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**TRYOUT OF AN ORGANIZING STRATEGY FOR
LESSON DESIGN: MAINTENANCE
PROCEDURE WITH CHECKLIST**

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13. ABSTRACT (Maximum 200 words) <p>Guided Approach, Instructional Design Advisor (GAIDA) is a computer-based module of instruction on how to design instruction. The example investigated in this study was designing a lesson on conducting a functional check of the electrical circuits of the gun in the F-16 aircraft, using a checklist. The designer module is aimed at Air Force personnel who are well acquainted with the equipment, but inexperienced in designing instruction. A formative evaluation study was performed in the one-on-one mode, with six students who taught gun maintenance procedures in the Armament Specialist course.</p> <p>These students had no difficulties in comprehending instructional design processes, or in using them to devise a storyboard for a computer-based lesson on the functional check of the gun. While potential improvements such as pictorial additions were noted, student- judged the lessons to be satisfactory and potentially effective. The GAIDA approach to teaching instructional design using a narrowly focused model appears to be feasible and capable.</p>				
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PREFACE

This paper reports the results of work done as a portion of the project on the Advanced Instructional Design Advisor (AIDA). Support derived in part from a Senior Associateship awarded by the National Research Council to Dr Robert M. Gagné with a starting date of 2-4-91. The work received wholehearted support of Dr Scott Newcomb, Instructional Design Branch Chief, as well as other personnel of the Technical Training Research Division, Human Resources Directorate. It was facilitated by the patient guidance of Chief Scientist William C. Howell as Research Advisor. Grateful acknowledgement is also made of the substantial assistance of Mr Brian Dallman and personnel of the Technology Branch, 3400 Technical Training Wing, Lowry Air Force Base.

Tryout of an Organizing Strategy for Lesson Design: Maintenance
Procedure with Checklist

SUMMARY

Guided Approach, Instructional Design Advisor (GAIDA) represents an approach to delivery of instruction embodied in a computer-based lesson on how to design instruction. The particular example employed in this lesson was the task of conducting a functional check of the M61A1 gun in the F-16 aircraft. This procedure employs a checklist to test the several different voltages in the electrical circuits that activate the gun. The purpose of the present study was to seek evidence of the comprehensibility and workability of these directions for designing instruction in a number of Air Force personnel who were representative of potential users. These are typically airmen of intermediate rank who are well acquainted with the aircraft and its equipment, but are novices in instructional design methods.

A formative evaluation study of the lesson involving the functional check of the M61A1 gun was conducted one-on-one with six men who were instructors in the Armament Specialist course at Lowry Air Force Base. They knew the equipment well, but were inexperienced in instructional design. During each individual session, the student designer was given a brief introduction to the GAIDA display and the purpose of the computer-based lesson. He was then directed to go through the lesson on the functional check procedure, recording in a step-by step fashion the instruction he would propose to give to an Armament Specialist trainee. A record of this newly designed instruction was written in a series of lined-paper pages in a notebook. Notes were added to indicate graphics of appropriate equipment components, so that the whole became a plan for a storyboard of a computer-based lesson. In addition, a tape recorder was employed to record the designer's questions, comments, and reflections on the task he was doing.

Students experienced no difficulties in comprehending the instructions, and no difficulties in using them to design a lesson on the functional check of the M61A1 gun. Students considered the resulting lessons to be satisfactory for the instruction of trainees in the Armament Specialist field. Possible improvements by the addition of high quality visuals were noted.

It appears that this type of narrowly focused instruction, following the model for the particular task to be taught, is capable of mediating the production of reasonably good instruction. The resulting lesson design is produced with a small expenditure of time and effort. The question of transfer of learning from such an exercise to design for other varieties of task remains for future investigation.

INTRODUCTION

As described in Air Force Regulation 50-8, the design and development of instruction follows a five-step model detailed in AFM 50-2, Instructional System Development. Details of the procedure are described in AFP 50-58, Handbook for Designers of Instructional Systems. Responsibility for training design in maintenance specialties is typically given to airmen of non-commissioned rank who have job-related experience with the equipment on which training is to be given. Instructional designers of this variety receive a small amount of professional training, although they may have considerable experience in on-the-job maintenance and as instructors.

As indicated in a recent report entitled "Revision of the Air Force Instructional System Development Process--Baseline Analysis Report" (Golas & Shriver, 1991), many instructional developers find the model described in these publications complex, inflexible, and difficult to apply to a variety of maintenance jobs. Such a finding suggests a need for simplification of the instructional design process. Since this need has actually been recognized for quite some time, a number of different suggestions have been put forward as remedies. Several of these involve the development of computer-based systems such as intelligent tutoring and expert systems. Still others depend on the use of systematic design procedures that are oriented to instructor-led classroom instruction as well as to the computer-based variety.

Training design at the level of the lesson continues to be an enterprise that challenges the ingenuity of the Air Force designer. When a new weapon system is adopted, or when an existing system is modified, the volume of new maintenance information to be taught is often very large. In dealing with the necessity of communicating such a mass of information, the designer may be sorely tempted to fall into two kinds of error in the attempt to simplify his task. These tendencies may be described as follows:

1. Reducing the knowledge to be acquired to the declarative form, and thus neglecting the procedural variety of knowledge; learning the names of equipment parts is not equivalent to learning how to use these parts.

2. Reducing the instructional techniques to only two, which may be called TELLING and PRACTICE; while these typically constitute the core of instruction, other features of instructional strategy, such as elaboration, interactivity, and feedback, are often found to enhance instructional effectiveness by significant amounts (Bloom, 1984).

One promising approach to the simplification of the instructional design process is automating the procedure of design

and delivery. An effort to develop and test automation techniques is involved in the project AIDA (Advanced Instructional Design Advisor; Hickey, Spector & Muraida, 1991). This project is engaged in the development of computer shells representing a number of different instructional strategies, each of which pertains to a different learning goal. For example, one goal is identifying equipment and equipment parts, while another is executing a procedure, and a third is interpreting malfunctions. For any one of these goals, the shells of instructional procedures can be selected and put together so as to represent an effective module of instruction aimed at that particular goal. The content for the instruction, of course, must be selected and added, but how it is presented, in a manner conducive to efficient learning, depends upon the nature of the shell that is employed. Thus, AIDA uses automated computer-human interaction as a means of instruction for particular kinds of goals. The goals and the enterprises they represent must be identified by the instructional designer.

Simplification of the process of instructional design can also be done in a manner that does not require the degree (or kind) of automation involved in the approach of AIDA. Instruction, it is evident, consists of a set of events external to the learner that occur in a loosely invariant sequence (Gagné, 1988, 302-319). These events may be directions or suggestions to the learner about what to do next, demonstrations of action sequences, pointed references to aspects of the learners' environment, reminders of previously learned knowledge, solicitation of learner responses, feedback and corrections of learner responses, and others (Gagné, 1991). When a designer of instruction follows the prescriptions in this nearly invariant sequence (called the "Nine Events of Instruction"; Gagné, Briggs & Wager, 1992) further automation is unnecessary. As is true for AIDA, the content of these events must be identified and selected by the designer. Otherwise, however, a large amount of flexibility is possible in the design of specific learner-interactive events.

A project that follows this process of limited automation in presenting instruction on designing instruction is GAIDA (Guided Approach, Instructional Design Advisor). Because this approach leaves much of the details of design to the judgment of the designer, it is particularly appropriate that a study aimed at formative evaluation of GAIDA be carried out.

The GAIDA Project

Computer-based (CB) instruction dealing with how to design instruction can deliver a set of directions to the novice instructional designer. The latter may find these directions easy or difficult to understand, easy or difficult to implement. For

example, if the directions say, in effect, "at this point - tell the learner to recall some previously learned knowledge that is relevant to the new learning task", the student designer should be able to comprehend the message with its inclusion of the concepts "this point", "recall", "previously learned", "knowledge", and "relevant". The GAIDA approach assumes that novice designers are capable of understanding concepts of this sort in their precise meanings. The further assumption is made that directions of this sort can be "followed", in the sense that concrete instances of such an abstraction as "relevant knowledge" can be identified and selected from the domain of the equipment data base being dealt with.

GAIDA provides to the novice designer, a set of nine directions, in sequence, which are intended to tell the designer what kinds of events to devise as instruction. In order, these events (Gagné, Briggs & Wager, 1992) are as follows: (1) gain attention; (2) describe the goal; (3) stimulate recall of prior knowledge; (4) present the material to be learned; (5) give learning guidance; (6) elicit performance; (7) provide feedback; (8) assess performance; and (9) enhance retention and transfer. How readily these directions are understood, and how well they are implemented, will determine the quality of the instruction that is designed. The need for formative evaluation is therefore apparent.

GAIDA provides printed directions for each of these nine events. An example lesson is used to demonstrate the events. In the current case, the lesson aimed to teach the 32 steps in the procedure called "Functional Check of the M61A1 gun", which is the gun in the F-16 aircraft (Gagné, Dimitroff, & Whitehead, 1991). This preventive maintenance procedure is carried out with the use of a checklist. Since the system components are in two locations, one person executes some steps on equipment in the cockpit, while another carries out other steps by reaching connectors through panels on the underside of the aircraft.

The lesson on this procedure is designed to support the learning of the following: (1) verbal identification of abbreviated names and phrases in the checklist; (2) identification of the objects (switches, connectors, etc.) named in the checklist; (3) identification of the location of these objects; (4) easy progression from each procedural step to the next, following the printed checklist. In addition to these basics, a few interactive steps are included with the aim of enhancing the "system knowledge" of the trainee. This is done by requiring answers to questions about the wiring system of the gun. Thus, the added objective may be stated as (5) identifying one or more probable causes of malfunction in the flow of current in the wiring system.

The Lesson

The lesson on the functional check follows this outline:

Event 1. Gain Attention. The gun is named, and a graphic picture is displayed. A future development would use a picture with motion.

Event 2. Describe the Goal. A descriptive text, with accompanying pictures, describes the process of making the functional check. Included are the purposes of the check, the locations of switches and connectors, rules for gaining access to the gun and its components, rules for safety.

Event 3. Stimulate the Recall of Prior Learning. Messages of text remind the learner of previously learned information, safety rules, etc.

Event 4. Present Material to be Learned. A picture is to be shown of the initial page of the checklist.

Event 5. Provide Learning Guidance. This takes the form of displaying the direction for each step in the procedure, including expanded abbreviations, and an accompanying picture.

Event 6. Check Performance. The learner is asked to carry out the performance of the checklist. Also, questions are posed relating to the flow of current in the electric circuits.

Event 7. Provide Feedback. Corrective feedback is given as the steps of the checklist are performed. Feedback in the form of explanations are given to each choice made to multiple-choice questions, testing knowledge of current flow in the electric circuits.

Event 8. Conduct Assessment. The suggestion is made that additional practice be given on the checklist procedure.

Event 9. Enhance Retention and Transfer. For this checklist procedure, this event is considered to be adequately covered by events 6 through 8.

The novice designer, in responding to these events, was asked to write out a script that described the CB instruction to be designed. It was expected that such a script could be used by a computer programmer to devise the program of the lesson. A revised version of GAIDA is planned, which would enable a designer to display the contents of the nine events directly on a computer screen. This aspect of GAIDA design could not be included in the current formative evaluation study.

Formative Evaluation

According to Dick and Carey (1991), formative evaluation is conducted during the time in which instruction is being developed for the purpose of identifying strengths and weaknesses in the instruction and the need for revision. An essential early move in a formative evaluation study consists of "one-to-one trials", carried out with representative learners from the target group for whom the instruction is intended. These trials provide a look at the viability of the instructional linkings of content, setting, and learners. The three main criteria are considered to be as follows:

1. Clarity. Are the directions clear?
2. Impact. What is the effect of the instruction on the achievement of its objectives?
3. Feasibility. Given certain support and time allocations, how feasible is the instruction?

No major difficulty was anticipated in the use of one-to-one trials of instruction with the lesson on the functional check of the M61A1 gun.

METHOD

The formative evaluation study was conducted at Lowry Air Force Base. Six individuals participated in the study, each serving as a novice instructional designer. Five of these people were noncom airmen who had experience as instructors in the Armament Specialist course. One was a civilian who was an instructional developer in various aircraft maintenance specialties. All of these participants were acquainted with the F-16 aircraft and its equipment, including the M61A1 gun. In the jargon of evaluation studies, they were considered to be SMEs (subject-matter experts). These men ran through the instruction individually, one in the morning and one in the afternoon, on each of three days.

Each "designer student" (hereafter called the student) was seated facing the computer monitor screen, which rested on a table in front of him. He was told the purpose of his participation as a try-out of a computer-based lesson on designing instruction, containing an example of the checklist procedure for the M61A1 gun in the F-16 aircraft. He was told the instructions would be given on the screen. The investigator (Gagné) would be seated at his back, and would be available for questions if there were any. Also, he would be alert for any hang-ups with equipment operation,

and would help out if called upon. The student was to describe the lesson being designed by writing its description (in the manner of a "script") in a notebook provided. Available to the student were (1) a copy of the 32-step checklist, (2) a copy of the wiring diagram for the electrical circuits of the gun, and (3) a set of black-white drawings of the various components of the electrical system of the gun (switches, connectors, display panels, etc.). The checklist, of course, was an essential feature of the material to be taught. The wiring diagram was intended to provide a conceptual base for understanding the wiring system and its checking. The drawings of equipment components were to be used in assessing performance, after the check had been gone through at least once.

Each student was asked to describe his designed instruction, following the Nine Events as an organizing principle. In addition, each student was asked to "think aloud" concerning the three criteria of evaluation previously mentioned (clarity, impact, feasibility). Students wrote out the verbal communications they wished to make for each event, and also selected a drawn picture of a relevant switch, connector, or component, identifying it by letter from an array mounted on a display board. Students' oral comments were recorded by means of a tape recorder.

Duration of these sessions was approximately two hours, and was not recorded. At the close, each student was asked to state any general comments considered relevant, and helpful to the design and revision of the CB instruction.

RESULTS

Results of students' efforts in designing instruction are reported individually. Besides the textual message for each step, a picture (drawing) is usually identified. General comments are reported at the end of each student's lesson.

Student No. 1. (SSgt)

Event 1. Gaining Attention

"The equipment is the gun in the F-16 aircraft. Figure 1 shows the F-16 cockpit area with the gun in red". Picture - the M61A1 gun, positioned in the aircraft. Student comment: Better to have motion in the picture, as in firing the gun.

Event 2. Describing the Goal

"The procedure is the functional check of the M61A1 gun".

"The gun is a Gatling type, hydraulically driven at a firing

rate of 6000 shots per minute. It is loaded with 511 rounds of 20 mm ammunition. These can be fired in bursts, or continuously in a dogfight mode. Constant ventilation is provided to cool the gun and remove gun gases from the gun and ammunition bays".

"Figure 2 shows the gun". Picture - M61A1 gun.

Event 2. Describing the Goal (cont)

"Some of the controls for the gun are in the cockpit".

"The Master Arm and SMS Power Switches are on the MISC and AVIONICS POWER panels (figures 3 & 4). The GUN Switch is on the STORES CONTROL panel (figure 5). The DOGFIGHT Switch is on the throttle grip (figure 6). The Gun Trigger Switch is on the Side-Stick Controller (figure 7).

"When the switches on the panels have been set and the Trigger Switch is pressed to the second detent, the gun is in a firing mode. The Gun Control Unit is activated. This unit controls the firing of the gun." Pictures - panels, throttle, side stick controller.

Event 2. Describing the Goal (cont)

"The following controls are on or near the aft portion of the gun, through access panels 3415 and 3019.

"The Last Rounds Bypass Switch (figure 8) can be held ON to simulate the presence of ammunition." Picture - Aft portion of gun; Last Rounds Bypass Switch.

Event 2. Describing the Goal (cont)

"Within the gun Purge Door (below Panel 3415) is the Gun Ground Safe Switch (figure 9) which disables the gun when the aircraft is on the ground, and the Purge Door Limit Switch, which prevents firing before the Purge Door opens." Picture - Gun Gas Purge Door.

Event 2. Describing the Goal (cont)

"On the right side of the aircraft through Access Door 3206, is the Rounds Limit Switch (figure 10), which is normally used to limit the rounds available per mission. When conducting the Functional Check the rounds shown on the counter should show a number that is not zero (0)." Picture - Rounds Limit Switch. Student Comment: Text should explain that the ON position of this switch limits the rounds that can be fired. When OFF, rounds that can be fired are unlimited.

Event 2. Describing the Goal (cont)

"A functional check is done to insure that (1) the gun's

electrical circuits are in working order, (2) that there is no stray voltage in these circuits, and (3) that the safety circuits function properly. To test voltage, a Test Set (Voltage Detector, figure 11) is used that is shaped like a beer can. Its cable is fastened to the firing connector of the gun." Picture - Voltage detector, cable, and gun connector. Student Comment: Need to explain that the Test Set is the 50-60 Test Set, which contains the voltage detector, or the "beer can."

Event 2. Describing the Goal (cont)

"The check has to verify that voltage is getting to the gun. For this reason, some circuits have to be turned ON. But this must be done in such a way that the gun doesn't actually fire."

"A diagram of the electrical circuits is in figure 12, on the next page, and also on the table beside you. A description of these circuits is on the page following the diagram."

Diagram of gun electric circuits is displayed.

Event 2. Describing the Goal (cont)

"28v. DC current begins at a breaker panel, and flows to the Stores Control Unit, through the Gun Control Switch and the Master Arm Switch. When these switches are closed, the Stores control Panel shows PWR ON. Switches on this panel to other functions are CLEARED, and the gun is LOADED. This 28v. power activated the Gun Control Unit so that it is ready to fire. Go to the previous page and click the RED button to outline the electrical flow. Click the button again to remove the outline.

"AC current (115v.) from the AC panel flows through the Purge Door Limit Switch to the Gun Control Unit. Here the voltage is transformed to 250v. AC, and the current makes the gun ready to fire, after it goes through the Gun Fire Safety Pin. Go to the diagram page and click the BLUE button to outline the electrical flow. Click the button again to remove the outline.

"28v. DC also passes through the trigger on the side-stick controller, and from there to the Last Round Switch, passing through the Rounds Limit Switch. The action of rounds limiting is canceled when the Last Rounds Bypass Switch is held ON (during the functional check). This allows a gun-fire signal to be sent to the Gun Control Unit. Go to the diagram page and click the GREEN button to outline the electrical flow. Click the button again to remove the outline.

"AC firing voltage is passed from the Gun Control Unit, synchronized with DC voltage to the gun's hydraulic power system.

DC voltage also controls the opening of the purge door. Go to the diagram page and click the YELLOW button to outline the electrical flow. Click the button again to remove the outline."

Student comment: Likes the colored circuits. A big help.

Event 3. Stimulating Recall of Prior Knowledge

"WARNING! High voltage is used in this check-out!"
Student Comments: Reminders might be given of other knowledge: aircraft familiarization, safety features.

Event 3. Stimulating Recall of Prior Knowledge

Student comment: The questions on the current flow are good.

Event 4. Presenting the Material

Student comment: There should be a photographic copy of Page 1 of the checklist, rather than a typed copy.

Event 5. Providing Learning Guidance

Student followed the instructions exactly. He provided a "plain English" version of each abbreviated step of the checklist, and chose to display an appropriate picture illustrating the step.

Event 6. Checking Performance

Student described four test items for checklist steps, as follows:

- (6) SMS pwr sw - SMS; SCP displays PWR ON
Question: What if PWR ON fails to appear?
- (15) Gun gas exit door - SUFFICIENTLY OPEN
Question: What would happen if the gun gas exit door is not sufficiently open?
- (16) LAST ROUND BYPASS sw - ON
Question: What happens to the voltage flow if this switch is not held ON?
- (21) Release gun trigger sw - STAT LT OFF
Question: If Status Light stays on, what is the most likely cause?

Event 7. Providing Informative Feedback

Student comment: No problem here. Question of Event 6 should provide feedback and corrections when appropriate.

Event 8. Assessing Performance

Student comment: Checklist could be reviewed once more, before asking trainee to conduct the check in the aircraft.

Event 9. Enhancing Retention and Transfer

Student comment: Best next step is practice on the F-16 aircraft.

General

Student commented that he found the instructions (about designing instruction) readily comprehensible. He would not find it too tough to design instruction in accord with the model provided. He believes such instruction is useful, and probably effective in preparing an airman to do the check in the aircraft.

Student No. 2 (S/Sgt)

Event 1. Gaining Attention

Student comment: Relate significance of the gun to the F-16 aircraft and its capability. "Verifying proper functioning of the gun system is our task."

Event 2. Describing the Goal

Student comment: Make sure the instructions refer to "the cockpit." Identify as the A model of the F-16 aircraft.
Instructions to trainee: Same as Student No. 1

Event 2. Describing the Goal (cont)

Instructions and drawings: Same as Student No. 1.
Student comment: Better to separate descriptions of panels and other components.

Event 2. Describing the Goal (cont)

Instructions and drawings: Same as Student No. 1.
Student comment: Need to identify exactly what panel gives access to the Last Rounds Bypass Switch.

Event 2. Describing the Goal (cont)

Instructions and drawings: Same as Student No. 1.
Student comment: Instructions about the Rounds Limit Switch should be clarified. For example, "the rounds shown on the counter should show a number that is not zero (0)."

Event 2. Describing the Goal (cont)

Instructions and drawings: Same as Student No. 1.
Student comment, on the wiring diagram: There is no component of the wiring system called the "Stores Control Unit." There is, however, a "Central Interface Unit", and perhaps that is what is intended.

Event 3. Stimulating Recall of Prior Knowledge

Student comment: Remind trainee of safety precautions relating to slippery surfaces of the aircraft. Also, the necessity to fill out AF forms regarding the maintenance work.

Event 4. Presenting the Material

No comment.

Event 5. Providing Learning Guidance

Instructions and drawings: Same as Student No. 1.

Step 1. Student comment: No need to translate. Trainee will know what SMS Power Switch is.

Step 5. Student comment: Should show voltage detector setting as PV, not PWR.

Step 8. "Depress and release OSS, adjacent to Gun Sw, then enter 5, then 1; then release the step switch."

Step 18. "Pull the gun trigger switch to the second detent, and hold until told (by partner in check) to release it."

Event 6. Checking Performance

Suggested Questions:

- (6) What is the location of SMS power switch?
- (15) What is the consequence if the gun gas exit door is not fully open? What indication on the voltage detector panel?
- (16) In what direction is the Last Rounds Bypass Switch held to be ON?
- (21) Likely consequence of not releasing trigger is burning out a fuse in the voltage detector.

Event 7. Providing Informative Feedback

Student comment: Feedback should be designed for questions on steps 6, 15, 16, and 21.

Event 8. Assessing Performance

Student comment: Explain to trainee that he will be asked to carry out the steps, using the checklist, but without further help. His performance will be rated for quality.

Event 9. Enhancing Retention and Transfer

Student comment: Suggests that conducting this checklist procedure would likely transfer to other checklist procedures (e.g. bomb rack), because of common elements (use of voltage detector, others). Agrees that transfer would occur to other

aircraft (e.g. F-15), although specific differences would need to be newly learned.

General

Student comments on the CB lesson on designing instruction were quite favorable. Directions easy to follow. Considers the instruction for the trainee worthwhile. Fairly confident he could construct a lesson on a new and different functional check.

Student No. 3 (S/Sgt)

Event 1. Gaining Attention

Instructions and drawings: same as Student No. 1.

Event 2. Describing the Goal

Student comment: Display switch positions are different in other F-16 models. These directions assume A model.

Event 2. Describing the Goal (cont)

"When the safety pin is installed into the gunfire safety switch, it cuts off electric power to the gun" (a suggested rewording).

Event 3. Stimulating Recall of Prior Knowledge

Instructions and drawings: Same as Student No. 1.

Student comment: Remind trainee to remove watch and any personal jewelry before performing the check.

Event 4. Presenting the Material

No comment.

Event 5. Providing Learning Guidance

Instructions and drawings: Same as Student No. 1.

Student comment: SMS means Stores Management Subsystem.

Event 6. Checking Performance

Questions for the several designated steps:

(6) Where is the SMS power switch?

(15) How does the gun gas purge door interact with the Gun Fire Circuit Safety Pin?

(16) What is the effect on the electrical system of having the Last Round Bypass Switch ON?

(21) If the Status light remains ON after the trigger switch is released, what is the probable cause?

Event 7. Providing Informative Feedback

Student comment. Same as Student No. 1.

Event 8. Assessing Performance

Student comment: Same as Student No. 1.

Event 9. Enhancing Retention and Transfer

Student comment: Same as Student No. 1.

General

With this kind of CB instruction, the trainee would be able to perform the check in the F-16 aircraft. Of course, he would need to be supervised. And some initial training on aircraft orientation and safety should be assumed. Effectiveness of lesson for trainee is judged to be good.

Student No. 4 (S/Sgt)

Event 1. Gaining Attention

Instructions and drawings: same as Student No. 1.

Event 2. Describing the Goal

Instructions and drawings: Same as Student No. 1.

Student Comment: Rather than describing the components and their location, tell the student that he should be familiar with the aircraft and its equipment in order to perform a functional check.

Event 3. Stimulating Recall of Prior Knowledge

Instructions and drawings: Same as Student No. 1.

Student comment: Remind trainee of safety procedures in aircraft and gun system.

Event 4. Presenting the Material

Instructions and drawings: Same as Student No. 1.

Event 5. Providing Learning Guidance

Step 8. "Store Code 377 (the code for ammunition) is entered, using right and left rows of switches on the Stores Control Panel. Then the number 51 is entered, indicating the amount of ammunition loaded (510 rounds)."

Event 6. Checking Performance

Student describes four test items for checklist steps, as follows:

(6) With the SMS Switch ON, if the Stores Control Panel does not display PWR ON, what is likely to be the trouble?

(15) If the gun gas purge door doesn't open, what should be checked?

(16) If the Last Round Bypass Switch is not held in the ON position, what problem would occur?

(21) If the Status light stays ON after the gun trigger switch is released, what is the probable cause?

Event 7. Providing Informative Feedback

Student contributes no comment.

Event 8. Assessing Performance

Student Comment: Trainee should be allowed to practice the check until he feels comfortable doing it.

Event 9. Enhancing Retention and Transfer

Student comment: Same as Event 8.

General

Student reported little difficulty in following the sequence of nine events, or in designing instruction according to the example provided. A comment on the event of Describing the Goal:

Much information (location of controls, switches) would seem to have to be absorbed very fast. An improvement would be to have a film which showed the actual location of these components.

Student No. 5 (T/Sgt)

Event 1. Gaining Attention

"The F-16 aircraft has a 20 mm gun which fires 6000 rounds per minute. But unless the gun fires when the trigger is depressed, the gun isn't worth much."

Event 2. Describing the Goal

"Let's ensure that the gun works by performing a functional check of the system."

Student comment: The instruction here is an overload. Just knowing where the switches and controls are, is not sufficient. Needs to know their function, and needs to understand what's happening. The checklist is an abbreviated version of the T.O., and the T.O. goes into much greater detail. (Expanded comments are in the General section). +

Event 3. Stimulating Recall of Prior Knowledge

Student comment: Instruction needs to be given on electrical safety.

Event 4. Presenting the Material

No comment.

Event 5. Providing Learning Guidance

Step 1. "SMS power switch - located on the Miscellaneous Panel, and is used to apply power to the Stores Management System for weapon system operation."

Step 2. "Rounds limiter is used for pilot training. It limits the amount of ammunition that is being fired on a given training mission. It has two positions: Limit and No Limit. In combat, the No Limit position is used. It also has a counter on it, which is controlled by a thumb wheel to set the limit. It counts down as the gun fires by a gear mounted to the access unit."

Steps 2A-2D. Instructions and drawings: Same as Student No. 1.

Step 2E. Student comment: Describe why light would be on. Also, voltage flow, to include: what each setting is checking for; fuse, and adapter cable. Include close-up display on face of voltage detector.

Step 2F. Student comment: Inform trainee why this setting is made.

Step 6. Student comment: It should be possible to assume that the SCP (System Control Panel) has already been gone over in detail.

Step 7. Student comment: Student needs to have working knowledge of the SCP. Its clearing needs to be taught in a previous lesson.

Step 15. Student comment: Explain why gas exit door must be open; show a picture.

Step 16. Student comment: Explain the function of the Last Round Bypass switch, and why it must be held ON.

Step 17. Student comment: What is the meaning of RDY. Ready for what? Why is it necessary to be ready?

Step 18. "Depress and hold."
Step 19. Student comment: Explain why the status light is OFF.
Step 22. Student comment: Explain stray voltage, and why a check is made for it.

Event 5. Providing Learning Guidance

Instructions and drawings: Same as Student No. 1.
Student comment: See General section.

Event 6. Checking Performance

Student comment: See General section.

Event 7. Providing Informative Feedback

Student comment: See General section.

Event 8. Assessing Performance

Student comment: Same as Student No. 1.

Event 9. Enhancing Retention and Transfer

Student comment: Same as Student No. 1.

General

This student (No. 5) is experienced as an instructor, and also as an instructional designer. He strongly disagrees with the organization of this CB lesson. His suggested organization is in the following list:

- (1) Introduction to the F-16 aircraft as a weapon system; display and description of its major components.
- (2) Controls and switches in the cockpit, along with their functions.
- (3) System Control Panel (SCP) - its functions. How to clear, how to load.
- (4) Safety procedures - electrical, hydraulic, and others.
- (5) The M61A1 gun - its capabilities and working features, including electrical and hydraulic.
- (6) How to do a functional check.
- (7) Executing the functional check by steps.

This student believes that a good deal of highly organized "system knowledge" should precede the learning of the functional check procedure. His further suggestion is that this CB lesson would be useful for 5-level airmen who are transitioning from a different aircraft (e.g. F-15) to the F-16. Such people would already know substantial system knowledge, and would be helped to learn the procedure of the functional check.

Student No. 6 (Civ, GS-11)

Event 1. Gaining Attention

Student comment: Same as Student No. 1.

Event 2. Describing the Goal

Instructions and drawings: Same as Student No. 1.

Event 3. Stimulating Recall of Prior Knowledge

Same as Student No. 1.

Event 4. Presenting the Material

Student comment: Should display an actual picture of the T.O. page.

Event 5. Providing Learning Guidance

Step 2E. "Set voltage detector switch to AT position - STAT LT ON."

Step 2F. Student comment: Need picture of the face of the voltage detector.

Step 7. Student comment: Trainee needs to be told how to clear the memory.

Step 8. Student comment: Need to explain how to program the computer for the ammo load.

Step 22. Student comment: Need picture of the face of the voltage detector, showing switch position. Also, explain SV as stray voltage.

Event 6. Checking Performance

Student described four test items for checklist steps, as follows:

(6) Power light does not come on. What could be the cause?

(15) If the gas exit door is not sufficiently open, what effect does this have on the electrical system?

(16) In order for the electrical circuits to function properly, what should be the position of the Last Round switch?

(21) When the trigger is released, what could cause the STAT LT to stay on?

Event 7. Providing Feedback

Same as Student No. 1.

Event 8. Assessing Performance

Same as Student No. 1.

Event 9. Enhancing Retention and Transfer

Student comment: This event could perhaps be combined with Event 8. Trainee might be given a chance to review before being evaluated on his performance.

General

Student considers this lesson to be very good. Notes that really good pictures would be an improvement; the trainee could learn best from these. Believes the CBT lesson designed in this manner would be helpful in producing a 3-level airman who is somewhat sophisticated, and consequently able to pick up new skills faster on the job. Believes such a CBT lesson would be valuable, even though it must be followed by "hands-on" training and experience.

GENERAL FINDINGS

The following trends and generalities may be summarized from the preceding protocols of six individuals:

(1) Some errors of omission and transcription were noted by the students. These are correctable, and the revisions will lead to an improved lesson.

(2) It would appear to be essential to provide designer students with information about the status of knowledge in the trainees for whom the training is intended. In the case of this lesson, a functional check of the M61A1 gun, designers need to know that trainees are assumed to have prior knowledge about the conformation of the aircraft, the location and function of its main components, and fundamental safety precautions.

(3) Access to visuals as a component of instruction was given strong emphasis by these designer students. They tried to find and use the most detailed and realistic visuals that were possible to obtain.

(4) The description of the goal (Event 2), as presented in this lesson, appeared to the students to be highly compressed. To be most effective, the description of the goal needs to have a more articulated organization than it has in this lesson.

(5) The treatment of learning guidance (Event 5) in this lesson was considered appropriate by all the students. Essentially, this treatment consisted of: (a) presentation of the

text of each step in the form of the checklist; (b) statement of the step directions in "plain English", by expansion of abbreviations; (c) a graphic presentation for each step that illustrated the particular equipment part and its location.

(6) Students approved of Event 6, Checking Performance, and Event 7, Providing Feedback. They were able to suggest subject-matter for four multiple-choice questions, relating to checklist steps 6, 15, 16, and 20. The investigator did not require them to spend time on the precise formulation of questions to accord with acceptable psychometric principles.

(7) Students agreed that an unprompted execution of the 32-step procedure was desirable for purposes of assessment. Scoring of performance could be done by checking off the steps, noting where errors occurred.

(8) It was thought that transfer (Event 9) could best be identified in terms of performance of the procedure, with checklist, on the aircraft. Several other possibilities exist, including the gun system in other models of the F-16 aircraft and in the F-15 aircraft. Some students stated that using a checklist to make a functional check would probably transfer to other procedures, such as a check of the bomb release system.

DISCUSSION

The questions addressed at the beginning of this investigation were whether (1) CB instruction could communicate an understanding of the process of designing a lesson on a technical procedure, and (2) the resulting lesson would be judged as a reasonably complete and adequate product, as designed for delivery via CB monitor. Instructional design was exemplified by a lesson on a procedure. The example chosen was the procedure called a Functional Check of the M61A1 gun in the F-16 aircraft. This is a procedure carried out by reference to a checklist. Omitting a few final steps pertaining to restoring the aircraft to its stable resting state, the functional check contains 32 steps.

The approach to instruction on instructional design employed in the current lesson maintains a narrow focus on executing a procedure with a printed checklist. The student is expected to follow the sequence of the "nine events of instruction", and to develop his own manner of communicating each of these events to trainees. The student designer is led to depend heavily on the example of the functional check that is provided, even to the extent of using the sentences in the text of the example, if he chooses to do so.

As a consequence of this approach, what is developed as a lesson is narrowly oriented to the M61A1 functional check in the F-16 aircraft. It is not yet known whether this lesson on designing instruction would show transfer of training to (a) a functional check of the electrical system of a different gun; (b) a checklist procedure for a different system, such as a hydraulic or electronic system; or (c) a procedure such as plotting distances and directions on a map. These are important questions affecting the usefulness of the CB lesson, and need to be investigated in future studies.

The students in this study experienced no difficulty in understanding the instruction of the CB lesson, nor in using it to describe a lesson using the nine events of instruction. The lessons they designed each followed closely the model task provided as an example. It may be concluded from this evidence that the instruction was both feasible and understandable. As experts on the hardware system, five of the six students judged the lesson they designed to be useful and effective, while the sixth took exception only to its scope. In general, the method was judged to be adequate for the production of practical instruction.

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