. Recommendations for evaluation strategies are provided, and consideration for future research areas are presented.

Examples will be drawn from an AWACS Modeling and Simulation (AMS) Training System which is currently being developed for the U.S. Air Force. This total training system will enhance initial skills of AWACS weapons directors (WD) to perform a job which requires the integration of many knowledges and skills and which is performed in a fast-changing and stressful environment.

APPLICATION OF THE NEW PARADIGM OF ISD

While retaining the steps of the ISD process, there are differences in application in the analysis, design, and development of embedded ICW. Each phase as it applies to the new paradigm is described below.

Analysis

Conducting an analysis of a training system which includes advanced technology, such as simulators and embedded training, requires the combined skills of instructional designers, system engineers, and subject matter experts. First, design goals and requirements are specified. From these goals the baseline requirements of the training system are developed. The team must analyze the target audience, content domain, media required for ICW, and hardware/software requirements.

Target Audience. Analysis of the target audience for the new AMS indicated that the students will have a variety of backgrounds. Some will have no AWACS experience of any kind. Others will have had AWACS experience as weapons technicians, a job which requires observation, but not the conrolling responsibilities of the WD. WD trainees will increasingly be enlisted personnel, although no specific analysis of the effects of this shift on the basic curriculum was made.

Content. The starting point for the content analysis is a thorough understanding of the knowledge and skills the WD must have to do his job effectively. The WD must be able to derive situational awareness from visual and auditory cues; perform AWACS console procedures; understand the tactics and capabilities of weapons systems; conceptualize and plan intercepts based on an understanding of the geometry; and communicate required information in a precise format that reduces the mental processing required of the person receiving the information, usually the fighter pilot. The Air Force subject matter experts (SMEs) described in detail the knowledge and skills which most students have difficulty understanding and applying during simulator exercises. Sometimes students "get by" in early exercises, but when scenarios become more complex, their failure to integrate basic skills and knowledge becomes apparent. One of the reasons students fail in more complex exercises is that during those exercises, it is difficult for the instructor to isolate specific problems, provide immediate feedback, and provide adequate remediation and practice. Therefore, it was determined that training materials should be developed that would overcome this problem by addressing the skills which need practice and remediation.

Media. Analysis of the situation indicated that training should continue to be provided through classroom instruction because instructors provide information in the form of real-life stories that are beneficial to new WD students. Classroom lectures should be augmented by self-study materials, and lab periods in which students perform simulated and live exercises on the AMS. Students will spend two hours in the classroom and six hours in the lab. This may change as a result of the new training system but until evaluations are conducted, the mix of classroom and lab will remain at 2:6. The student:instructor ratio is expected to remain at 2:1. One instructor will observe two students while they perform in simulator exercises.

As a result of the content and media analyses it was determined that embedded ICW should be used to: (1) present concepts which require dynamic 2D and 3D graphics to enhance understanding and help students form appropriate mental models; (2) provide opportunities to practice communication skills; (3) provide specific training in attaching meaning to visual and auditory cues; and (4) provide in-depth training in the geometry required to bring aircraft together. Tutorials were designed to develop understanding of concepts which are necessary for the performance of all tasks. An example of this tacit learning is understanding how speed and angle of bank affect an aircraft's turn radius. Exercises were required to provide part-task practice of particular skills, e.g., communication skills, to a point of comfortable mechanization as preparation for simulator exercises in which several activities are performed at once.

In addition, students needed practice in the procedural skills of console operation. Embedded ICW was considered and rejected in favor of a programmed text with practice exercises performed on the simulator. The rationale was based on the cost of development vs. instructional return on investment and the fact that students could do no harm to the equipment during practice; that there are many different techniques and procedures to achieve the desired outcome; and the student:instructor ratio (2:1) which can provide adequate coaching and feedback if the student experiences difficulties.

Analysis revealed that students also needed an advanced organizer for each of the three major sections of the curriculum (cutoffs, sterns, and air refueling) to provide a context of meaning for new information to be learned. The advanced organizer will orient the student to the subject matter, relate the subject matter to any existing knowledge the student may already have, and help the student anticipate the performance requirements of the job. Because one of the most dependable methods for establishing the proper attitude is by means of a set of learning conditions that include human modeling, it was determined to develop the advanced organizer on motion video using experienced WDs and mission commanders. Digitized video in an embedded ICW format was considered and rejected for two reasons. First, it would take up valuable simulator time which would be better spent in performance of simulator exercises, and second, presentation of this material during class time would allow for instructor-facilitated discussion.

Hardware/Software. With the system requirements of the total training system identified, the next step is an analysis to determine the hardware and software to be used for the simulator and the embedded ICW. In the AMS, a robust speech recognition system was required that would be speaker-independent and capable of recognizing relatively continuous speech of up to 30 words. The Hark Speech Recognition package was selected. The hardware and software selected for the AMS were required to be capable of providing real-time 2D graphic representations of the AWACS displays, as well as 3D representations of the external environment. Silicon Graphics hardware was selected along with the following hardware for the simulator and the embedded ICW: C++, an object-oriented software language; X-windows/Motif windowing package; Iris Performer, Silicon Graphic's high-performance graphics system; Open GL graphics package; and Multigen, a graphics model software tool.

AMS Training System Components

The AMS Training System components and the contribution of each component to the total training solution are described below.

Simulated AWACS WD Stations. These are the primary student stations and emulate the console displays and provide full functionality for all controls and communication functions identified as relevant for training. The student stations are used for live and simulated exercises, and for embedded ICW. In stand-alone simulation exercises, speech recognition is used to maneuver the assigned fighters in response to the student's transmissions. Pilot responses are generated from prerecorded audio files. All unassigned aircraft (strangers, targets, etc.) follow "canned" tracks. Integrated simulation exercises consist of a single student directing one or more aircraft that are controlled by a single operator at a pseudo-pilot station. In combined simulation exercises, up to 24 students can control in the same airspace in which simulated aircraft may be flown by a simulator on the DIS network, controlled at a pseudo-pilot station, or follow canned aircraft tracks.

Pseudo-Pilot Stations. These stations are used during simulation exercises to control the flight of simulated aircraft. The pseudo-pilot "flies" the aircraft using a hand controller or by setting autopilot parameters. The pseudo-pilot stations provide a HUD display, the pilot's radar display, the AWACS WD radar display, and a variable range scale map. Students can take the role of pseudo-pilot, which allows them to correlate the symbology available to the pilot and to the WD, helping them to form shared mental models with the pilots. "Flying" the aircraft helps the students to understand the capabilities and limitations of the aircraft they are controlling. The pseudo-pilot stations help the student to identify with the pilot. They can begin to understand how it feels not to get information they need, to get more information than they need, or to get incorrect information.

Display and Debrief System. The display and debrief system saves exercise data for later replay and evaluation. During debriefing sessions, the students can see and hear the whole scenario as it was played out. On one screen, the student sees the AWACS WD display; on the other screen, the student views the 3D air situation. The student hears all audio available to the WD during the mission. It is expected that instructors will select especially relevant scenarios for class replay and discussion.

Embedded Interactive Courseware (ICW). The embedded ICW will be provided on the student stations. The embedded ICW uses the 3D modeling capabilities of the simulator system to teach concepts that are difficult for the student to visualize from printed media or classroom lecture. The embedded ICW utilizes the AWACS symbology and communication system to provide opportunities for learning the meaning of visual and auditory cues. The embedded ICW also uses the speech recognition capabilities of the system to provide opportunities to practice key communication skills.

Additional Training Materials. In addition to the embedded ICW, analysis indicated the requirement to revise course control documents and paper-based curriculum materials as well as to develop additional training materials. New materials include a programmed text, which is used in conjunction with the student station, to provide procedural practice using the AWACS console controls, and video tapes to provide pre-briefings intelligence information. The following table shows the hierarchy of requirements and how the AMS will achieve the requirements at all levels.

The analysis resulted in a Training System Basis Analysis Report (TSBAR) which included the learning hierarchy matrix shown as Figure 1. The learning hierarchy matrix illustrates the learning that takes place from simple to complex and the components of the AMS which will be developed to achieve those requirements.

Hierarchy of Requirements		Live Radar Feed From ARSR-4	Display and Debriefing System	ICW For Prebriefing and Intel Updates	DIS With Data Feeds From WTTs	Air Environment Generator	Pseudo-Pilot Workstations	Embedded ICW	Speech Recognition	Printed Student Texts	Classroom Instruction
Complex	Live Tactical Intercepts	x	x	x		x					
↑	Live 1v1 Stern Bumpheads	x	x	x		x					
↑	Live 1v1 Cutoff Bumpheads	x	x	x		x					
↑	Simulated Large Force Employment		x	x	x	x	x				
↑	Simulated Tactical Intercepts		x	x	x	x	x				**x**
↑	Simulated Air Refueling		x	x	x	x	x				**x**
↑	Simulated 1v1 Stern Profiles		x	x		x	x	x			**x**
↑	Simulated 1v1 Cutoff Profiles		x	x		x	x	x			**x**
↑	Simulated 1v1 Stern Attacks		x	x		x		x			**x**
↑	Simulated 1v1 Cutoff Attacks; Emergencies		x	x		x		x			**x**
↑	Communication Skills							x	x		
↑	Equipment Familiarization							x		x	
Simple	Knowledge/Theories/Concepts/Academics							x		x	x

Achievement of Requirements

x Goal is to reduce time in class room.

Figure 1. Learning Hierarchy

Design of Embedded ICW

One design goal for the embedded ICW should be to improve the efficiency and effectiveness of the simulator by providing activities that will help students prepare for the exercises performed on the simulator. The other design goal, perhaps more important, is to provide activities that will facilitate transfer of skills from the trainer to the work environment. Embedded ICW should provide activities which focus on learning the meaning of physical stimuli (cue development), developing the ability to derive information from the cues so that the correct responses can be made, and developing the ability to generalize cues and responses to different situations. Embedded ICW should focus on providing meaningful context for learning and providing activities in which the student will respond to visual and auditory cues that are as close to the real equipment as necessary to provide adequate cue information. Moreover, activities in embedded ICW should require the student's performance to be as close as possible to the performance required on the job. At the same time, activities should be structured to provide immediate and specific feedback. This type of feedback may not be available in a simulator where the feedback is, as it should be, the realistic result of performance and may occur many steps after the student has actually gone astray. Embedded ICW can provide feedback that informs the student of the appropriateness or lack of appropriateness of interpretations of cues and responses to those cues

It is important during design to work closely with the subject matter expert to determine common student errors. Embedded ICW can also provide guidance in a way which would be artificial in the scenarios used during simulation exercises. Guidance speeds learning because it can identify desirable cues and responses that the student may be unable to recognize without help. Identifying correct cues and responses early in the learning process reduces the possibility of forming incorrect thought processes and behaviors. It is difficult even for experienced instructors to catch all of these wrong ideas and behaviors during a simulation exercise, where the student is likely to be judged on the overall outcome rather than the specific behaviors. The embedded ICW should be designed to provide just-in-time training. To overcome the effect of prolonged practice under restricted conditions, which can lead to rigid, nonadaptive performance, embedded ICW exercises should be immediately followed by exercises of increasing difficulty on the simulator. When new cues and skills are to be taught, additional skills can be taught in the embedded ICW and then the new skills practiced in the simulator.

In the AMS, tutorials and exercises were developed to provide learning on learning, that is, activities which would develop a foundation for the learning that would occur in simulator activities. Tutorials, which incorporated animated 2D and 3D graphics were designed to increase student understanding of basic concepts. Exercises were designed in which the students can practice verbal communication skills, allowing them to perform this critical task in isolation to achieve proficiency, and in which students can learn and apply geometry to develop attack solutions with feedback at each step of the process. The student interface for the ICW was designed to present instruction and practice at the moment of need. On each training day, a Training Day Menu presents the tutorials and/or exercises the student is required to perform prior to performing the simulator exercises for that training day. Unlike conventional stand-alone ICW, the students' ability to apply the knowledge is immediately tested in the simulator exercises.

The instructional strategies and content areas were documented in an ICW Instructional Design Strategy report which was submitted to the Air Force for approval. When the Instructional Design Strategy was approved, storyboards were developed for the tutorials and exercises. Storyboards contained enough detail for careful review by the client as well as providing a guide for the developers.

The following paragraphs describe the embedded ICW designed for the AMS training system and the ways in which they help to prepare the student for performance in the simulator exercises.

Tutorials to Increase Student Understanding of Basic Concepts. During analysis of the learning objectives for the course, it was determined that there were dynamic concepts that were particularly difficult for students to understand and for which understanding could be improved with the addition of 2D and 3D graphical presentations. The AF SME, instructional designers, and system engineers reviewed all of the objectives to determine which concepts should be presented as embedded ICW. Five embedded ICW tutorials were selected for development. *Aircraft Forces* uses animated 3D aircraft to show the relationship between wind, speed, angle of bank, and turn radius. *Barometric Pressure and Altimetry* uses 3D aircraft moving through space to show the dangerous situations that can arise when altimeters are not set to local barometric pressure when required. *Radar Fundamental* uses 2D graphics to show how the radar systems work and how the fundamental capabilities and limitations of radar affect the WD's radar display. *Communications Systems* uses 2D graphics to show the capabilities and limitations of the AWACS voice communication systems. *FAA Airspace* shows a 3D representation aircraft moving through controlled airspace and the related R/T and control procedures. These tutorials are not meant to replace the student texts, rather they are meant to augment texts. Testing is provided in the Practice Exercises found in the texts.

Communication Exercises. It is hard to over-emphasize the importance of communication skills. Exercises were developed which would allow students to practice as often as necessary and receive feedback which specifically addresses communication skills. Two types of exercises were developed to help the student become proficient in communication skills: *Words of the Day* and *R/T Rehearsal.*

Words of the Day Exercises

There are approximately 300 "words of the day," so called because during each of the first 30 days of training, the student memorizes the definitions of 8-10 of the unique vocabulary words of the language of control. The Words of the Day exercises contain questions which require the student to apply the definitions and at the same time practice aural and oral communication skills. During analysis, it became clear that there were two different types of words and the performance objectives for each are different.

For words more likely to be heard by the WD in a radio transmission (R/T), the performance objective is to derive situation awareness from the transmission. For these words, a question type was designed in which the students hear R/T. They must decide who is speaking and what situation is being described from the audio cue. To respond, the student selects one of four possible situations which appear on the screen. For example, a pilot is heard saying, "Eagle 2 out south." The student must be able to determine that the speaker is the wingman and that he is leaving the engagement.

Directions: Select the response that most closely describes the situation:

A. Lead is making an informative call that the wingman is pursuing the southern target.
B. Lead is making an informative call that the wingman is leaving the airspace.
C. Wingman is making an informative call that he is turning away from the engagement.
D. Wingman is making an informative call that he has lost situational awareness and is heading south.

An added advantage of presenting the audio cue is that the pilot models correct R/T syntax and speech conventions which are shared with the WD community. An example of a speech convention is the way numbers are spoken. Heading is stated as single digits, e.g., "three three zero," while bearing is "thirty-five."

For words more likely to be spoken by the WD, the performance objective is to use the words, syntax, and format correctly to convey meaning to the hearer. For words of this type, a question type was designed in which the student speaks an entire R/T communication, inserting the correct word of the day. He is guided by the appearance on the screen of both the R/T (with the word of the day missing) and a hint. In early Words of the Day exercises, when the student has less experience speaking R/T, the hints are more like "English translations." In later Words of the Day exercises, when the student has more experience with R/T, the hints become more cryptic. A sample is shown below. (The correct word is "ID".)

> Directions: Transmit the R/T. Key the microphone before speaking.
>
> R/T: "Eagle 1, ____ left 240, angels 24, stern."
>
> HINT: Direct fighter to identify a target.

Speech recognition is used to determine if the student's response is correct. If the student answers incorrectly, he hears the sentence spoken by an experienced WD as part of the feedback. The student can listen to the transmission and respeak the R/T as often as desired. The skill being practiced is exactly the same skill the student will use later during simulator exercises and in performance of the job. Like any language, retaining vocabulary is a matter of practice. To encourage the student to continue practice, a vocabulary game is available during the last half of the course. The system advertises the "top gun" scorer to foster competition among students.

R/T Rehearsal Exercises

The student gains further experience in verbal communication skills as well as experience deriving meaning from visual and auditory cues in the six R/T Rehearsal exercises. These exercises are designed to prepare the student to communicate effectively in each major type of simulator exercise: 1v1 cutoff, 1v1 cutoff with fade and evade, stern conversions, sterns, aerial refueling, and 1v1 in confined airspace. The R/T Rehearsal exercises are designed as scenarios in which the WD responds to visual and auditory cues and must respond with the correct R/T. The scenario approach provides the student with an opportunity to experience "communication cadence," which is the flow of communications in which the responsibility for initiating communication flows back and forth between the WD and the pilot. Although similar to a simulator exercise, the task isolates the communication skills and provides immediate feedback on each communication. An example of one scenario interaction is shown below.

> Before the student speaks, he sees the correct target and fighter symbology and other information available at this stage of the scenario. He hears the pilot say, "Fox 2." Then when the bandit symbology drops, "Jazz 21, kill, single, foxbat."
>
> If the student is in guided mode, he will see this hint: "Acknowledge splash, give post-attach instructions. Vector to 250, Altitude 15,000 feet, airspeed mach .53."
>
> The student is required to say, "Copy kill, vector 250, angels 15, mach .53."
>
> After a correct answer, the student will hear the pilot's comeback, "Jazz 21, vector 250, angels 15, mach .53."

Even when the student knows what he wants to say, saying it using just the right words, syntax, and conventions can be difficult. Several tools were designed to help the student to practice communication skills. He can play a recording of the R/T spoken by an experienced WD; he can listen to his own most recent transmission; and he can re-transmit. He can stay with one transaction before continuing on with the scenario as long as he desires.

The student can perform the exercise in either guided or unguided mode. The difference is that in guided mode, a text hint is provided. In unguided mode, the student relies entirely on the visual and auditory cues. If he is having difficulty, he can toggle to guided mode.

Geometry Tutorials and Exercises. It is important that the students understand intercept (cutoff) and stern geometry and understand how the geometry translates to performance of aircraft in a four-dimensional environment. Students must be able to apply their knowledge to devise an attack solution and communicate necessary information to the pilot. Tutorials and exercises were developed which explain the concepts and provide the student an opportunity to practice providing the necessary information. For intercept geometry, a tutorial was developed which uses animated 2D and 3D graphics to explain the geometry of cutoff. The student can manipulate variables to show the circumstances in which a cutoff is possible. Exercises use the AWACS symbology to show the positions of the fighter and target in a scenario approach. The student applies his understanding of the geometry to answer the following questions: What heading should the pilot be on? Is the target's aspect hot or cold? Should the pilot turn right or left to get on the right heading most efficiently? These are the questions the WD must ask himself (and answer) to provide effective control.

A Stern Overview Tutorial was designed which uses 2D and 3D graphics to explain the stern conversion concepts and to outline the steps of the procedure the student will be using to perform the three different types of sterns. It should be mentioned that this procedural approach is specific to the training environment, considered a necessary artifice to aid in learning sterns. Three additional tutorials are provided, one each for the 180 HCA stern, 160-120 HCA stern, and 120-090 HCA stern. These three tutorials use the AWACS symbology to take the student through the procedures. Exercises for the different types of sterns also use AWACS symbology and the student answers questions similar to those he must ask himself when performing a stern: What is the bearing? What heading should the fighter be on? Is a heading correction required? Is the fighter hot or cold? What is the correct direction of turn to get the fighter to the right heading as efficiently as possible?

Development

Once the storyboards are approved, the development of the embedded ICW can begin. The software used for the embedded ICW is the same as that used to develop the simulator. For the AWACS WD embedded ICW, the following languages and tools were used: C++ object oriented software language; X-windows/Motif windowing package; Iris Performer, which is a Silicon Graphics high-performance graphics system based on open GL; Multigen, which is a graphics model software tool; Hark speech recognition package; and Iris digital media library, which is a digital audio software package.

Two phases of development are planned. In the first phase, the following are being completed: (1) the graphical user interface (GUI), (2) the computer management component, (3) the conceptual and geometry tutorials which require animated 2D and 3D graphics and the Words of the Day exercises. Audio narration for the lessons to be completed in the first phase was recorded and digitized.

The second phase of ICW development will occur after the student station and pseudo-pilot stations are completed. The tutorials and exercises of the second phase include geometry tutorials and exercises and the R/T Rehearsal exercises. The graphics for these tutorials and displays, as well as the audio narration, will be geneerated during scenario exercises.

Implementation

Embedded ICW must be considered part of the total training system. Instructors must be taught where the embedded ICW fits into the curriculum. They must be taught how it works. They should be included during design and development.

There are two things that can be done to make implementation easier. One is to modify the training control documents to identify where particular embedded ICW tutorials and exercises are used, as well as what simulator exercises precede or follow the other forms of instruction including the embedded ICW. Another way is to use the simulator to manage the instructional components and keep track of what the students have completed and what they need to do on any given training day. For the AMS, all activities are organized into training days. Therefore, the GUI for the embedded ICW uses the same paradigm, with a menu for each training day which provides as options each of the activities the student must complete on that day before participating in the simulator exercises for that day.

Evaluation

Embedded ICW must be evaluated as part of the total training system. It must be looked at from several different perspectives. Does the embedded ICW result in increased performance and decreased time required in classroom activities? At the same time, although the tests may be more subjective, does embedded ICW provide more tacit understanding leading to improved performance on the simulator, especially later in the training process when understanding of underlying concepts becomes more important as students are required to respond to more complex scenarios. Does embedded ICW activities, which addresses specific part-task skills, such as communications, give the students enough confidence to allow them to focus on decision making and other more complex tasks earlier in the simulation exercises?

Integration of ICW with Simulator Performance

WD initial training lasts approximately 60 days. For the first 30 days, the student receives a combination of ICW and stand-alone simulation exercises, of increasing complexity. In the last 30 days, the students spend almost all of their time in simulation exercises. An outstanding feature of embedded ICW is that it provides a smooth transition for the student from learning concepts and theories, applying these quickly in suitable embedded ICW or simulation exercises, and receiving immediate feedback on their performance. Because most of the learning takes place on the simulator, which replicates the actual system, the students will become “mission-ready” in much less time than previously when training was conducted in the classsroom, on stand-alone ICW, and eventually on the simulator and the actual aircraft. A second reason learning is enhanced with embedded ICW is that the 3D graphics medium ensures that students are forming appropriate mental models. Many students find it difficult to formulate a correct image of what is happening from a two-dimensional graphic or from a written or verbal description.

SUMMARY

If the ultimate value of ATD training depends on the extent to which skills learning during that training will transfer to the aircraft, the ultimate value of embedded training is based on its ability to enhance transfer and perhaps to reduce the total training time required. Transfer of training studies should be planned to compare operators trained using embedded training against those trained in the same tasks without embedded training. Performance should be monitored for each group in the simulator, and later in the actual aircraft. Embedded training has the potential for improving overall training effectiveness and efficiency. Embedded ICW should be an integral part of the total training system, which produces “near-mission-ready” performers.

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