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Personnel

INFORMATION FOR DESIGNERS OF INSTRUCTIONAL SYSTEMS

DESIGN GUIDE FOR DEVICE-BASED AIRCREW TRAINING

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This handbook provides information and guidance to ensure that the Instructional System Development (ISD) process is properly applied during design of instruction for device-based aircrew training. This handbook is a guide for Air Force personnel who acquire training for aircrew training systems or training devices to be integrated into the training system.

Chapter 1
GENERAL INFORMATION

Overview

Introduction

This handbook serves as a guide for applying the Instructional System Development (ISD) process during design of instruction for device-based aircrew training. This handbook follows the principles of ISD.

Background

This handbook supplements background in learning theory and instructional design theory as applied to complex integrated training, particularly in full mission simulation. The context of this handbook comes from several decades of aircrew training research and applied theory documented in an unpublished manuscript of Dr. William D. Spears. The concepts, though abstract, attempt to explain the process of learning as a new student takes individual tasks and begins to integrate them into complex aircraft operation, mission qualification, and then continued combat readiness.

Expanded use of training devices

The complexity and operating costs of Air Force aircraft and weapon systems, together with the technological advances made in flight simulation and training devices, have led to expanded use of training devices and simulators in the training and performance evaluation of aircrew members. Properly designed and used, these devices provide in-depth training and a high transfer of skills, knowledge and behavior to improve aircrew performance.

Definition of ATD

Aircrew training devices (ATDs) are used to prepare aircrew members for the actual performance of flight duties. ATDs include cockpit familiarization trainers (CFT), cockpit procedures trainers (CPT), operational flight trainers (OFT), part-task trainers (PTT), and weapon system trainers (WST).

Purpose

The purpose of this handbook is to draw to the attention of the training device and instructional design team the basic concepts that lead to integrated skill performance and the design of training devices within a total training system. This handbook also addresses the use of aircrew training devices, provides guidance on developing instruction for them, and offers suggested procedures to follow when aircrew training devices are selected for training of integrated activities.

Who should use this volume?

This handbook addresses the question: "How do you apply ISD theory and learning theory in design of aircrew training devices for total training systems?" But is this handbook for **you**? The following questions should help you decide.

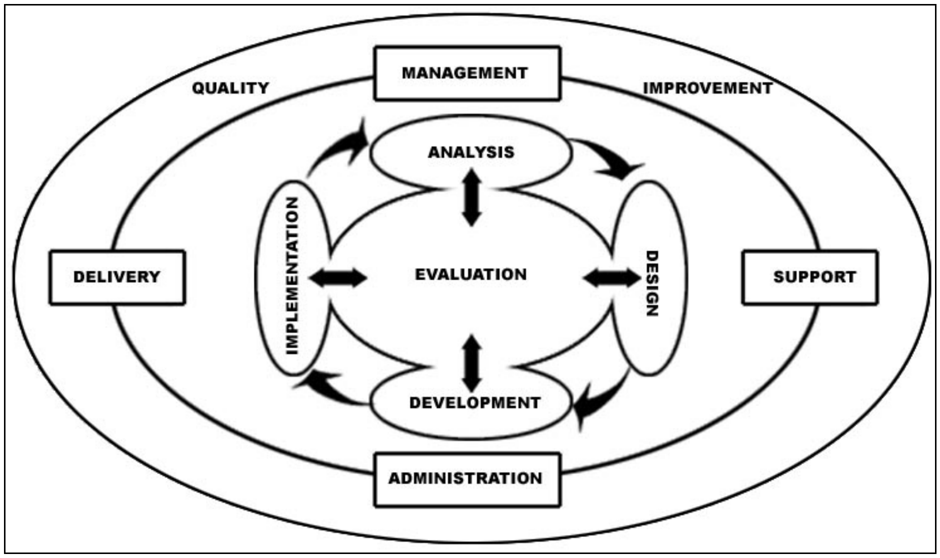
Are you responsible for . . .	**Yes**	**No**
Developing aircrew training or a total training system?		
Using training system requirements analysis (TSRA) results to assist in designing training devices?		
Selecting integrated training events for training devices?		
Instructing in training devices?		
Mission generation?		
Are you . . .	**Yes**	**No**
A training manager, curriculum developer or instructor?		
An ISD expert (with at least five years experience in ISD)?		
A flight simulation engineer?		
A training psychologist?		

If you checked yes on any of these questions, this handbook will assist you.

Updated ISD model

Figure 1 shows the Air Force ISD model as it appears in AFMAN 36-2234. In the model, the system functions and ISD phases are embedded in the quality improvement process. Refer to AFMAN 36-2234 for detailed discussion of ISD.

Figure 1 Updated Air Force ISD Model



Basis for ATD design

The ISD process of media selection should identify the integrated activities and the training devices most appropriate for training those activities (AFMAN 36-2234). The ATD should be designed to effectively train those integrated activities.

Multi-disciplinary team required

The use of training devices is different from the past concept of replicating the aircraft. There are known capabilities that only a training device can support, such as repeated reset and predetermined conditions. The context or "big picture" in which the training device is used should also guide the design. The functions covered by the design should trace back to the training, support, and operations requirements. The concept of design is for training rather than for engineering simulation. The design will require a multi-disciplinary team approach.

New concerns

Today's concerns include not only classroom instructions, but instructions that are exported to the job site using new delivery methods and technologies. New automated instructional development tools can make instructional development more efficient.

Building quality

Building quality in instructional systems is a key concern. Other concerns include the concept of totally integrated training systems and how to use the ISD process in different applications such as systems acquisition, education, aircrew training, and technical training programs.

Evolution of ISD to meet complex technology

Principles of ISD have evolved over the past three decades from ISD as a tool for applying behavioral learning principles to classroom instruction. It began with models of step-by-step procedures designed to enable anyone to develop instruction and evolved to sophisticated models concerned with complex technological as well as cognitive and attitudinal issues that require experienced instructional design experts to sort out.

Experts required

Today's instructional development, updating, and revisions require expertise not only in instructional design but also in media (e.g., computer hardware and software, video, interactive systems), cognitive learning theory, and vastly complex content areas. The scope of required expertise has gone beyond the capabilities of the single instructional design expert and now requires a team of experts from several disciplines.

Introducing expert systems

Attempts are being made to use expert system techniques to help both the experts and novice instructional developers cope with contemporary advancements. If successful, these techniques will impact instructional design in fundamental ways, such as by providing ISD expert system tools.

Adaptability

The new model of the ISD process reflects the movement away from rigorously applied procedures and emphasizes adaptability to changing environments. These concerns have become cornerstones of the Air Force ISD process.

FAA qualification and SIMCERT

The Federal Aviation Administration (FAA) and the major command team for simulator certification (SIMCERT) have qualification and certification programs designed to ensure that training systems and devices provide an accurate, credible environment for training in specific events.

Terminal proficiency objectives are developed on the basis of the ISD training in specific events. The suite of aircrew training devices is designed to meet the terminal objectives allocated to them and to prepare for meeting the remainder of the terminal objectives completed in the aircraft.

The FAA has defined in FAR Part 121, Appendix H, levels of simulators by alpha characters, with numeric designations for training devices. The Air Force has defined SIMCERT in AFP 36-2211.

How to use this handbook

This handbook is a guide. Keep it handy for frequent reference. It incorporates basic concepts and provides guidance on what has worked in the past. This information can guide decisions toward effective training design. This process is in the context of the "big picture" total training system, accounting for the full life cycle of training required to operate or maintain the defense system in peacetime and in combat.

Why use this handbook?

This handbook incorporates lessons from several decades of aircrew training experience in the design and use of aircrew training devices. Therefore, it is a ready reference for dealing with issues that drive effectiveness and efficiency of training. Wise use of this handbook will give you this breadth of understanding.

Where to read about it

This chapter contains two sections.

Additional information

For additional information on aircrew training devices, see:

AFPAM 36-2211, *Guide for Management of Air Force Training Systems*.

Section A
Background

Past difficulties

In the past, application of ISD to aircrew training device design has been difficult. The traditional structural analysis approach of ISD works relatively well with training in how to operate and maintain systems and how to respond to the status indicators of the system, whether normal or emergency procedures. At this level, the tasks can be broken down and then arranged in a hierarchical relationship.

Structured analysis approach breakdown

When the tasks become more complex and shift from a specific objective per task to multiple objectives combined to achieve a common goal, there is a breakdown in the structural analysis approach. Dynamics such as those in crew interactions or interactions with systems outside the aircraft (especially if hostile or unknown) have been shortchanged. Previously, critical requirements were not identified; particularly requirements beyond initial qualification training.

Complex activities

These complex, integrated activities were often left to a skillful instructor and the learn-as-you-go practice of the crew, especially in continuation training. "Mission-ready" took on new meaning when the crew was able to practice a full combat scenario in a weapon system trainer. Something more was needed.

Section B
Lessons Learned

Training system reviews

Lessons on how to integrate aircrew training simulation into a total training system took time (Bills, 1987; Nullmeyer and Rockaway, 1984). Training effectiveness studies led to reviews of training systems.

Model aircrew system

A model aircrew training system (MATS) was derived (Fishburne, Spears, and Williams, 1987) providing a method for introducing new training technology. It required a review of the total system perspective, keeping in mind the entire life cycle of crewmember development through the training system.

Training to proficiency in simulation

Certain tasks were certified as trainable to proficiency in simulation, allowing instructors to better focus their attention in the operational aircraft. This focus was on events that could only be completed in flight. Criterion proficiency of an event first achieved in simulation results in a significant reduction in the number of attempts to attain proficiency in the aircraft. The complex training capability of full weapon system simulation required considerable preparation in lower-level media in order to gain the benefit of the training capability in a full-mission/full-crew environment.

Techniques of instruction in simulation

Techniques of instruction in simulation were shown as different from those used in flight. Caro (1978) noted that instructors could be taught WST features such as adaptive training, performance playback, backward chaining, and automatic performance monitoring. They could be shown instructional techniques such as discovery learning or individualized proficiency advancement. They should be given an opportunity to practice simulator instruction before beginning with a new student. Even proficiency assessment, usually by the expert judgment of instructors, needed standardization.

Updated need for integrated skills

An update of the Air Force ISD process was needed to address training development for integrated skills and media design, particularly training device design, within a total training system. This enterprise should be a comprehensive one, incorporating all categories of learning. Gagné and Merrill (1990) defined an enterprise as an integration of multiple objectives, which come together in pursuit of a comprehensive purpose or common goal.

The human process of learning is complex and is integrated in real life. This being the case, then the application of ISD must also be an integrated approach.

Advances from computing power explosion

Capabilities for simulation have advanced. For example, visual display systems once driven by a room full of computers can now be operated on a single supercomputer. The addition of computing power to advances in software design has widened the range of effective and more efficient training devices and simulators.

Chapter 2
USE OF AIRCREW TRAINING DEVICES

Overview

Introduction

This chapter presents the principles for use of aircrew training devices. These principles will not cover functional requirements of aircrew training device capabilities. There are no mechanical procedures for application of learning principles to aircrew training device instruction. Since these are not categorical rules, judgment is required. A foundation for structuring such judgment is provided in this chapter.

Value of ATD

The ultimate value of ATD training depends on the extent to which skills learned during that training will transfer to the aircraft. Three factors affecting this transfer should be considered:

- Cue development
- Cue and response discrimination
- Generalization

Cues

Being able to interpret cues and respond to them appropriately is the essence of aircrew skills. Thus, ATD instruction should focus on teaching aircrew members to learn cues (i.e., the meaning of physical stimuli), and to derive pertinent information from them so that the proper response can be made.

Response discrimination and generalization

The aircrew members must learn to discriminate (i.e., recognize and select) the cues and responses appropriate to a given task, and must then generalize these to situations different from the situations in which these were learned.

ATD training advantage

Although the focus of all aircrew instruction is on teaching the discriminations underlying aircraft performance, ATDs have a distinct training advantage over aircraft in that discriminations can be taught in ATDs at times and in ways that promote the most efficient development of skills.

Cue information criterion

It is the cue information available in an ATD, rather than stimulus fidelity per se, that should be the criterion for deciding what skills or skill components are taught in it. Because transfer is based on cue information, all valid cue interpretations learned in an ATD can be generalized in both vehicles. Thus, it is important that ATD training focus on the generalizable meanings of the cues they can provide.

Using ATDs to their full potential

Transfer depends on meanings, whether ATD stimuli and responses are realistic or not. "Similarity" explanations of transfer, upon which many conceptions of ATD training value rely, focus only upon the physical similarity of training devices to aircraft, and upon their capability to provide for task performance as it is actually done in the aircraft. When ATD training objectives are determined by dependence on physical and task fidelity, ATDs cannot be used to their full potential.

Description of mediation process

Mediation is a complex psychological process, which permits performance in devices of various fidelity levels to acquire meanings similar to the meanings of corresponding performance in aircraft.

Definition of mediation

Mediation is the **intermediary** process that provides meaning for the situation at hand when generalizing from previously learned discriminations. Mediation comes between, or mediates, the acts of sensing a stimulus and responding. Thus, through mediation, ATD training is not limited to device-aircraft similarity.

Mediation and ATD effectiveness

Through mediational processes such as language and mental rehearsal, the effectiveness of all ATDs is enhanced.

Where to read about it

This chapter contains eight sections.

Additional information

Additional in-depth information about the principles for use of aircrew training devices can be found in Caro, Shelnutt, and Spears (1981).

Section A
Cognitive Training

What it is

Cognitive training consists of learning about:

- Cues and responses that must be discriminated.
- Purposes of those discriminations.
- Meanings of symbols that will substitute for aircraft cues and responses in ATDs.
- Subtle differences between ATDs and aircraft that must be noted before transferring to aircraft.

When it takes place

Effective and efficient ATD training depends upon preparation for learning. That preparation takes place in classrooms, briefings, discussions, ATDs and aircraft, and in a variety of other formal and informal settings.

What it involves

Much of this preparation involves cognitive processes, i.e., thoughts, ideas, mental images, and concepts that are both verbal and nonverbal. It basically consists of the cognitive foundations upon which ATD training, and ultimately, aircrew performance rests.

Principles applicable to cognitive component

The following principles apply to the cognitive component of ATD training:

- A meaningful context should be provided for the learning of skilled performance in the ATD.
- Mediation should be employed systematically in teaching cue and response discriminations.
- When students are practicing in the ATD, they should be instructed to think about the meaning and effects of their actions with respect to requirements for performance in the aircraft.
- Briefing for ATD sessions should anticipate and guard against a student's relating what he or she does during ATD practice only to the device itself.
- Recognizing that transfer is a mediational process, a major goal for ATD training should be to exploit the types and uses of mediation that maximize transfer.

Section B
Feedback

What it is

Feedback refers to information that informs a learner about the results or effects of the learner's actions.

Roles during ATD training

Feedback has two important roles during ATD training:

- To maintain a student's motivation to learn.
- To inform the student of the appropriateness or inappropriateness of interpretations of cues and responses to those cues.

Principles applicable to feedback

The following principles apply to the role of feedback in ATD training:

- Feedback determines the nature and extent of discriminations that will be learned.
- Feedback should focus on specific aspects of cognitive, perceptual, and motor actions that must be discriminated.
- Augmented and supplemental feedback should be used only when task-intrinsic feedback cannot be discriminated, and its use should be specifically for the purpose of teaching cue and response discriminations intrinsic to the aircraft task.
- Timely supplemental or augmented feedback should be used to signal the availability of intrinsic feedback.
- When intrinsic feedback is needed as a signal for a subsequent action, ATDs must provide it quickly enough to avoid disrupting the action.
- Feedback will help maintain student motivation if the feedback ensures progress.

Section C
Guidance

What it is

Guidance is the directing of a learner's actions toward a desired goal. The actions being guided may be thought processes, physical movements, oral communications, selection of cues, or processing of cue information.

When it happens

Guidance is involved every time an instructor comments to a student about what the student should do, remember, or think about.

How it helps

Properly used, guidance helps in the learning of aircrew skills in two ways:

It speeds learning when it identifies desirable cues and responses that the student cannot recognize unaided.

By identifying correct cues and responses, it reduces the likelihood that inappropriate cues will be used and incorrect responses made. Thus, it helps prevent learning of erroneous actions that would eventually have to be unlearned.

Principles applied to guidance

The following principles apply to the use of guidance in ATD training:

The purpose of guidance is to focus the student's attention on correct cue and response discriminations and to avoid incorrect cue interpretations and actions.

To avoid dependence on guidance, it should not be used when the student is able to make the required discrimination without help.

Contrasting, through guidance, desirable with undesirable cue interpretations and responses can highlight critical cues and responses when the discriminations to be learned are difficult.

When feedback is used primarily in a guiding role, it should occur as soon as practical after the action, and the student should repeat the action without undue delay.

Principles applied to guidance (Continued)	Guidance should be used during advanced training when needed to focus students' attention on new cue and response discriminations, or on previously mastered discriminations that can be generalized to new tasks. Guidance can be valuable for experienced aircrews when their skills have deteriorated appreciably, or when it can define or clarify standards for performance. Guidance should focus on aspects of ATD skill performance that are transferable to aircraft, or that can promote transfer.

Section D
Priorities for ATD Scheduling

Scheduling priorities

Scheduling ATDs for training must be responsive to two types of priorities. One type involves different kinds of training (e.g., combat crew training vs. continuation training vs. instructor training). The second involves different training needs within a training group (e.g., aircraft control vs. emergency procedures vs. low-level navigator).

How to establish priorities

It is desirable to establish priorities for training tasks on the basis of the kinds of training that can be done best with each available device. Alternative resources, including aircraft, should be identified for each task to be trained, and the relative effectiveness and efficiency of each resource estimated. Trade-offs can then be made between priorities and alternative ATDs, with cost helping to determine the trade-offs.

Principles applicable to scheduling

The following principles apply to priorities for ATD scheduling:

Priorities for scheduling ATD use should be developed systematically, considering the needs for serving different groups as well as the relative needs within each group.
ATD training priorities should optimize the effectiveness and efficiency of all available devices.
Course syllabuses should reflect training priorities and identify alternative resources.

Section E
Sequencing ATD and Other Training

Considerations for integrating ATD with other training

The contribution of ATD training varies, depending on how it is integrated with aircraft and academic training. Four considerations are relevant:

ATD training can provide concrete meaning for theoretical knowledge and timely practice in applying that knowledge.
Academic instruction can sometimes be more meaningful if it follows ATD practice.
Transfer of ATD training to aircraft often requires practice in the aircraft soon after ATD learning.
Some ATD instruction will be more meaningful if it is preceded by exposure to the tasks in the aircraft.

Principles applicable to sequencing

The following principles apply to sequencing ATD training relative to academic and aircraft training:

ATD practice should be designed and scheduled to provide experience in the use of knowledge and concepts previously learned at the verbal level in academic training.
When students have not had experiences needed for academic concepts to be understood, ATD experience of an appropriate kind should precede or be concurrent with academic training in those concepts.
ATD and aircraft training should be sequenced as needed to maximize the contributions of both.
The experience level of a student should help determine the length of delays among related academic, ATD, and aircraft experiences.

Section F
Allocation of Training Among ATDs

Developing a plan for using ATDs

ATDs can vary in effectiveness and efficiency for teaching a particular skill. In such cases, a plan for the use of specific ATDs should reflect the capabilities of individual devices. In addition, occasions arise when two or more different types of ATDs are available and are essentially equivalent in value for teaching a particular skill. If so, factors other than device capabilities can be considered in their use.

Principles applicable to allocation

The following principles apply to the allocation of training among ATDs:

- For any task to be trained in an ATD, key cues and responses related to the task should be represented meaningfully.
- If precise visual-motor skills are to be learned, precise performance must be practiced.
- The experience levels of students should be considered when allocating training to ATDs with differing capabilities.
- Training should be allocated to individual ATDs according to their effectiveness and efficiency in training portions of tasks.
- Training can be allocated to an ATD with characteristics different from a particular target aircraft, provided that the skills being practiced are not specific to the aircraft.
- When two or more ATDs are equally useful for training a particular set of skills, allocation of training to a device should consider relative cost, overall program efficiency, and preferences of instructors and students.

Section G
Organizing Tasks for Practice

Important points for organizing tasks for practice

A consideration in the design and conduct of any ATD training activity is the need to organize the tasks to be learned into practice sessions. Whether motor skills, procedural skills, communication skills, or more typically, a combination of skill types are to be learned, two points stand out:

Cue and response complexity should be reduced in early stages of development of a skill.
Skills should eventually be practiced in situations representing the full complexity of operational performance.

Questions to answer when organizing tasks for practice

Two questions follow the above points:

How should tasks be separated for practice so that their complexity can be reduced while learning the component tasks?
How can training ensure the eventual integration of tasks learned separately?

Principles applicable to organizing tasks for practice

The following principles apply to organizing tasks for practice in ATD sessions:

Tasks should be separated, or grouped, for practice to reduce cue and response complexity (simplify) early in training, then provide opportunities to put the "simple" in context of the more complex "big picture."
Complex tasks should be separated into parts, or subtasks, if it makes the parts easier to learn.
Tasks should be separated from each other during early learning if separation aids cue discrimination.
Tasks separated for practice should be divided so as to maintain integrity of the parts.
When tasks normally occur together or in a contiguous sequence, but are practiced separately, some cues and responses related to the omitted tasks should appear at appropriate times during practice.

Section H
Duration and Frequency of Practice

Factors of concern

Optimum practice schedules depend on a number of factors that vary with the tasks being trained, when they occur during the training program, and the relative skill level of the aircrew students. The factors of primary concern are:

- Effects of interference.
- Level of previous learning.
- Amount forgotten during training.

Principles applicable to duration and frequency of practice

The following principles apply to the duration and frequency of practice in ATDs:

- ATD practice sessions should be of a duration and frequency that permit steady progress during learning.
- Schedules for practice should prevent intertask interference as much as possible.
- Practice during task acquisition should not continue to the point that a student becomes unduly bored or fatigued.
- As skill mastery progresses, practice sessions can be both longer and more frequent.
- Practice sessions should be frequent enough to prevent unacceptable deterioration of skills.

Chapter 3
BASIC CONCEPTS LEADING TO SKILLED PERFORMANCE

Overview

Introduction

This chapter presents basic concepts leading to an understanding of how to guide training design so that it results in skilled performance of integrated activities. These concepts have broader application than aircrew training device design. The human process of learning is complex. The methods for preparing instruction have grown out of an attempt to understand this complex process.

Instruction and learning

Regardless of how well instruction agrees with the human process of learning, instruction will continue to take place. People will be taught or they will find out on their own what they need to know and how to do what they need to do in order to meet the demands placed upon them. In the course of events, unforeseen detours will be made, unneeded costs will be incurred, and in some cases there will be unnecessary failures.

Attempts to improve the learning process

A body of psychologists and educators has attempted to better understand this complex process of human learning and to derive methods for improving the effectiveness and efficiency of corresponding instruction. This understanding starts with the basic concepts presented in this chapter.

Where to read about it

This chapter contains seven sections.

Section A
Discrimination

What it is

Discrimination refers to the process of telling the difference between one stimulus and another.

Cues and cue patterns

Skilled aircrew performance requires innumerable discriminations of cues and cue patterns. For a pilot controlling the flight of an aircraft, a cue pattern at any instant may include:

The status of several displays.
Selected characteristics of out-the-window scenes.
Complexes of accelerative forces on the body resulting from the motion of the aircraft.
Sounds from the engines and flow of air across aircraft surfaces, kinesthetic and other "feel" stimuli arising from inputs to controls and their touch and resistance characteristics.

Changes in information

At another instant, any or all of these sources of information may be changed. The pilot must monitor the changes as they occur, assessing the overall status of the cue complex and adjusting responses according to the status and the pilot's immediate, short-range and long-range goals. During this process, the pilot's actions, especially those regarding control inputs, must be finely discriminated.

Discrimination for crew members

Crewmembers, other than the pilot or copilot, also must make numerous discriminations. Depending on the crew position and stage of a mission, their required discriminations may be almost entirely cognitive in nature, but no less complex. The difference, usually, is that purely cognitive discriminations by adults can be formulated according to verbal rules. Indeed, language can be described as essentially an elaborate discriminative and generalizing system.

Section B
Generalization

What it is

Generalization refers to the extension of cue and response discriminations across time and situation. Without generalization, all learning would be specific to the time and situation of the learning. Just responding the same way on two different days requires that minor or major differences in the stimulus be accommodated, thus deriving cues from what the situations have in common.

Cue characteristics

In complex behavior, it is usually necessary to key on cue characteristics that are often subtle, especially those arising from feedback of a kinesthetic nature (resulting from body position, presence, or movement). Hence, desirable generalizations require highly discriminated frameworks of cues and responses to be made to them.

Relationships to training

In one way or another, effective training programs focus primarily on this point. Trainees practice under conditions with sufficient variation for the trainees to learn to identify which common cues to key on and how to tailor actions to the nuances of cues and contexts. These elements of training relate to cues:

Guidance Guidance helps direct trainees' attention to cue peculiarities and what they mean in terms of required responses.

Feedback Feedback helps trainees discriminate between correct and incorrect cue interpretations and selections of responses.

Practice Practice provides repetition of the experiences in varying conditions so that discriminations can become generalized and habitual.

Generalized discriminative system

The result is a broad context for associating cue meanings and selections of responses with situational requirements. In other words, the result is a generalized discriminative system.

Novice / expert differences

Any account of the main differences between an expert and a novice in a skill, in one way or another, will focus on the greater scope of the expert's generalization system for the skill and the greater number and detail of mastered discriminations within the system.

The following table (Tennyson, 1991) further clarifies the differences between novices and experts.

Novice	Expert
Recalls on raw memory.	Uses chunking and schemas to remember relationships and groups.
Classifies problems according to concrete similarities.	Classifies problems according to underlying relationships.
Focuses on specific features of a problem and tries to link them to a memorized formula.	Focuses on the big picture and looks for relevant principles.
Relies on disorganized general knowledge.	Relies on hierarchically (concrete to abstract) domain-specific knowledge.
Considers a large number of alternatives and works through all logical possibilities.	Cuts the problem down to size by quickly identifying relevant schemas and then uses them to analyze, categorize, solve.
Works backward (unknowns to givens using means-end analysis).	Works forward, uses shortcuts, estimates ballpark answers, converts unfamiliar problems to familiar ones.
Focuses on problem solution rather than on problem solving process.	Focuses on problem formulation and problem solving process and knows solution will come.
Has little self-awareness of the strategies being used.	Has great self-awareness and a plan for the strategies being used.

Section C
Transfer

What it is

In applied settings, transfer is typically viewed only as a product of training. A much more profound influence of transfer on behavior is due to its role as a process of learning.

Transfer as a process of learning

The continuity of behavior is attributable to transfer as a process of building new learning on old learning. Experience is a complex matrix of discriminations that is generalized selectively to each new experience. Everything from simple motor skills to profound understandings depends on what experiences have gone on before and how they are brought to bear on the present. This is transfer as a process of learning.

How transfer works

Much experimental and theoretical effort has been directed toward understanding how transfer works as a process of learning and how to optimize it for particular purposes. While any brief explanation of transfer in these respects seriously oversimplifies the concept, one may begin by considering transfer a generalized discrimination system. Its effectiveness and efficiency as a process thus depend on the adequacy of discriminations at the time, and on the scope and structure of the framework within which the discriminations are generalized.

Building learning on learning

The idea underlying almost all of the preceding discussions is that one learns something new by building on what is already known. As knowledge increases, there is an ever-expanding generalization, and discrimination, of a complex knowledge base. At the same time, new learning experiences add to the knowledge base and can be built upon in the future.

Influence on training design

At any point in training, there should be deliberate provisions for drawing forth from students whatever is in their background that can be effectively and efficiently brought to bear on training issues at hand. Training design for given objectives should anticipate how what is learned in one set of exercises can be incorporated into the knowledge base in such a way that it can be further built upon in later training.

Section D
Learning Hierarchies

Definition of hierarchy

As used here, learning hierarchy refers to an organization of skills and related elements that shows when transfer would occur during learning, building learning on previous learning.

Hierarchical levels

At the bottom of the hierarchy are those skills and elements that should be learned first. Their priority is due simply to the fact that once they have been learned sufficiently, they facilitate learning of skills and elements at the next hierarchical level. In turn, what is learned at the second level facilitates acquisition at the third level, and so on. To take advantage of this process, it is necessary to know what learning facilitates other learning and to conceptualize the hierarchy accordingly.

Alternative hierarchies

Due to the complexity of behavior and of the interactions of required discrimination systems, more than one arrangement of the hierarchy can work. Hence, optimal training must select among alternative hierarchies and choose those best for the purpose. Unfortunately, what may be best for efficiency of training as measured by speed of skill acquisition may not be best by some other criterion, such as retention. Furthermore, individual trainees differ in learning styles, which are important determinants of how a learning hierarchy should be arranged. A learning style is identified, in effect, by the optimal hierarchical structure for learning.

Difference between learning hierarchy and skill hierarchy

It is important to recognize that a learning hierarchy is not the same as what is called a "skill hierarchy." The latter usually refers to an organization of skills and elements defined by their relation to job requirements. Such an organization would rarely conform to experts' schemas for skill performance.

Section E
Short-Term Processes

Definition of short-term processes

Short-term processes comprise the interface between a performer and a task situation, and between training delivery and a student. The individual brings experience to the situation, and what happens depends largely on the nature of previous learning that is brought to bear. Two concepts, encoding and chunking, are involved.

Where to read about it

This section covers two topics.

Encoding

Definition of encoding

Encoding is the process of taking the incoming "message" and putting it into meaningful "code" or units.

Encoding

A brief look at the process of encoding will clarify what goes on when a performer or student approaches a task. Generally, there are four encoding steps that comprise what is often referred to as "pattern matching."

1. Selection of factors for attention.
2. Transformation of factors (e.g., stimuli) into meaningful representations (e.g., cue recognition).
3. Abstraction of patterns of the transformations, sorting out what goes with what in what order.
4. Spelling out the results as needed to understand the task.

After a skill is learned, these four processes become more or less automatic.

Encoding by experts

Experts bring more knowledge and experience to a situation. Thus, experts are more likely to pick up all relevant stimuli (step 1), have a greater variety of useful transformations available (step 2), have better habits of abstracting key features of patterns (step 3), and be more versatile in obtaining the final pattern match (step 4). Experts are also more likely to recognize failure to obtain an adequate match.

Encoding by students

Students typically fall short on all four of the encoding processes. In fact, a major goal of training is to provide the knowledge and processing skills that make these four steps automatic and comprehensive. To do so, instruction must build on the experiences students bring with them at the beginning, and provide new experiences as required to expand or replace older ones.

Chunking

Definition of chunking

Chunking is the process of establishing relationships among units so the organization of the units has meaning to the performer or student.

Example of chunking

Most people can usually recall no more than nine unrelated numbers if pronounced without emphasis and one second apart. (The average for adults is seven digits.) More can be recalled if pronounced in a rhythmic manner because the rhythm imposes an organization that the hearers can adopt.

The same is true for unrelated words. But if the words comprise a sentence, a large number can be remembered, not just immediately, but for days, even years. Through meaning, a sentence organizes–"chunks"–the units. Thus, though one may be able to recall only seven or so new digits presented one second apart, one may just as easily recall seven chunks of digits such as phone numbers where each chunk has several digits.

Why chunking Is necessary

Chunking in the sense of meaningful organizations of units is obviously necessary if one is to respond to multiple factors in performance situations. An insight into how it can be brought about was suggested by earlier sections regarding the need to pattern cue and response systems. The most useful patterns are those grounded in experience. Further, the inclusiveness and efficiency of chunking in given situations will be determined by the degree of hierarchical structure developed within the process.

Chunking should derive from existing meaning structures, especially those that go beyond rote learning and are organic in nature. When we speak of chunking, then, reference is to the complexity of cue-response organization discussed earlier.

Mnemonics and chunking

Mnemonics are memory-improving systems for organizing information and thereby facilitating its retention. A more useful application of mnemonics is in reference to strategies for chunking and other aspects of encoding that go well beyond rote memory. Hierarchical processing systems are mnemonic in function, and they run the gamut to, and include, expert systems.

Section F
Long-Term Processes

Definition of long term processes

Enduring learning is stored in long-term memory. In this discussion, we will ignore what long-term memory is and what "storing" might involve. This focus is on processes that characterize the long-range effects of learning and how past learning becomes adapted over and over again, as situations require.

Training to proficiency

Training to proficiency is a powerful approach. If training is designed for only one or two trials where all objective indicators are acceptable, neither mastery nor organic knowledge will likely result. Research has demonstrated that when an event such as air refueling is mastered in the training device, training to proficiency in the aircraft is significantly reduced (Nullmeyer and Rockway, 1984.) There should also be ample provision in the future for continuing practice on the skills in other contexts to ensure a broad range of experience in using the skills.

Section G
Integration of Human Activities

Introduction

Categories of learning help us understand the complex process of human learning, but in application the approach is to integrate. Fishburne, Spears and Williams (1987) noted that integration is such a complex process that training could surely be improved if conditions fostering integration were identified and exploited during instruction. Useful terms in discussing integration are schemas, enterprise theory, and metaskills.

Where to read about it

This section covers three topics.

Schema

Definition of schema

"Schema" is probably the most valuable concept in modern psychology. The term usually refers to a hierarchical organization of cue-response processing patterns that govern the adaptation of behavior to the situation at hand.

Cue and response selectivity becomes attuned to goals and conditions for performance. The governing schema must be sensitive to changes in pertinent cues and responses as requirements evolve during the performance. The schema must also be sensitive to changes in conditions as they affect cue and response selection.

Fishburne, Spears and Williams (1987) also described a possible schema structure which would show patterns, relationships, situations and circumstances, similar schemas, approach, attention required, subgoals or checkpoints, rules, context and dynamic patterns (timing, coordination, variation, cause-effect factors). Again, this illustrates the complexity of learning. The formulation of schemas takes place within an enterprise.

Schema as an adaptive transfer system

A schema is an adaptive transfer system. Its value in performance, and for facilitating a learning process, depends on its comprehensiveness relative to the situation at hand. Comprehensiveness requires not only adequate scope, but also appropriate discriminations among nuances of variations in cue patterns and response requirements.

Comprehensiveness of schemas

Building appropriate schemas is essential for skill adaptability or "robustness," as it has been called. One of the primary differences between expert and nonexpert performers is in the comprehensiveness of the schemas that govern their performance.

Skill adaptability and skill retention

All training should target schema development. The resulting organization and patterning of skills and their components are critical to skill adaptability and skill retention. Further, because comprehensive schemas are elaborate transfer systems, the earlier they develop the greater their value in subsequent learning (learning to learn).

Success of learning hierarchies

The success of a given learning hierarchy in training design will depend on the extent to which schemas for separate skills come to encompass more than just the specific conditions for practicing the separate skills. It is for this reason that prolonged practice under restricted conditions can lead to rigid, nonadaptive performance. Only limited schemas are called for, so performance becomes relatively task- and condition-specific.

Relationship of cognitive processes and schema development

It should be apparent that cognitive processes are critical to comprehensive schema development. This is especially true of language, whether overt or as an implicit mediational vehicle. For adults, language is a highly generalized, highly discriminative system. The more required generalizations and discriminations that can be meaningfully formulated by a performer, the greater will be the skill adaptability. Other non-language cognitive processes also serve important mediational roles in this respect. Many persons depend on implicit visual imaging during motor performance.

Enterprise

Definition of enterprise

An enterprise is a purposeful, planned activity that may depend for its execution on some combination of verbal information, intellectual skills, and cognitive strategies, all related by their involvement in the common goal.

Gagné and Merrill (1990) proposed a method to identify learning goals that require an integration of multiple objectives. They proposed that such an integration of multiple objectives be conceived in terms of the pursuit of a comprehensive purpose, in which the learner is engaged, called enterprise.

Task for instructional designers

The task for the instructional designer is to identify the goal of a targeted enterprise, along with its component skills, knowledge, and attitudes, and then design instruction to enable the student to acquire the capability of achieving this integrated outcome. The student works toward a goal and wants to achieve.

Relationships between enterprises

Relationships between enterprises begin in part task training, starting first with normal procedures. The initial enterprises are simplified goals with proficiency required before proceeding to the next enterprise. Relationships are established part-to-whole and practice begins in integrating related enterprises. Through this process, learning is built upon learning and enterprises become more complex.

Macro approach to understanding

Variations such as emergency procedures are introduced and interactions are required with other players. The resulting complex enterprise performed proficiently under varying conditions must be organized in a manner that can be described in terms of hierarchical relationships. This is a macro approach to understanding enterprise components and the strategies for accomplishing them.

Example of enterprise development

A good approach to understanding what must happen during successful development is to focus on the differences between the schemas of novices and those of experts.

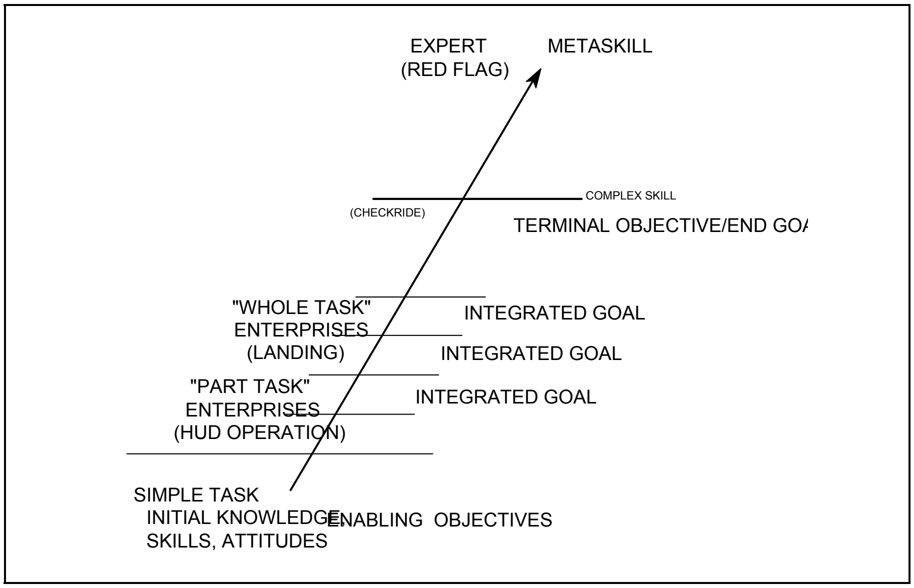
Novice. In aircrew training there is a point called acquisition of initial proficiency when the new pilot can accomplish all the checklist items and perform the maneuvers correctly. There the integrated performance is that of the novice. The instructor recognizes that the right schemas for safe flight are formed, but the novice must continue to work other enterprises in order to gain "age and experience."

Expert. The pilot continues from initial qualification to mission or combat qualification. The schemas are now expanded to meet the demands of the "real world." The squadron commander knows that this is not enough. Exercises such as Red Flag, combat training in simulation and in-flight practice in multiple situations build on the schemas. In time, the expert emerges, having achieved a repertoire of metaskills.

Progression from simple task to metaskill

Figure 2 shows the progression from simple individual objectives to the more complex end goal or terminal objective. The integration of multiple objectives, or enterprises, is developed along the simple-to-complex continuum. The highest plateau on this continuum is the metaskill.

Figure 2 Enterprise and the Continuum from Simple Task to Metaskill



Metaskill

Definition of metaskill	Spears (1983) defined a metaskill as the complex skill of adapting, monitoring, and correcting the use of individual skills in complex performances that integrate all learning processes. The person with metaskills can deal with even novel situations successfully.
Generalized and discriminative metaskills	A metaskill is the skill required to adapt the specific skills it affects to the requirements of a situation. The more developed the metaskill, the greater the variation among situations that can be accommodated. The more discriminative the metaskill, the more likely that given adaptations will be appropriate and precise.
Incorporation of schemas in metaskills	A metaskill thus incorporates schemas for performance, becoming a transfer system that can serve as both a process and a product of training. It should be noted at the outset, however, that metaskills are typically complex systems or composites. They involve hierarchies of components and ranges of complex enterprises. The components will normally vary in nature, ranging from verbal systems to kinesthetic systems.

Chapter 4
ATD INSTRUCTION WITHIN THE TOTAL TRAINING SYSTEM

Overview

Introduction

This chapter presents key issues to be considered in the design of aircrew training devices within the total training system. These issues have broader application than aircrew training device design.

Considerations for the total training approach

The total training approach takes into consideration three things:

The full life cycle of training from entry to exit for any person in the operation, maintenance, or support of the defense system.
Every situation and any environment in which training will occur in order to achieve the goal or mission.
Confidence that the pilot or aircrew will succeed in achieving the goal or mission and returning safely.

Achieving "Perfect Practices"

Vince Lombardi once said of his total training design:

"Practice does not make perfect; perfect practices make perfect."

The following key issues lead to the design of aircrew training devices so that "perfect practices" can be achieved within the total training system.

Where to read about it

This chapter contains eight sections.

Section A
Total Training Approach

Building learning on learning

The total training approach recognizes that the most profound facilitator of learning is efficient and effective building of learning on previous learning. Another way to say this is to capitalize on the concept of transfer in the process of acquiring a skill. This ties the new skill to the context in which it will be integrated, which enhances the retention of the skill.

Discrimination of differences

Discrimination of differences in situations and the requirement to achieve the goal within those situations are presented in a broad context so that the skill is more adaptable and becomes more robust through experience. As much as possible, meaning is gained by the learner in a natural way, which also enhances motivation.

Conceiving the "big picture"

Success in this approach is in the analysis and design phases so that the comprehensive "big picture" is conceived and the appropriate schedules of learning experiences are derived. This design establishes the pattern of skill components within the enterprise hierarchy. There are several good ways to implement this approach. The key issues in the remaining sections will guide you in doing it correctly.

Section B
Structure of Skill Repertoire (Training Tasks List)

Task analysis

The task analysis provides for the aircrew a set of required skill repertoires from a very limited perspective. It does not take into consideration the many circumstances in which various skills must be adapted for successful performance; nor should task analysis try to capture all possible circumstances. However, no training program can be successful if all these circumstances are ignored.

The expert performer

The difference between an expert and a novice is in their skill repertoires. The expert has a skill repertoire in which separate skills are integrated into broad complexes of skill patterns, together with conditions for their performance.

Metaskills

A pilot with years of experience in all phases of flight can develop a broad spectrum of adaptive skills, which in time emerge as metaskills. The schemas formed as the tasks from the task analysis are brought together in enterprises. These enterprises provide the foundation for this broad spectrum. The goal of training is to hasten this normally slow acquisition of metaskills.

Key to structuring skill repertoires

The key to structuring skill repertoires is to keep in mind the moment-to-moment adaptations required by circumstances in phases of flight. Properly designed training should:

Build the integration as much as develop individual skills separately. In order to understand the nature of the integration, one must understand the broad similarities among expert repertoires.

Use the understanding of integration to develop enterprise hierarchies. The patterns should also show what to avoid to prevent interference of learning during training. Some skills support others while some interfere.

Example of structuring

During practice in a simulator, it may be desirable after a landing to reset the initial conditions over and over to a point in the approach where several attempts can be made in a short period of time. For a novice, much could be accomplished. Immediate retrials would take advantage of whatever memory traces had not yet dissipated. At the same time, it would normally be desirable to vary the initial conditions each time the simulator is reset–a slightly different altitude or attitude, a change in wind speed or direction, etc. By so doing, skill adaptation is practiced along with landing.

ATD advantages in structuring skill repertoires

Variation in initial conditions occurs naturally in an aircraft insofar as some parameters are concerned (e.g., altitude), but the simulator has advantages. These advantages include immediate retrials, greater possible variations in conditions during a given practice period, etc.–advantages that allow a degree of control in the development of skills (and their underlying metaskills) that is not possible in the aircraft.

Section C
Organization of Training

Why organization is important

Training should be organized so that effectiveness and efficiency are jointly optimized. In practice, there are realistic constraints such as the number of aircraft that can be generated for training in a given day and the number of instructors available. Other constraints come from cost control measures and time and facility limitations. Without regard to constraints, the basic principles remain the same. Constraints may impact how these basic principles are implemented. Important considerations for the organization of training are discussed in the five subsections that follow.

Where to read about it

This section covers five topics.

Sequence of Training

Present sequence of training

Overall, the present sequence of aircrew training by stages is quite valid on logical grounds. Given certain entry skills on the part of the trainees:

Initial qualification training provides for basic orientation to skill requirements and development of basic skills.

Mission qualification training ensures that trainees learn to perform their respective skills to minimal levels of mission proficiency, both as individuals and as members of a combat team.

Continuation training ensures that proficiency in the acquired skills is maintained, performance is "polished," and new variations are learned.

The achievements must generalize to a variety of situations never before encountered by the crew, and must generalize immediately in operational circumstances.

Principles applicable to sequencing of training

Decisions for sequencing training are guided by six principles:

Build learning on prior learning. To optimize training efficiency and effectiveness, it is necessary to build learning on prior learning. The training designer should understand interrelations, especially those that are supportive, among various skills and skill components. From this knowledge, learning hierarchies can be identified, at least to a first approximation. Knowing the organization of learning hierarchies, building learning on learning can be accomplished in a straightforward manner.

Facilitate transfer as a process of learning. Sequencing of training experiences should be such that transfer as a process of learning is maximized, other things being equal. As illustrated in an earlier example, the close response-feedback loop required for a pilot to fly by instruments can result in a highly generalized skill of aircraft control, so generalized that it can transfer to a variety of flight control

Principles applicable to sequencing of training (Continued)

tasks and under a wide range of flight conditions. This fact alone speaks for fairly early practice of instrument flight skills. Similarly, many other skills can have broad effects on the learning and performance of others.

Maximize meaning for a complex of separate skills. There is another dimension of the sequencing issue that deserves considerable attention. The concern in this case is the meaningfulness of practice at given times (and hence student motivation as well). Meaning necessarily incorporates interconnecting among skills, performance, goals, situational factors, etc., that promote both skill acquisition and retention. (Meaning is also the primary vehicle for the development and manifestation of metaskills.) Thus, it is important to maximize meaning to the extent practicable during every training experience.

Establish appropriate anchoring experiences in a timely manner. Without discounting the roles of overall verbal comprehension of interrelations among tasks, it is still necessary to realize that many—in some cases most—meanings are perceptual and visceral in nature. The essential characteristics of the required meaning systems cannot be understood through verbal descriptions alone.

The training problem, then, is to ensure that appropriate experiential foundations, in the concrete sense, have been established in a timely manner. Familiarization rides for beginning student pilots prior to flight training obviously have this need in mind. But the issue should permeate the conception of an entire training program, especially at the stages where trainees may encounter tasks and situational requirements for which they have no prior anchoring experiences.

Target metaskill development day-to-day. This is done by drawing attention to the approaches used by experts. One method is to encourage learners during training practices to conceptualize and verbalize what they are or will be doing. Then the instructor puts his or her approach in context of the approach used by experts. This context should be directed so that clear discrimination occurs and builds to more generalizable metaskills.

Observing metaskill development

The tenuous observable status of day-to-day metaskill development is little problem provided that:

- The development is provided for in daily training plans.
- The provisions are not compromised by daily objectives that students are to achieve at the time.
- The overall training design ensures continuing provisions for metaskill development.
- Metaskill proficiency is assessed at appropriate times and proper remedial training is provided if necessary.

Team Training

Team training requirements

The concept of metaskill is useful for understanding the essence of teamwork, and hence of team training requirements. In fact, teamwork can be characterized as a special kind of metaskill. Individual crewmembers must perform their various duties within constraints imposed by the activities of other members of the team. As varying situations require each member to adapt his or her skills to a matrix of situational factors, the constraints on others arising from each person's adaptations also vary from situation to situation.

Aircrew teamwork example

The problem is perhaps best exemplified in the management of crew resources, especially under conditions of stress. It may often happen that a given crewmember would have to give a second member assistance with tasks the first member normally would not perform. In some cases, the first person may have to perform the entire second set of tasks while keeping up with, or handing off, normal responsibilities. Individual crewmembers should be sensitive to such evolving requirements; this state of readiness to act when called upon is integral to team training.

Description of formal programs to train team members

Line-oriented flight training (LOFT), mission-oriented simulator training (MOST), and cockpit resource management (CRM) are formal programs to train team skills, as opposed to individual skills. However, in practice LOFT, MOST, and CRM are used mainly to add an element of teamwork to crews who have already achieved considerable proficiency in their individual skills. When viewed as efficient learning of a metaskill, the practice of team coordination by novices should occur to some extent with almost every skill while they are learning it. It should begin as soon as they have acquired enough proficiency not to disrupt other members of the team due to ineptness in their own personal domains. This is not to say that every practice session should be team-oriented.

Principles applicable to coordinating team training

Training for team coordination should recognize six principles:

As a metaskill, team coordination will develop gradually.

Varying the skills and conditions to be coordinated will foster its development. Mastery of team coordination for particular skills and conditions is not of itself indicative of metaskill development.

Team coordination should be incorporated into practice as early as possible. This assumes each crewmember has overcome any ineptness in skills that would disrupt team efforts. It is not necessary, or even desirable, that once team coordination becomes an implicit aspect of practice, it should be so for every practice session. There should be ample provisions for independent and individualized instruction in areas of need, whether for mastery training or for practice on new skills.

The ultimate goal of comprehensive crew coordination should not be stated as a formal objective to be achieved during any one-practice session. Crew coordination is an orientation and awareness of personal responsibilities in context of the team. It includes who does what, when, and to whom, and involves timing, sequencing, decision authority, and response. Crew coordination is in context of the team effort to achieve the mission. The formal objective is the successful completion of the event.

As learning progresses, provisions should be made for periodic checks of the status of team coordination. The times for the checks should be such that levels of team achievement can be identified and assessed. It is at such times that objectives for the metaskill of team coordination are meaningful, and the objectives should be stated in terms of coordinated team behavior.

Any deficiencies noted following periodic assessments should be diagnosed and remedial measures implemented.

Part-task Training

Part-task training

Part-task training (PTT) is often a poorly defined concept. With PTT, a learner typically breaks any whole task, no matter how small at the start, into facets, only one or two of which will be the focus at any particular time. Research indicates that the focus shifts from facet to facet, on a moment-to-moment basis, depending on the extent to which the learner's immediate goals at the time incorporate the facets.

Example of PTT

When first practicing landings, a student pilot's focus shifts from, say, airspeed control to angle of attack to line-up with the runway to glideslope, and back again, over and over, to any facets that the pilot is capable of incorporating into the effort without disrupting the whole process.

Practice and integration of facets

At the outset, the student is momentarily attending to only one facet at a time, and progress will depend on the ability to monitor and control each facet when, and as, circumstances require. With practice, at least some separate facets will be integrated perceptually and behaviorally into a single facet (e.g., angle of attack and glideslope). Eventually, the entire maneuver will be integrated into a schema wherein each facet has a priority for attention only as monitored feedback indicates a significant departure from expectations (templates).

Questions for designing PTT

The question for designers of part-task training is how to ensure efficient progress toward schematic skill integration both during part-task practice and later when the part-task is to be integrated into whole-task performance.

Relevant points for PTT

The example highlights four points which are relevant to designing part-task training:

A novice must adopt a part-task approach to a task of even low complexity. An instructor's preference for whole-task training notwithstanding, the learner is going to break the task into manageable pieces.

What is manageable depends to a great extent on the time available to monitor and respond to the requirements of each facet, without chaos, and on the conflicts (interference) among facets, such as simultaneously controlling airspeed, angle of attack, line-up, and glideslope. Simultaneous control of all four requires skill integration at a schema level. Manageability at a given time reduces to avoiding chaos.

The example illustrates that, with practice, the learner can come to terms with all facets, if not simultaneously, at least in acceptable patterns of variation.

The learner can eventually "insert" the skill in a performance sequence when and as required.

Plans for PTT

Plans for part-task training should consider these two general principles:

Emphasize part-task practice to a point of comfortable mechanization of the skill, and then begin integrating it with other activities. This principle concerns part-tasks that are relatively isolated from others in the whole task. That is, cues for the required actions are unique to the part-task, and the actions themselves are not part of a cueing-feedback complex that governs, moment-to-moment, the performance of the remaining part-tasks.

As an example of this principle, consider the communications with the ground or among crewmembers that occur during flight control tasks, navigation, monitoring of instruments, etc.

Avoiding interference

In these cases, the primary problem of whole-task integration is avoiding interference when the part-tasks must be time-shared. At least up to a point, such interference can be reduced if each part-task has been previously mastered to the extent that it can be performed more or less mechanically.

Avoiding isolation of part-task

At the same time, there is at least some indirect evidence that prolonged practice on part-tasks in isolation may result in performance habits that are too restricted to allow the easy adaptation to whole-task performance and the required sharing of attention.

Task context

It normally helps if, during part-task practice, the learner maintains cognitive or situational awareness of the entire task context and how the context affects, and is affected by, the part-task. Thereby, the eventual schematic organization of the whole task should be facilitated.

Refresher training

For experienced performers undergoing refresher training, whole-task integration usually is not a significant issue, so even prolonged part-task practice should be productive.

> **Develop a general schema in which separate responses take into consideration their total effects.** This principle concerns part-tasks that are not isolated from the others in the whole tasks. The earlier landing example is a good illustration. The problem to the novice is that responses to one element affect the status of others. Prior to integration, trainees normally trade off attention among task elements.

How to identify skills for PTT

Training designers, depending perhaps more on experience than logic, should consider part-task training when:

> Beginning trainees trade off attention among elements within the task.
> The scope of the part-task can be managed so that the learner does not encounter conditions that cannot be

How to identify skills for PTT (Continued)

corrected. (Device features such as parameter freeze are useful for ensuring manageability at the start.)

It is desirable to include, at the same time, all task elements whose performances directly affect each other.

Some elements are to be temporarily omitted. Care should be taken that practice does not continue for long in the oversimplified context.

It is all right if the learner has to struggle during the task, provided that noticeable progress occurs. The task should be simplified, parameters frozen, other focus techniques used only to maintain manageability. Even so, it would be wise to expose the trainee periodically and briefly to the more complex conditions to prevent restrictive, element-specific habits from developing. This also helps monitor progress.

Alternative less costly approaches

There are numerous alternative approaches to part-task training, depending on the tasks and the level of development of the learner. For this reason, training designers should also consider issues related to training resource management and utilization. In most cases, equipment needed for part-task training is usually less costly to acquire, use, and maintain than that required for whole-task training. Hence, using less costly equipment, part-task training can also target specific trainee deficiencies for intensive practice. This can be done without entailing similar effort on related skills on which the trainee has already reached at least a tentative level of proficiency.

Learning Styles

Variations in learning styles

Recent years have seen an increasing emphasis not only on processing habits in skill performance, but also on variations in processes which different students depend on to learn a skill.

Learner Difference. "Visual" and "auditory" learners are mentioned often to designate, respectively, those who learn more readily through reading and graphic displays versus those who do better if they hear the same material described. Another difference is that some people learn more easily when an idea is presented in a mathematical equation, while others require a verbal formulation of the same idea. Still another difference is due to the extent of "field dependence" versus "field independence" on the part of the students.

Do a learner's actions and thoughts have to be led or guided via a lot of direction, examples, etc.? This is an indication of dependence on the "field" of external stimulation. Or does the learner do better with a minimum of guidance, relying on himself or herself instead? This is an indication of independence of the external "field."

Learning styles. These and other differences are referred to as learning styles.

Benefit of computer-based training

With the advent of computer-based training (CBT), it is feasible to consider learning styles during courseware development. Good textbooks have attempted to do so for years, of course, by presenting more than one approach to materials to be learned. But CBT can mix auditory with visual presentations, use animated graphics, and have the learner interact physically with a simulation.

Conducting target audience analysis

Whether a training program is blessed with talented students or must serve a mixed lot, training designers should anticipate major patterns in learning styles and allow for them. In doing so, persons who plan the training should have information regarding variations in major strengths and weaknesses of the student population.

Because poor reading is such a common difficulty in many training programs, it is important to identify the likely incidence of this problem first.

Individualized Instruction

Individualization and compromise

The preceding discussions imply that learning is a highly individualized and personal process. Ideally implemented, instruction would be tailored to each trainee's peculiarities with respect to learning hierarchies as determined by individual learning styles: rate of progress on separate skills and metaskill development, specific training difficulties, etc. As an efficient system for training, however, compromises may be made in individualization of training. In some cases, chaos could result.

Effective general plan

An effective general plan is to develop a model program that:

Recognizes the value of individualizing instruction to the extent feasible.
Is adaptable to broad classes of individual differences, especially concerning development of skill mastery.
Has provisions for individual instruction when feasible and desirable.
Implements assessment and diagnostic procedures that identify training difficulties that indicate needs for individualized guidance and practice (instructors play a critical role here).

Five principles applicable to learning foundations

Five principles regarding the development of learning foundations are presented below.

Developing metaskills is just as important a concern for individualization as development of the separate skills that they govern. While instructors often recognize this intuitively, they often do not know how to teach metaskills specifically, and they know even less about how to assess and identify problems in their development. If, as suggested, metaskills are targeted early in training, it will be necessary to prepare instructors for these responsibilities.

Five principles applicable to learning foundations (Continued)

Emphasize the peculiarities of learning metaskills. When narrowly conceived, training to proficiency on particular tasks, as a universal guide for individual practice schedules, can lead to inferior metaskill development. Proficiency on task- and condition-specific performance is no guarantee that broadly adaptive schemas have been acquired. In fact, and paradoxical though it may seem, metaskill development can be expected even when criterion performance is not achieved until the learner is fairly well along in training. This is not to say that one should not train to proficiency. Rather, the intent is to emphasize the peculiarities of learning metaskills. The requirement is a variety of experiences for task performance, using different combinations of tasks and task elements.

Once a trainee has achieved proficiency on specific task-condition performance, the trainer should permit additional practice, even under conditions that might never normally occur.

A fairly common observation in pilot training is that, when left to themselves, students often try "way out" stunts in a flight simulator. Instructors have been observed doing the same thing. From the standpoint of metaskill development, this is a good practice so long as normal discriminative cue-response complexes are maintained through practice in realistic situations.

Recognize the central role of transfer as a process of learning and tailor individual instruction accordingly. The individualization of instruction under the philosophy expounded here would surely result in better skill retention, and hence less need for refresher training. Building on each trainee's past learning, ensuring achievement in the process, should result in more meaningful learning and superior skill integration. Retention rests on meaning and integration, especially as the point of habitual patternization of skills is reached. Hence, it is important that individualized training be more than just trainees practicing separately.

Five principles applicable to learning foundations (Continued)

Allow trainees some flexibility to individualize their instruction. Students will often recognize their needs better than their instructors will, especially with respect to disruptive interference patterns. For evidence, one need only recall that, as in an earlier example, novices' trade off attention to facets of a skill, concentrating on what they feel to be important at the time. Instructors are typically unaware that this is happening. Obviously, trainees can identify some particular difficulties in their performance that instructors may not notice. Therefore, there should be some opportunities for the trainees to manage their instruction as they see fit. Occasional monitoring of the trainees will ensure that the time is well spent.

Ensure that team training follows the above principles. Team training should follow principles that are analogous to those listed above. The team as constituted at a given time is a unit, and it will have its own needs and peculiarities.

Section D
Attitudes

Concept of attitude

In aircrew training, the attitude of the instructor and the attitude of the student toward using a training device, rather than an aircraft, impacts the effectiveness of the training.

Role of attitude

Attitudes reflect sensitivities to certain kinds of information and selection of certain habitual modes of processing and responding to information. To tie into the discussion of goals, for example, a student or performer who is said to have a "poor attitude" is one whose self-based goals fall short of normal requirements. Attitude governs what one responds to, how it is interpreted, and the actions that follow. An attitude has a strong evaluative component, usually with emotional overtones—"I like it!"

For example, the new pilot has learned from past experiences that trust in the instructor and doing what the instructor says will result in safe flight. As the pilot begins initial qualification on the new aircraft, the attitude is to continue that pattern.

Establishing performance goals

What governs quality of job performance, day in and day out, are the goals that performers set for themselves. Goals become equivalents of manifestations of effort; of how much effort performers are willing to make to satisfy themselves in what they do. A training developer might decide to focus on an enduring pride of accomplishment on the part of students, a life-long positive attitude that makes everything turn out right. That developer should look forward to success only with students who have this characteristic already generalized in their behavior. For other students, training that targets such an attitude will be tantamount to preaching.

Skill mastery

Experts in skills expend less effort than novices in performing the same tasks, and experts perform at a superior level. Perhaps this is one reason many people strive for skill mastery–it makes a task easier to perform.

Related to performance are proficient ways of processing information. During the item-by-item analysis of performance, identify what processing has become more or less second nature to achieve quality in performance. The implication of this point is that training in the long haul–total training–should make proficient performance easy compared to nonproficient or borderline performance.

Milestones of achievement

A critical point: students' general and specific comprehension of what they are doing, and why, should advance day by day. As they complete a lesson, they should grow not only in the specific skills addressed that day, but in overall skill comprehension as well. They should recognize which holes are being filled.

The overview should have milestones of achievement against which students can regularly assess their progress. At the same time, emphasis should not be on how many skills or skill components have accumulated. Progress should be related to a real-life view of skill requirements. "You have learned to do X yesterday and today. Tomorrow you will see how this fits into (applies to, etc.) these other tasks."

Section E
Feedback

Importance of feedback

The most important thing in maintaining interest and effort during training is recognizing that one is making progress. Feedback regarding effort is essential. Never leave students in doubt as to whether they have learned something. Even if progress has been slow, find something that is done correctly and point it out; they may not be able to recognize it themselves. Also, provide other encouragement on a regular basis.

Intrinsic feedback

Inherent in training is the goal that students recognize and interpret feedback that is a natural outgrowth of their actions. This can be termed "intrinsic" feedback because it is intrinsic to performance itself. If one turns the steering wheel of a moving car, the direction of movement changes. By visually noting this feedback, the amount and rate of change, the driver can monitor the pressure on the steering wheel so as to achieve the desired direction of movement. At the same time, the tactile sensations arising in the hands from pressing the steering wheel, and the kinesthetic sensations from muscle contractions, are also important intrinsic feedback cues.

Supplemental feedback

In contrast to intrinsic feedback, supplemental feedback is not a natural outgrowth of actions. As the term suggests, the feedback is added to any intrinsic feedback that might occur. In training, supplemental feedback is often contrived to take the place of intrinsic feedback. Two general applications follow:

> If students are not far enough along to recognize intrinsic feedback, supplemental feedback substitutes for intrinsic feedback while discrimination of the latter is being learned. Given practice situations may not be capable of providing intrinsic feedback as it occurs in real contexts. This is true for most part-task training as well as CBT when perceptual and motor components are represented symbolically. In these cases, creating supplemental feedback is necessary.

Using supplemental feedback

An important principle for using supplemental feedback in training is that it should be designed, and timed, to focus attention on intrinsic feedback that is to be discriminated. Specificity of feedback is very important. If feedback is too general, it cannot guide attention to specific factors intrinsic to actions.

Students must focus on integrating what they are practicing and how it relates to whole skills and to situational factors not represented in part-task contexts. It is usually necessary to provide them information about the effects that their actions would have on the total system. Without such supplemental feedback, eventual skill integration could be delayed, because there would be no basis for anticipating the missing intrinsic feedback. Worse, students' comprehension of skill requirements could become restricted to part-task contexts in ways not easily overcome.

General rule for using supplemental feedback

A general rule for the use of supplemental feedback is to reduce or withdraw it systematically as proficiency progresses. If from direct observation or monitoring a student is found to be floundering, temporarily provide more supplementary feedback. Help the student focus on the discrimination of intrinsic cues and their interpretation.

Timing of feedback

Effective timing of the delivery of feedback to the student depends on how the feedback is to be used by the student.

Soon enough. In an ongoing, dynamic practice, feedback must be available soon enough to allow the performer to make needed adjustments during the action. For closely coordinated actions, such as perceptual-motor responses, delay can be disastrous. The latest time feedback should be available is determined by how long it takes the performer to interpret the feedback cues and process them into the action dynamics.

Not too soon. In practices where the response time is not a critical factor, feedback is less effective if given immediately and it becomes disruptive. Feedback provided either too early or too late can disrupt rhythmic coordination.

Timing of feedback (Continued)

Self-feedback. If practice is intended to have students learn how to evaluate their own actions and develop the expectancy templates needed for the task; feedback provided too early can stop the process in its tracks. Both during and after an action, students should be mentally reviewing what they did, the bases for their selection of responses, and their interpretations of cues that led to actions.

Productive delay of feedback

There are times when feedback can be delayed, productively, a day or even a week. If students spend part of the interim thinking through why they might be right or wrong, and discussing it with their classmates, they will learn much more about the processing of performance than they will learn if this self-analysis is short-circuited by immediate feedback.

Section F
Practice as a Vehicle

Role of practice

Practice is simply a means, or a vehicle, whereby other things occur.

Discrimination and generalization

In the practice of task performance, students should be forced to consider alternative interpretations of task requirements, and to select from alternatives their own courses of action. Practice will also teach them how to monitor and assess the effects of their choices, and recognize when they need to take different approaches or adapt their approaches in order to increase their probabilities of success. This kind of practice will result in learning discriminations and generalizations.

Repetitive practice

In designing course content for successive practice sessions, one should keep in mind that organic knowledge, and the mastery that makes it effective, requires repetitive practice across time.

> The practice involved should have clear purposes. Thus, provisions can be made for returning to skills practiced earlier, not only for review but to broaden generalizations.
> In the process, training goals should include integration of the earlier skills with those practiced later.
> Whatever is to be integrated, whether overall interrelations among skills or overt actions accompanying separate skills, hierarchical understanding should be pursued systematically over time.

Contexts for practice

Students learn to generalize by practicing generalizations. The task for the performer is to scan the stimulus conditions and then identify characteristics that signal what to do. No two sets of stimulus conditions are identical. Unless the performer has learned to abstract the stimulus complex, as it exists, to get cue information, actions will probably be misguided. That is, one must learn to identify features that can be found in any situation where the skill is to be performed. Consider the following points:

Contexts for practice (Continued)

Abstraction. Abstraction is required because one must **create**, in one's own mind, a structure for processing whatever objective stimuli are provided so that a **constancy** of interpretive information results. The emphasized terms, create and constancy, focus the issue.

Example. An example will clarify this. Locations of fences in airport environs are not constant. Further, teaching student pilots to rely on a fence makes unnecessary the creating of a system for processing stimulus conditions that can generalize across landing fields.

Variable Practice Conditions. In restricted practice conditions, students often learn to key on factors peculiar to the conditions. In variable practice conditions, they are forced to search for pertinent commonalities–constancy amid all sorts of variations–and in so doing they abstract (create) characteristics of individual cues and cue patterns that can be recognized in numerous different stimulus complexes. This is generalization.

Variations that require generalization

Full metaskill development requires practice of a number of different skills, which involves more than simply varying conditions for practicing individual skills. Even if restricted practice conditions are indicated, introduce variations that require generalization as soon as feasible in plans for practice.

Insert something new. This can be done even though additional restricted practice is needed. Introduce periodically something new that students have to think about, then return to the restricted routine. This technique can keep the generalization requirements in evidence, thus preventing undue focus on cues and actions peculiar to immediate practice requirements. It also provides opportunities for monitoring progress toward skill adaptability that can be valuable for individualization of instruction.

Think through. Whatever the purpose of a given lesson, think through contexts for practice. Do not let them develop inadvertently as a mechanical outgrowth of a focus on proficiency requirements.

Boredom and practice routines

Regardless of the interest students may have in skills being trained, practice routines can become quite boring. This is especially true when the actions involved are tediously difficult or training content is a sequence of humdrum actions or details to be assimilated. When boredom sets in, interest flags, concentration is disrupted, and performance becomes mechanical. Learning necessarily suffers. In fact, sloppy if not outright erroneous performance often results. And if it does, it is likely to become what the student learns.

Limit duration. Plan patterns of practice so that boring routines are limited in duration for any one-practice session.

Intersperse. Boring routines should also be interspersed with practice content that is intrinsically challenging or at least interesting.

Switch trainer. Especially valuable in this regard is the availability of different kinds of training equipment–CBT, part-task trainers, and actual equipment–so students can switch not only content but also training devices.

Section G
Diagnostic and Remedial Techniques

Individualization of instruction

Individualization of instruction is probably most often achieved through analyses of sources of individual learning difficulties and of ways they can be directly addressed. Good instructors do this regularly. By observing students during practice and questioning them about apparent problems, instructors identify specific difficulties and prescribe corrective practice routines for their correction.

Increased need to identify

With the current emphasis on CBT and the correlated changes in instructor roles, there is an increased need for incorporating diagnostic techniques and remedial instruction into courseware itself.

It is necessary first to identify the kinds of difficulties that are likely to arise, and to do so clearly enough to lay a foundation for remedial instruction.

Monitoring metaskill development

In addition to basic and integrated skill development, it is also possible to monitor metaskill development in at least two ways:

> Day-to-day rates of progress. Over time the data collected from this tracking can be used to derive a meaningful norm or standard for a given stage of training. As a general rule, the greater the metaskill development, the more rapid will be the acquisition of a new variation or adaptation of the skill.
>
> Assessment of the tasks and enterprises that form the composite of the metaskill. Deficiencies in the composite structure will normally be reflected as difficulties in specific task or enterprise performance. The general principle is that the degree and rate of skill decay are dependent on the underlying metaskill.

The "Aha" phenomenon

There is another consideration termed the "aha" phenomenon–"Aha! I've got it!" The pattern is a relatively sudden emergence of proficiency in specific skills following a period of little or no apparent progress. Instructor pilots have noticed this sudden insight manifested by the student's immediate improvement in a number of related skills where there clearly was difficulty in all earlier trials. In this case, the indicators of metaskill development will not be apparent until the insight is acquired.

Proficiency of performance

Overall, once a metaskill is developed, proficiency of performance will have little variability. The indicator would be that when the student performs the composite tasks and enterprises in different circumstances or adaptations, and does them proficiently, it is apparent that the student is approaching the desired metaskill.

Section H
Media Selection for Integrated Activities

Approaches to selecting media

Gibbons (1993) described a method for selecting media for integrated activities. The following table shows the approaches to consider when selecting media for integrated learning activities. Examples of learning activities for each approach are provided with possible media for supporting those activities. The instructional designer should consider the learning activity for which instruction is being prepared and select the appropriate media to achieve the integrated goal, end goal, or terminal objective.

Approach	Example of Activity	Example of Media
Provide alternate media for presentation and practice.	Function of parts	Computer-based training (CBT)
	Procedures	Part-task trainer or simulator
Provide multiple media for the same task.	Emergency procedures	Classroom, CBT, simulator
Provide intermediate practice exercises.	Air refueling	PTT, simulator, aircraft
Provide repeated, spaced practice.	Landing an aircraft	Simulator, aircraft

Advantages of optimal training

Human beings can learn under a variety of conditions as long as the learners are motivated, their goals are reasonably well defined, and they can discriminate between adequate and inadequate responses. They can even learn under the training regimen that violates most, if not all, standards for good instructional practices. The advantages of optimal training programs lie in the efficiency of training with respect to the following:

Advantages of optimal training (Continued)

Cost and time required.
Operational adaptability of the learning to situational requirements.
Greater retention of learning.
Avoiding the acquisition of erroneous or maladaptive habits that interfere with proficient skill performance.

To help ensure optimal training in the device-based arena, the following media selection table (in five parts) may help you choose the appropriate media that matches the training you have been tasked to perform. **Note: In most cases, these tools are simply support tools to help the instructor obtain the specific lesson objectives.**

Training Media Selection, Part 1

TRAINING	MEDIA SUBSETS	TRAINING FUNCTIONS
Self Study	Tech manuals, tech orders, workbook, audio and videotapes, supplementary materials.	Cognitive–predominantly symbolic/representational didactic process.
Academics	Classroom lecture, seminar, audio-visual media, mockups, and demonstrations.	Cognitive–concepts, procedural knowledge, decision-making knowledge.
Interactive Courseware	Computer-based instruction, interactive simulations. Digital video interactive and interactive videodiscs are technology enablers.	Cognitive, psychomotor (partial). Perceptual skill development.
Familiarization Trainers	Cockpit familiarization. Avionics familiarization.	Cognitive–knowledge of system operation. Procedural/sequential operations.
Part-Task Trainers	Cockpit and avionics familiarization, switchology, emergency procedures, air intercepts, air-to-air combat, air-to-surface weapon delivery, multi-task and unit training device trainers.	Cognitive–knowledge of system operation. Procedural/sequential operations. Psychomotor-tactile facilitation and stimulation. Decision-making knowledge.
Operational Flight Trainer/ Simulator	Simulator with or without visual system, domed simulator, networked systems.	Permits high skill development prior to, or in conjunction with, aircraft training phase.
Weapon System Trainers	WSTs for specific aircraft.	Supports full mission training or rehearsal.
Actual Systems	Aircraft. Embedded. Electro-optical devices. Helmet displays.	Supports full mission (non-threat) training or rehearsal.

Training Media Selection, Part 2

TRAINING	LEVEL OF INTERACTIVITY	TASK FIDELITY
Self Study	Representational. Abstract.	Not essential.
Academics	Student/group responding activities, random/frequent verbal questions, frequent summaries.	Cognitive media generally restricted to cognitive domain.
Interactive Courseware (CEITS)	Situational simulation. Comprehension and application. Can be networked for team interaction.	Provides high functional fidelity and low physical fidelity.
Familiarization Trainers	Capability to interact realistically with the stimuli and response characteristics of procedural tasks.	Position of controls relative to the crewmember, their configuration and tactile characteristics. Total fidelity of real-time system operation may not be critical.
Part-Task Trainers	Capability to interact realistically with the stimuli and response characteristics of specific procedural tasks in a non-threat environment.	Position of controls relative to the crewmember, their configuration and tactile characteristics. Full- fidelity simulation of the target tasks. Can be networked to provide team training. Total fidelity real-time system operation may not be critical.
Operational Flight Trainer/ Simulator	Full scale.	Near full to full-scale fidelity.
Weapon System Trainers	Full scale.	Limitations in field-of-view resolution and luminance.
Actual Systems	Full scale.	Limited by safety to personnel and equipment.

Training Media Selection, Part 3

TRAINING	FEEDBACK CAPABILITY REQUIRED	EXAMPLES OF CONTENT
Self Study	Effectiveness depends on design of study materials.	Avionics systems, weapon delivery, threat characteristics.
Academics	Instructional feedback to specific item responses.	Aircraft systems, mission planning, air combat tactics.
Interactive Courseware (CEITS)	Corrective feedback and remediation practice.	Instrument/symbology interpretation. Procedural familiarization.
Familiarization Trainers	Not specifically designed to provide feedback, but could be provided with instructor assistance.	Basic radar modes, Head-Up Display (HUD) interpretation, checklist and emergency procedure practices.
Part-Task Trainers	Instant feedback via avionics and instruments. Training scenarios can be designed to be menu- driven with options for feedback and self-practice.	Basic radar modes, HUD interpretation, checklist and emergency procedure practices. Selected aspects or tasks involved in the overall mission (see media subsets).
Operational Flight Trainer/ Simulator	Provides real-time feedback to the limit of available technology.	Instrument approaches and landings, emergencies, radar penetrations and weapon deliveries.
Weapon System Trainers	Provides real-time feedback to the limit of available technology.	Radar penetration and weapon deliveries.
Actual Systems	Training mission scenarios are briefed/debriefed to ensure feedback (usually with videotape).	Takeoff, landings, approaches, weapon deliveries, air-to-air, air-to-surface, and actual weather mission elements.

Training Media Selection, Part 4

TRAINING	ADVANTAGES
Self Study	Inexpensive, easy to revise.
Academics	Inexpensive, easy to revise.
Interactive Courseware (CEITS)	Learner-controlled visual and auditory presentation.
Familiarization Trainers	Least costly of all trainers. Allows adjustable pacing. Self-contained, portable.
Part-Task Trainers	Instant feedback in near-real environment. High-fidelity training of specific phases/aspects of system. Less costly than expensive OFT simulators. Allows adjustable pacing. Self-contained, portable. Visual motion, exact scale. Selective fidelity.
Operational Flight Trainer/ Simulator	High-fidelity training of all phases/aspects of basic systems. More efficient and effective debrief system. Not limited to peacetime- only systems. Greater fidelity. Provides limited external environment. Allows adjustable pacing, simulated external visual.
Weapon System Trainers	High-fidelity training of all phases/aspects of all systems. More efficient and effective debrief system. Not limited to peacetime-only systems. More readily available than actual aircraft. Provides limited internal and external environment. Allows adjustable pacing.
Actual Systems	Total reality and fidelity to the limit of peacetime use. Provides full capability for student procedural psychomotor performance to include real external and internal environmental conditions. Full-range sounds.

Training Media Selection, Part 5

TRAINING	DISADVANTAGES
Self Study	Visual presentation only, except with audio/video tapes.
Academics	Instructor-dependent as to availability and ability to teach. Visual and auditory presentation.
Interactive Courseware (CEITS)	Can be expensive and difficult to revise–timeliness of changes. Professionals required for production. Reluctance to use by training managers.
Familiarization Trainers	No representation of external environment. No moving parts or feedback from trainer. No motion.
Part-Task Trainers	Can be expensive and difficult to revise –timeliness of changes. Professionals required for production and operation. Higher maintenance cost. Space requirements. Limited external visual environment. Limited in audio and kinesthetic feedback.
Operational Flight Trainer/ Simulator	Expensive and difficult to revise–timeliness of changes. Professionals required for production, operation, and maintenance. Space and environment requirements. Limited in motion. Very expensive. Not transportable. Expensive to maintain.
Weapon System Trainers	Expensive and difficult to revise–timeliness of changes. Professionals required for production, operation, and maintenance. Space and environment requirements. Very expensive. Expensive to maintain.
Actual Systems	Expensive to operate; many support systems required; large air and ground space needed; degraded by weather; training not observable and repeatable. Availability of aircraft in required configuration. Unable to perform certain tasks for safety reasons or inability to replicate situation/scenario.

Method for assessment

A method for assessment of proficiency of performance by flight event is to use the following grading criteria based on student progress in context of instructor involvement. The scale goes from total instructor demonstration (level 1.0) to no instructor intervention (level 4.0). As a general rule, initial proficiency is defined by achievement of level 3.0.

Grading Criteria on Student Progress Reports

Level 1.0	The student demonstrated a lack of knowledge about the task or made major deviations or omissions that made accomplishment of the task impossible. The instructor was required to demonstrate proper accomplishment of the task.
Level 1.5	The student demonstrated limited knowledge of the task. Although the student can begin the task, performance deteriorates quickly and extensive instructor interaction is required to maintain safe accomplishment.
Level 2.0	The student has a basic understanding of the task, but errors or deviations are significant and would jeopardize safety or mission accomplishment. Even under ideal conditions extensive instructor intervention is required for safety or mission accomplishment.
Level 2.5	The student made errors or deviations. Limited assistance along with frequent coaching by the instructor was essential for safe accomplishment of the task. The student has sufficient systems knowledge to make correct response when provided coaching by the instructor.
Level 3.0	The student accomplished the task successfully, but there were slight errors or deviations that the student could not correct. The instructor was required to provide coaching for smooth performance, but not for safe mission accomplishment. The student can perform under ideal conditions, but would have difficulty under adverse conditions.
Level 3.5	The student was able to accomplish the task safely and successfully with minor errors or deviations. The student was able to correct these minor errors, and no assistance was required from the instructor.
Level 4.0	The student performed the task without errors or deviations. No instructor intervention was required. The student has progressed beyond mere proficiency and could probably perform well under adverse conditions.

Using the grading scale

This scale has been used successfully as grading criteria on student progress in both simulation and inflight aircrew training. The scale is the basis for rating forms that track the crewmember's performance on each flight event. See the following sample form.

Sample progress report form

A rating from the scale is given for each flight event accomplished during the training session. The form has the rating scale across the top and the flight events by phase of flight listed down the side. There is space to the side of each event for recording the rating and any notes the instructor feels important to record.

Progress Report - Flight Phase - Pilot

Student	Rank:	Crew No:	Crew Position:

Sortie Date:	Sortie Number:	Takeoff Time:	Flying Time:	Aircraft Number:

INSTRUCTIONS: Column 1: enter number times event accomplished. Column 2: enter F or D if familiarization or demonstration only. Remaining columns: enter number of times event accomplished at each proficiency level (DO-10 51-11).

Required Instr Intervention	Demonstration Required	Extensive Asst Required	Substantial Asst Required	Limited Asst Required	Coaching for Technique	None-Errors Cor by Student	None
	1.0	1.5	2.0	2.5	3.0	3.5	4.0
Student Performance	LACK OF KNOWLEDGE		SIGNIF ERRORS OR DEVIATIONS		SLIGHT ERRORS OR DEVIATIONS		NO ERRORS OR DEVIATIONS

		__ INFLIGHT __ WST			PROFICIENCY LEVELS							Narrative description of student performance, including discrepancies/ recommended corrective action if necessary.
Key	**Code**	**Training event**	**Acc**	**F/D**	**1.0**	**1.5**	**2.0**	**2.5**	**3.0**	**3.5**	**4.0**	
		Takeoff and Climb										
1	40	PREFLIGHT										
2	47	PRETAKEOFF										
3	PO8	TAKEOFF										
4	P11	TAKEOFF NIGHT										
5	P12	T.O. CLIMB PROC										
		Air Refueling										
17	P22	CELL FORM										
18	14	A/R FORM/TKR CELL (LD)										
19	R19	A/R FORM/TKR CELL (N-LD)										
20	R36	ENROUTE REND2										
		Navigation										
30	N16	NAV AID FIXING										
31	N51	CELL NAV LEG										
33	79	CRUISE										

Individual mission grade-sheet

This is another scale, which has also been used successfully in grading pilot performance. This scale does not use decimal increments. See the following explanation of grade and corresponding sample form.

Individual Mission Grade Sheet Sample

INDIVIDUAL MISSION GRADESHEET	MISSION NUMBER OFT -	POSITION NUMBER N/A	MISSION DURATION	DATE
NAME	CLASS NUMBER	AIRCRAFT MODEL F-16 ________	INSTRUCTOR	

OPERATIONAL FLIGHT TRAINER AIR-TO-AIR ALL SYLLABI (EXP 1) MISSION ELEMENTS	UNKNOWN	DANGEROUS	GRADE 0	GRADE 1	GRADE 2	GRADE 3	GRADE 4
1. MISSION PREPARATION							
2. GROUND OPERATIONS							
3. TAKEOFF							
4. TRAIL DEPARTURE							
5. WEAPON SYSTEM CHECK							
6. AIR REFUELING PROCEDURES							
a. Rendezvous							
b. Checklist							
7. FENCE CHECKS							
8. INTERCEPTS							
a. GCI Procedures/RT							
b. Radar Search/Lock on							
c. Single Turn to Collision Course							
d. Horizontal/Vertical Intercepts							
(1) Head on							
(2) Front Quarter							
(3) Beam							
e. Sorting Single / Formation							
f. Targeting Single/Formation							
9. WEAPONS EMPLOYMENT							
a. Achieve Parameters							
b. Missiles (Shots ________ Valid__________)							
c. Guns (Shots ________ Valid __________)							
10. EMERGENCY PROCEDURES							
a. Ground							
b. Inflight							
c. Landing							
d. Aircraft Control							
OVERALL GRADE							

MISSION STATUS

Effective __

Non-Effective/Student Non-Progression (NE/SNP) __

Non-Effective/Other (NE/OTH) __

REMARKS (Continue on reverse side)

Explanation of Code

UNKNOWN Not Observed / Not performed

DANGEROUS Unsafe (requires "0")

Instructor Intervention / Student Performance

0 Demonstration required / Lack of knowledge

1 Extensive assistance required / Significant errors or deviations

2 Limited assistance required / Recognizes and corrects errors

3 Coaching for technique / Correct without hesitation

4 None / Reflect high degree of ability

SIGNATURE INSTRUCTOR	STUDENT INITIALS	SUPERVISOR INITIALS

Chapter 5
GUIDELINES FOR DEVELOPING INSTRUCTION

Introduction

In the 1980s, William D. Spears worked on development of a model aircrew training system for the Air Force. The training is based on learning principles derived from analyses of complex human performance and emphasizes mastery of learning and development of metaskills.

A major goal of the training was the full integration of individual skills in the individual crewmember and the same level of skill integration (coordination) in the aircrew team. A major portion of this handbook is based on the Spears writings.

Summary of guidelines

This handbook was written as a guide for applying the ISD process during aircrew training device design considerations. This chapter summarizes the concepts presented throughout this handbook.

The concepts have implications for design of training devices as well as total training systems.

The guidelines are grouped and presented in the following order:

Presentation
Guidance
Practice: Content and Organization
Practice: Schedules
Feedback
Part-Task Training
Assessment of Progress and Difficulties

Presentation

Consider these four areas of presentation:

Build on Past Experience

Design each aspect of training with **prior** training experience in mind. How can earlier exercises and achievements be built upon?

Presentation (Continued)

Emphasize meaning for all cues and actions through associations with past experience, interrelations of skill components, and performance objectives.

Contrive ways of presenting materials that require students to verbalize what they are perceiving, doing, and why. In addition, require them periodically to relate, verbally or perceptually (via graphics, for example), what they are perceiving and doing to things they already know or are learning at the time. Insist on organization of experience, and hence of skill knowledge.

Focus on Cognitive Learning Tasks

Emphasize logical relations among task objectives, situational factors, and performance requirements. This should be done for any kind of skill, procedural as well as perceptual-motor, or application of concepts and principles.

Focus on related cognitive components during practice of motor skills. Self-monitoring and evaluation via feedback expectancies are always appropriate for their attention, and performance plans and awareness of situational factors usually are appropriate as well.

Ensure mastery of any information that must be built upon during skill learning. To prevent forgetting or cognitive isolation of previous learning, work it in periodically as it applies to new skills being practiced. Refresher training can be an alternative.

Present occasions for students to summarize their understanding or actions in their own words. Do not simply ask them to recognize a suitable summary as presented on video, for example. Organic knowledge has to be self-organized and skills self-performed. Picking out what to do from a video display is quite different from performing in the job where operators have to come up with options on their own.

Lead students to use intrinsic cues as starting points in recalling facts and principles. Use intrinsic cues to trigger mnemonic systems.

Ensure meaning for all otherwise isolated events by relating them to other aspects of skills or tasks.

Presentation (Continued)

Skill Building

Encourage students to associate entire cue patterns / sequences with entire action patterns / sequences through questions and variations in conditions

If two or more skills or components are mutually supportive (i.e., each can transfer to the other), have students practice first those skills or components requiring the most precision in performance.

Ensure practice on subordinate skills or components do not continue for too long before tapping their transfer value in practice of skills or components higher in the learning hierarchy.

Consider the future

Design each aspect of training with future training in mind.

How will given exercises be built upon in the future?

Emphasize thinking ahead.

Guidance

Points to consider:

Use a variety of guidance early in training–models, performance aids, checklists, examples, formats, instructions–but as students progress, steadily reduce guidance to what they can expect on the job.

Use guidance as necessary to prevent floundering on the part of students, and undue repetition of erroneous actions. Note, however, all errors would **not** be prevented; only corrected in a timely manner. Discriminatory learning requires knowing what is wrong as well as what is right.

Through explanations and especially through demonstrations, periodically provide students with models of correct performance.

In demonstration, include only what students can understand, or be expected to understand, by the end of the exercise (exception–when demonstrations are to broaden perspectives for skills to be learned at the time).

Emphasize relations among cues and guide students in identifying characteristics of cue patterns.

Guide students to note the **feel** of actions in order to recognize kinesthetic feedback for planning and monitoring actions.

Guidance (Continued)

For common errors in performance, illustrate how/when they might occur by contrasting demonstrations of correct and erroneous performance, emphasizing how and why they differ. (Performance in this case includes cognitive as well as perceptual-motor tasks. For example, incorrect applications of concepts or principles.)

Following the earliest stages of practice on a skill, the effectiveness of guidance depends on the complexity of the skill. Simple motor actions require only feedback, but as demands of a cognitive-perceptual matrix of tasks requirements increase, guidance will be necessary, at least periodically, until considerable progress has been made.

Practice: Objectives

Bear in mind that practice by itself is only a vehicle for, not a producer of, learning. Never leave it entirely up to students what they will get from an exercise. Always be sure students understand a clearly defined set of objectives for any exercise, recognizing that the focus can be on any combination of the following:

Build Cognitive Base

Recognition of task requirements
Performance planning
Performance evaluation

Develop Skills

Cue-action discriminations
Cue-action generalizations through varied conditions
Performance strategies
Performance monitoring
Encoding strategies and techniques
Metaskill development (through widening the scope of conditions of skills involved)
Patterning of cues and actions

Improve Performance

Mnemonic systems
Hierarchical structuring of skill knowledge
Stabilizing performance, including reaction times and rhythmic processes

Practice: Objectives (Continued)

Accommodating interference
Skill integration

Before students are very far along in skill development, provide the specific information they need for an exercise (unless the training objective is for them to learn to obtain the data on their own) so as to avoid lost time in seeking information. As students progress, reduce supplementary information to only what will be available on the job.

Practice: Content and organization

Consider the following three areas:

General Design Considerations

During early, rote stages of learning, do not overload students with too many things–data, sequences, etc.–to remember at one time. Organize data, sequences into meaningful subgroups.

Brief pauses can often be as effective in long tedious practice routines as long pauses. When total calendar time poses a constraint, practice need not be distributed over days; several sessions can be held in a single day, or even a morning or afternoon.

As training media permit, arrange for students to attempt a variety of skills related to those to be learned, whether or not proficiency is to be achieved on some of the skills attempted.

As training media permits, require actions as they would occur on the job.

Increase data processing load as students progress, ending with a load characteristic of on-the-job performance, or even a somewhat heavier load so as to provide practice under pressure (some of the load should be due to naturally occurring irrelevant information that has to be sorted out.)

Familiar skill components should dominate during mental rehearsal.

Mental rehearsal should be more than a mechanical "ticking off" of sequential cues and responses. Encourage students to think **why** as well as what and when.

Effective Techniques

When developing encoding and elaboration of cues, focus on intrinsic onset and feedback signals.

Practice: Content and organization (Continued)

For organic knowledge and metaskill development, regularly vary conditions for performance, including performance objectives. When feasible, vary how skills are to be performed, reflecting on-the-job circumstances.

Require responses from students. When only mental actions are called for, regularly require an overt response that can indicate whether the mental actions were performed, and correctly so.

Provide for actions to occur at appropriate intervals following cues, unless the intent is to encourage analysis and self-evaluation on the part of the students prior to responding.

Periodically require students to identify alternative interpretations and courses of actions before responding and, as appropriate, require them to anticipate what will happen with each alternative.

When practicing decision-making, vary situational constraints and specific performance goals, as well as cue patterns.

When kinesthetic cueing is involved, including sequential procedural actions, provide for realistic action sequences and focus students' attention on what they experience during movements.

Encourage independent mental rehearsal, **both before and following a trial** of all aspects of performance, emphasizing:

Cues and their interpretation

Recognition of task requirements

Plans for performance

Expected outcome, step by step, during performance

How students themselves assess outcomes, step by step, in light of task requirements

Awareness of situational factors and of what they are doing in relation to task and situational requirements

Specific Issues

Be sure student responses are pertinent and well timed. Do not introduce irrelevancies through required responses and do not short-circuit thought processes.

In focusing on discrimination of cues and responses, first emphasize correct interpretations and actions, illustrating incorrect aspects only after a positive structure begins developing. Let students see what is correct before showing them what is not correct (do both, however, to the extent necessary to learn required discriminations.)

Practice: Content and organization (Continued)

Vary irrelevant as well as relevant stimuli when teaching cue discriminations and interpretations. Increase discrimination requirements as students progress.
Vary cue complexes in ways that require abstraction of cue patterns for interpretation.
Unfamiliar components should be "flagged" in students' minds in such a way that they say, "I've got to concentrate on **that** the next time I do this." Familiar components should dominate because too many "**thats**" will lead to confusion.

Practice: Schedules

Consider the following:

In allowing for total practice time, note that practice requirements increase with the number of unfamiliar skill components to be learned.
To the extent that learning is still in a serial stage, distributed practice is generally more effective than massed practice. In either case, do not let so much time elapse between practice sessions that students have difficulty returning to earlier proficiency levels.
The effectiveness of massed practice depends on the degree of organic knowledge that students have at the time. (Because general understanding increases with maturity and experience, older students often profit from massed practice when younger students do not.)
Continue provisions for practice of motor actions until they are performed smoothly and without hesitation.
Ensure mastery of skill components through later periodic repetition in original and especially new contexts.
Even though students may have mastered a skill earlier, periodically require them to practice the skill in later exercises, preferably through working it into current practice materials, or through special arrangements that may not draw upon current materials.
To help break restrictive sets induced by sequential tasks, when tasks allow, provide for practice of different orders of tasks during performance. Organic understanding as opposed to mechanical, serial learning is thus enhanced, as is development of metaskills.

Practice: Schedules (Continued)

Encourage mental rehearsal of skills, both between practice sessions and prior to individual practice attempts. Not only can mental rehearsal often substitute for actual practice on a one-to-one basis, mental rehearsal also promotes skill comprehension, planning, and self-monitoring.

Encourage mental rehearsal of all sequential steps at least until organic understanding replaces serial knowledge.

Feedback

Consider the following three areas:

Intrinsic and Supplemental

Feedback should identify the nature of any discrepancy on the student's part.

Intrinsic feedback, or supplemental feedback that symbolizes it (i.e., when media cannot provide realistic intrinsic feedback), should be timed as it is in real-world performance. Delays can be acceptable up to a point unless the feedback is normally kinesthetic or is used to cue a sequence of coordinated motor actions.

For learning basic perceptual discriminations of cues and intrinsic feedback, provide supplemental feedback as soon as feasible.

Guide students to recognize and interpret intrinsic feedback as indicators of **personal** success (i.e., in the sense of motivational support). Students will likely take more pride in their performance if they see for themselves that they are doing a good job.

General Considerations

Use supplemental feedback generously early in training, but steadily reduce it in amount and frequency to no more than what will be provided on the job. Except when used for general motivational purposes, supplemental feedback should be specific to action components–cue recognition or interpretation, individual responses, analysis of skill requirements or situational factors that determine them.

Delays in supplemental feedback are beneficial provided students pursue analysis of their actions during the interim. Do not delay supplemental feedback if students are not likely to pursue appropriate analyses of their actions.

Feedback (Continued)

To ensure analyses, guide students via questions to examine their interpretation of requirements, what they did, and likely outcomes.

Encourage students to seek and identify redundancy in feedback cues during self-monitoring so as to confirm adequacy of actions and identification of task requirements.

For some motor actions and perceptual discriminations, it is not possible to communicate verbally just what students are to do or perceive. In such cases it may be necessary to "shape" the desired response by providing supplemental feedback for **ever-increasing approximations** of what is desired. At the same time, explain what you are doing, focusing on characteristics of desired performance.

Effective Techniques

As learning progresses, reduce supplemental feedback so as to:

- Avoid dependence on feedback that will not occur in operational situations.
- Force students to identify and use intrinsic feedback.

As learning progresses, extend time between response and feedback telling students that they have performed correctly or incorrectly. Students must learn to evaluate their performance on their own.

Do not be hasty in pointing out all student errors; Students need to learn to detect errors themselves from intrinsic feedback or from self-examination. Delayed feedback, with guidance as necessary, can promote this kind of self-examination and monitoring.

Part-task training

Purpose

Provide part-task practice to:

- Simplify practice content.
- Develop information-processing subsystems.
- Reduce the number of skill parameters.
- Establish preparatory sets.
- Reduce interference.
- Allow for appropriate amounts of training effort.
- Make duration of practice reasonable.

Part-task training (Continued)

Planning

In planning part-task training recognize that in many respects, skill **integration** itself can often be a candidate for part-task practice. In such a case, emphasis may be on interskill or intercomponent cueing, critical stages in time-sharing, action harmonics, or particular executive functions.

Recognize the interplay of cognitive, perceptual, and motor processes in any skill, and treat any of these processes as part-tasks when taught separately. Keep their eventual integration in mind when designing training.

In planning part-task training, focus as much on information processing variables as on objective descriptions of skill components.

Anticipate, and provide for, the "two-way street" of bases for meaning when:

- Hands-on experience is needed to give concrete meaning to concepts and principles.
- Conceptual organization is needed as a framework for understanding physical actions and perceptions of cues.

Group skills and skill components for part-task practice that:

- Comprise a set that is functionally independent of other skills.
- Involve mutual cueing to coordinate actions.
- Involve time-sharing that can be learned after separate skills or components are learned.
- Comprise a set of skills/components that do not vary when used in a variety of contexts or combinations with other skills.
- Comprise identifiable components or levels in learning hierarchies.
- Represent meaningful combinations, considering students' present levels of understanding.
- Involve integrative processes, which are themselves objectives of part-task practice.

Keep plans for part-task practice adaptable to individual learning styles. Permit students to go from part-task to whole-task practice and back again.

Part-task training (Continued)

Effective Techniques

Arrange to keep whole-task requirements in mind while students practice part-tasks; encourage verbalization for this purpose, and provide occasional practice in whole-task contexts as needed.

As availability of media permit, incorporate different media in part-task practice, and especially with respect to:
Interspersed, occasional whole-task practices.
Freedom for students to self-impose foci for part-task emphasis.

Ensure that integral sets of kinesthetic cueing sequences are **fully** represented in part-task practice.
Provide preliminary and subsequent periodic overviews of whole-task requirements as a context for part-task practice.
When part-task practice involves multiple skills or components, permit students to select and vary sequences to focus on at given times. (Recall that students self-impose part-task practice in whole-task situations, and usually in idiosyncratic ways.)

Skill Interference

If skills comprising the same tasks interfere with each other when being learned, separate the troublesome component skills for part-task practice so as to avoid or at least reduce interference while learning.
Let part-task practice on mutually interfering skills continue until performance becomes fairly automatic for at least one part-task set. However, periodically confront students with whole-task requirements so as to force recognition of the need to integrate part-tasks into whole tasks. Such confrontations should be more frequent as the possibility increases of learning incompatible habits in contexts for part-task practice.

Whole-task vs. part-task training

Experienced students (i.e., those who have previously learned or at least practiced whole-skills) are more adaptable to part-task practice because whole-task contexts and coordination requirements are more familiar. Consider the following points:

Whole-task vs. part-task training (Continued)

Continue part-task practice (with occasional practice in whole-task contexts as needed) until a reasonable level of mastery is achieved (i.e., performances become stable or consistent).
Avoid development of motor rhythms and harmonics during part-task practice that might be incompatible with whole-task skills that are practiced separately; check performance during occasional whole-task efforts to monitor any difficulties.
Do not continue part-task practice beyond the point of appropriately targeted part-task proficiency. Otherwise, cue-action sequences pertaining only to part-tasks may become "set," resulting in difficulty in whole-task integration.
The order of practice of different part-tasks should conform to optimum transfer processes in learning hierarchies.

Assessment of progress and difficulties

Consider the following:

If student actions are to be a basis for later analysis or diagnosis of difficulties, significant indicators in students' actions should be recorded.
Arrange for records of kind and frequency of errors made during practice. Records should be separate by student for individualization of training, and cumulative across students for assessing the training program.
As students progress through a training program, they should learn new skills more quickly than they would have learned the same skills if they had practiced them earlier. If students do not progress in speed of learning, there may be a deficiency in the development of their metaskills and/or organic organization of overall skill knowledge.
As with the preceding guide, if skills degrade substantially after relatively brief periods of no practice, metaskills development and/or organic knowledge may be lacking. Remedial training should focus on these high-order factors; limited refresher training may get them through a performance check, but later on-the-job performance may be deficient.

Assessment of progress and difficulties (Continued)

Interrupted Progress

If student progress seems to slow down or stop too soon, check for:

Cognitive Failures

Lack of adequate chunking during encoding (poor short-term retention).

Cognitive Failures (Continued)

Lack of recall of details of what they have just done and why (poor cognitive structuring).
Persistence in the same inadequate actions (misunderstanding of the problem, task requirements, intrinsic feedback, and/or lack of meaningful checkpoints for self-assessment).
Failure to recognize intrinsic feedback (consequent dependence on supplemental feedback).
Inability to adapt to changes (if any) in task requirements or conditions (poor generalizations).
Poor retention of basic task-situational requirements (lack of organization of task knowledge).
Tendency to react in ways that have undesirable outcomes (failure to assess effects of actions–lack of organic knowledge).
Need for excessive guidance (inadequate skill understanding, or inability to make effective use of knowledge–overdependence on guidance, no self-starting "programs" for open- and/or closed-loop actions).

Cue Processing Failures

Lack of an open-loop performance program (inadequate mastery or habitualization of basic cue processing and actions).
Tendency to simply react to cues and task conditions with no plans or even knowledge of what to do or expect (no expectancies; failure to stay ahead of system–poor organic knowledge).
Failure to note, assess, and prioritize all cues (cue-pattern deficiency).
Failure to discriminate false or irrelevant cues (cue or cue-pattern deficiency).

Assessment of progress and difficulties (Continued)

Failure to select proper actions (cue misinterpretation; failure to prioritize actions properly).
Undue delays in student responses (confusion regarding cues, their interpretations, action requirements; cue and/or action interference; insufficient mastery of at least some skill components).

Plateaus

Students will often reach temporary "plateaus" where, to a casual observer, progress has ceased. It is at such points that significant new integrations of skill components normally occur, resulting eventually in a fairly rapid increase in proficiency.

If a plateau seems to occur too soon (i.e., at too low a level of proficiency), or last too long, there is a need to find out why and correct the underlying difficulty.
If too soon, refer to the indicators listed immediately above.
If a plateau seems to persist too long, skill integration is likely a problem.

Additional Issues

In addition to the items above, check for emerging requirements (if any) in chunking and integration of skill components, which in this case are especially relevant aspects of organic knowledge.

Periodically–weekly, daily, action-by-action, as appropriate–provide students with nonthreatening updates regarding their progress. Be specific as to successes and shortcomings.

RICHARD E. BROWN, Lt General, USAF
DCS/Personnel

Attachment 1 – GLOSSARY OF REFERENCES AND SUPPORTING INFORMATIONReferences

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AFI 36-2201		Developing, Managing and Conducting Military Training
AFI 36-2301		Professional Military Education
AFMAN 36-2234		Instructional System Development
AFMAN 36-2236		Handbook for Air Force Instructors
AFH 36-2235		Information for Designers of Instructional Systems (12 Volumes)
	Vol 1	ISD Executive Summary for Commanders and Managers
	Vol 2	ISD Automated Tools/What Works
	Vol 3	Application to Acquisition
	Vol 4	Manager's Guide to New Education and Training Technologies
	Vol 5	Advanced Distributed Learning: Instructional Technology and Distance Learning
	Vol 6	Guide to Needs Assessment
	Vol 7	Design Guide for Device-based Aircrew Training
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ABBREVIATIONS AND ACRONYMS

AF	Air Force
AFH	Air Force Handbook
AFM	Air Force Manual
AFP	Air Force Pamphlet
ATD	Aircrew Training Device
CBT	Computer-Based Training
CFT	Cockpit Familiarization Trainer
CPT	Cockpit Procedures Trainer
CRM	Cockpit Resource Management
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
HUD	Head-up Display
ISD	Instructional System Development
LOFT	Line-Oriented Flight Training
MATS	Model Aircrew Training System
MOST	Mission-Oriented Simulator Training
OFT	Operational Flight Trainer
PTT	Part-Task Trainer
SIMCERT	Simulator Certification
TSRA	Training System Requirements Analysis
WST	Weapon System Trainer

TERMS

Attitude. (a) The emotions or feelings that influence a learner's desire or choice to perform a particular task. (b) A positive alteration in personal and professional beliefs, values, and feelings that will enable the learner to use skills and knowledge to implement positive change in the work environment. Also see **Knowledge** and **Skill.**

Behavior. Any activity, overt or covert, capable of being measured.

Computer-Based Training (CBT). Training in which computers are used for both training delivery and training management. The management functions often include scheduling, lesson selection, scorekeeping, and quality of student responses.

Constraints. Limiting or constraining conditions or factors, such as policy considerations, time limitations, equipment, environmental factors, personnel, budgetary, or other resource limitations.

Discrimination. The process of making different responses to a stimulus. A discrimination requires a person to determine the differences among inputs and to respond differently to each.

Enterprise. An integrated, purposeful activity that usually leads to accomplishment of a goal. The importance of an enterprise is that it is purposeful and relevant to the learner; it motivates learning behavior necessary to complete the component tasks. Also see **Metaskill** and **Schema**.

Fidelity. The degree to which a task or a training device represents the actual system performance, characteristics, and environment.

Generalization. Learning to respond to a new stimulus that is similar, but not identical, to one that was present during original learning. For example, during learning a child calls a beagle and a spaniel by the term "dog"; a child who has generalized would respond "dog" when presented with a hound.

Instructional System. An integrated combination of resources (students, instructors, materials, equipment, and facilities), techniques, and procedures performing effectively and efficiently the functions required to achieve specified learning objectives.

Instructional System Developer. A person who is knowledgeable of the instructional system development (ISD) process and is involved in the analysis, design, development, implementation, and evaluation of instructional systems. Also called Instructional Designer, Instructional Developer, Curriculum Developer, Curriculum Development Manager, and other terms.

Instructional System Development (ISD). A deliberate and orderly, but flexible, process for planning, developing, implementing, and managing instructional systems. ISD ensures that personnel are taught in a cost-efficient way the skills, knowledge, and attitudes essential for successful job performance.

Job Performance Requirements (JPR). The tasks required of the human component of the system, the conditions under which these tasks may be performed, and the quality standards for acceptable performance. JPRs describe what people should do to perform their jobs.

Knowledge. Use of the mental processes that enable a person to recall facts, identify concepts, apply rules or principles, solve problems, and think creatively. Knowledge is not directly observable. A person manifests knowledge through performing associated overt activities. Also see **Attitude** and **Skill.**

Learning. A change in the behavior of the learner as a result of experience. The behavior can be physical and overt, or it can be intellectual or attitudinal.

Media. The delivery vehicle for presenting instructional material or basic communication stimuli to a student to induce learning. Examples are instructors, textbooks, slides, and interactive courseware (ICW).

Metaskill. Cognitive strategy that an individual applies to the processing of new information in a situation not previously experienced. Metaskills include chunking or organizing new information, recalling relevant schemas, adding new information to old schemas, and creating new schemas. These skills are highly developed and demonstrated by experts in the context of complex enterprises. Also see **Enterprise** and **Schema**.

Metrics. Measurement tools used for assessing the qualitative and quantitative progress of instructional development with respect to the development standards specified.

Motor Skill. Physical actions required to perform a specific task. All skills require some type of action.

Performance. Part of a criterion objective that describes the observable student behavior (or the product of that behavior) that is acceptable to the instructor as proof that learning has occurred.

Schema. An individual's organization of knowledge. Different levels of learners have different types of schemas. The novice has a sketchy structure into which new information can be placed. The experienced learner has a better structure and is a quicker learner than the novice. The expert has a highly developed structure and is capable of rapid learning with little support. Also see **Enterprise** and **Metaskill**.

Skill. The ability to perform a job-related activity that contributes to the effective performance of a task. Skills involve physical or manipulative activities, which often require knowledge for their execution. All skills are actions having specific requirements for speed, accuracy, or coordination. Also see **Attitude** and **Knowledge.**

Target Audience. The total collection of possible users of a given instructional system. The persons for whom the instructional system is designed.

Task. A unit of work activity or operation, which forms a significant part of a duty. A task usually has clear beginning and ending points and directly observable or otherwise measurable processes, frequently but not always resulting in a product that can be evaluated for quantity, quality, accuracy, or fitness in the work environment. A task is performed for its own sake; that is, it is not dependent upon other tasks, although it may fall in a sequence with other tasks in a duty or job array.

Task Analysis. The process of describing job tasks in terms of Job Performance Requirements (JPR) and the process of analyzing these JPRs to determine training requirements. Also see **Job Performance Requirements**.

Training. A set of events or activities presented in a structured or planned manner, through one or more media, for the attainment and retention of skills, knowledge, and attitudes required to meet job performance requirements.

Training Needs Assessment (TNA). The study of performance and the environment that influences it in order to make recommendations and decisions on how to close the gap between the desired performance and the actual performance.

Training System. A systematically developed curriculum including, but not necessarily limited to, courseware, classroom aids, training simulators and devices, operational equipment, embedded training capability, and personnel to operate, maintain, or employ a system. The training system includes all necessary elements of logistic support.