COURSEWARE CONFIGURATION MANAGEMENT

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ABSTRACT

In the past there has been no standard configuration management methodology for management of educational courseware. This paper discusses the approach taken by the C-130 Aircrew Training System project team to develop the methodology required to maintain total Training System currency and system technical integrity in a constantly changing environment due to aircraft modifications, tactical mission changes, technical changes, etc. Following baseline establishment, Courseware Configuration Management, in concert with the Courseware Support Team, evaluates change requests. The evaluation identifies the potential modification requirements on the total training program, schedule impact, system performance and cost/benefit of the change. Additionally, the unique aspects of conducting the Functional and Physical Configuration Audits of courseware lessons are presented. This approach to Courseware Configuration Management offers considerable potential benefits on the life cycle costs associated with maintaining courseware concurrency because of the ease of lesson identification, tracking, and updating for any reason.

INTRODUCTION

Why was Courseware Configuration Management developed? It was developed for two reasons: 1) the magnitude of the number of lessons to be developed would have made maintenance of them costly and cumbersome and 2) it was a contractual requirement. The scope of this paper is to identify what courseware is; how it is developed, delivered, controlled and maintained; the tools used to accomplish this; the organizational structure to accomplish this; and the benefits derived during this evolutionary process and lessons learned to date.

Before discussing the configuration management processes and procedures, it is important that the reader understand what courseware is, and how it is developed.

COURSEWARE

Courseware is instructional information required to support training. This paper focuses on the courseware developed for the training of crewmembers in the C-130 Aircrew Training System (ATS). Each course is subdivided into units and each unit is made up of several lessons.

The following types of lessons have been developed in support of this endeavor:

a) Mediated Interactive Lecture-
A Mediated Interactive Lecture is a standup lecture presented by an instructor and supported with slides similar to a one to two hour lecture in college. A Mediated Interactive Lecture consists of an Instructor Guide, Student Guide, Slides and Quizzes.

b) Slide Tape-
A Slide Tape is an independent, self paced lesson using a 35mm slide projector and cassette tape. A slide tape consists of slides, cassette tape, student guide and quiz.

c) Computer Based Training-
Computer Based Training is an independent, self paced lesson similar to an interactive video game. Using a student guide, the student touches the screen to learn and practice sequencing operations.

d) Workbook-
A Workbook is an independent, self paced lesson which may be taken home. A workbook consists of a student guide and quiz.

e) Instructor Guided Review-
An Instructor Guided Review is a standup lecture presented by an instructor for the purpose of review of a course or unit prior to the unit test or end of course examination. An instructor guided review consists of an instructor guide, student guide and slides.

f) Unit Test-
A Unit Test is given at the end of each unit and tests the student's knowledge of all material in the unit.

g) Course Exam-
An End of Course examination is given at the end of the course and tests the students knowledge of all material in the previous units.

h) Briefs-
Once the student has mastered all academic training he/she will then practice hands-on (performance) training in Aircrew

Training Devices such as Part Task Trainers, Cockpit Procedure Trainers and Weapon System Trainers. A brief is a document which identifies to the student what tasks are to be performed in the Aircrew Training Device. A brief consists of a set of performance objectives and a gradesheet used by the instructor to evaluate the students on their performance.

THE COURSEWARE DEVELOPMENT PROCESS

The courseware development process can be described in terms of five phases: Analysis, Design, Development, Implementation, and Evaluation.

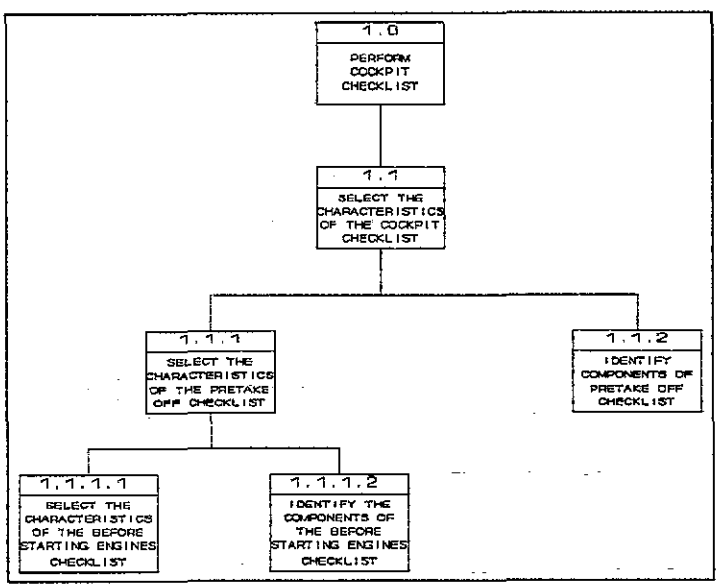
Analysis

Analysis is the first phase of the Instructional System Design (ISD) process. The first step in this phase identifies and lists every task needed to be completed by aircrew members in order to successfully complete their training. This is accomplished through the evaluation of checklists, procedures, regulations, performance data, mission requirements and available courseware. The results of this first analytical step are compiled into a task listing report.

Once all tasks are identified, supporting instructional objectives are developed and stated in behavioral objective format which includes appropriate conditions and standards. Conditions are the "givens" and they describe the circumstances under which the task will be performed. The standard specifies to what degree the student should be able to perform, how completely and accurately, the rate, to what degree of quality, the time limit, and within what safety considerations. The conditions and standard statements will assist the instructors in identifying when the student has satisfactorily mastered the behavior. For example:

1.0 Perform Cockpit Checklist given a C-130 aircraft and applicable checklists

The second step of the analysis phase is the development of the Objectives Hierarchy. The objectives are the building blocks on which the Instructional System Design process is based and are key to the course and lesson design. The Objectives Hierarchy identifies the roles and missions of each crewmember and consists of a set of performance objectives arranged in a hierarchial format to display the superordinate, subordinate and prerequisite relationships among the objectives (See Figure 1).



Objectives Hierarchy
Figure 1

Design

The first step in the design phase is to develop a Media Selection and Syllabus Report. Hands-on (performance) events are prioritized to facilitate the development of the basic syllabus structure and assign media type, based on physical fidelity requirements and training effectiveness. Academic objectives are also allocated to media; based on cognitive learning needs, feedback timeliness, remediation requirements, etc. Academic objectives directly related to hands-on (performance) events are grouped into lessons and sequenced within each unit of instruction in a prerequisite fashion. Each unit of instruction is then organized sequentially to compose the entire course.

All courses are uniquely identified with a course designator (for example, the Flight Examiner Pilot course is identified as FXP) and each lesson in the course is uniquely identified with a lesson designator. Each lesson designator has four parts: a course code, media code, lesson number, and unit number. For example:

FXP-200-01

Course - FXP
Media Type - 2
Lesson Number - 00
Unit Number - 01

Once the media selection and organization of the syllabus is completed, the second step of the Instructional System Design phase is to develop the lesson specifications.

For each course, lessons are identified and detailed lesson specifications are developed to identify content and instructional strategies. The purpose of the lesson specification is to provide all the information that an author will require during the authoring and production of a lesson. It provides the order in which the objectives will be taught and reference materials (military technical orders, flight manuals, and other government publications) from which the author may draw.

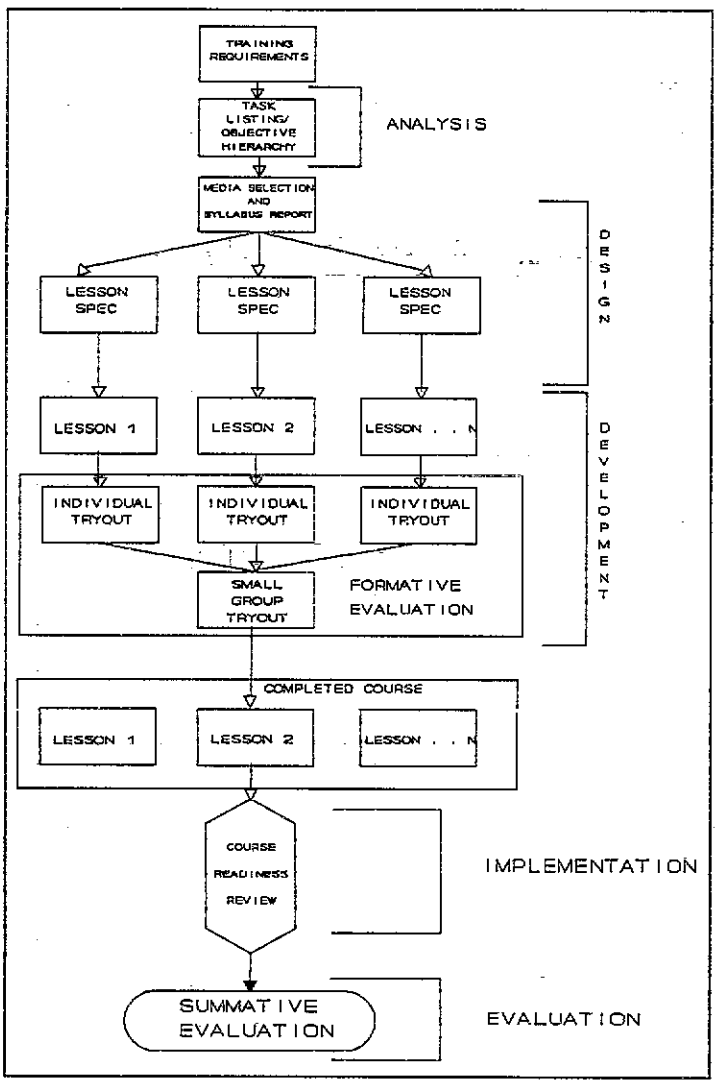
Each segment of a lesson specification includes the segment number/title, segment objective, and objective behavior required to master the objective. Each segment presents a generality that states and/or lists the critical topics to be discussed in the segment.

All segments of the lesson specification have a segment designator. All segment designators have an objective and system code tied to it for tracking within the Training Management System (TMS) which will be discussed later. Test questions are tied to segment designators as well.

The aircraft is made up of many systems. The Systems Code Table was developed to enable tracking the lesson segment to the system which is taught in that segment. This is stored in the Training Management System to be used by change control described later in the paper.

Development

The third phase of the Instructional System Design process is the development and production of the lessons. During this time, Subject Matter Experts (SMEs) author the lessons according to the lesson specifications and identify any graphics or visuals required to support the lesson. Instructional Developers ensure the lesson has instructional integrity. The Art Department creates the slides and graphics needed. This can be considered the courseware manufacturing process.



ISD Development Process
Figure 2

Formative Evaluation begins while the design is being developed and the material produced. This is accomplished using Individual Tryouts (ITOs) and Small Group Tryouts (SGTOs). These are conducted to test the lessons' integrity as they are initially being developed in order to maximize their effectiveness during actual training. This process examines the lessons for technical accuracy, instructional adequacy and effectiveness, student acceptability, as well as system related issues including the lesson durations and the scheduling of classrooms, Aircrew Training Devices, aircraft and instructor availability.

Implementation

Following development and successful completion of Formative Evaluation, the course undergoes a Course Readiness Review (CRR). A Course Readiness Review is conducted on a course by course basis to establish that each course is ready to be released for instruction. Successful completion of each Course Readiness Review results in the contractor assuming the responsibility for full Aircrew Training System operation, maintenance and instruction for that course which includes the guarantee of the students graduating.

Evaluation

Summative Evaluation begins immediately after the Course Readiness Review and addresses the ability of the Aircrew Training System to meet training requirements.

Examination of the components within the Aircrew Training System determine which are not effective or efficient and recommending improvements is the purpose of Summative Evaluation. If the Aircrew Training System fails to produce the desired outcomes, then attention must be made to the identification of actions, components, or characteristics that caused the ineffectiveness. The Summative Evaluation process ends at the Training System Readiness Review (TSRR) and Operational Evaluation begins.

Operational evaluation is the continuing review and revision of system elements, requirements, instructional methods, course-

ware and tests to enhance their effectiveness throughout the training program. This begins at Training System Readiness Review and continues throughout the life cycle of the Aircrew Training System.

WHY DO WE NEED TO CONTROL COURSEWARE?

As previously described, the development of courseware and its interrelationships is a very complex process. Since the C-130 Aircrew Training System is made up of 35 courses, 150 units, 1400 lessons comprised of: 32,000 slides, 255 audio tapes and 85,000 pages of text, it is obvious that some means of formal control is imperative. Formalized configuration management procedures and processes are requisite if change is to be effectively managed.

Changes occur throughout the life cycle of a system as more knowledge of the system design and operation is gained and mission requirements change. These changes must be controlled to ensure they are cost efficient and effectively documented so all users are aware of the current implementation status.

Thus the creation of Courseware Configuration Management.

WHAT IS CONFIGURATION MANAGEMENT?

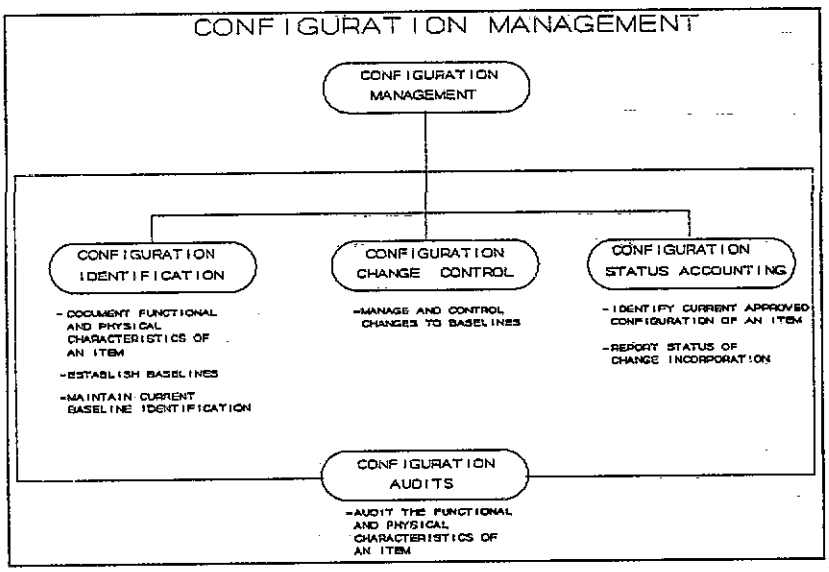
Configuration Management is a discipline that applies technical and administrative direction and surveillance to:

a) Identify and document the functional and physical characteristics of a configuration item (Configuration Identification)

b) Control changes to these characteristics (Configuration Change Control)

c) Record and report change processing and implementation status (Status Accounting)

d) Perform Functional and Physical Configuration Audits



Configuration Management Functions
Figure 3

Configuration Identification

Configuration identification is the documentation that describes the physical and functional characteristics of a Configuration Item so that it can be identically reproduced at anytime in the future.

Configuration Change Control

The systematic evaluation, coordination and formal approval/disapproval of proposed modifications and the implementation of all approved changes to the design and production of a Configuration Item after formal establishment of the baseline is called Configuration Change Control. The baseline plus approved changes to the baseline represent the current configuration identification.

Configuration Change Control assures that approved system modifications have been assessed for system impacts and all required changes have been identified for concurrent implementation.

Status Accounting

The primary function of status accounting is to maintain current and accurate records of the current baseline, pending modifications to the baseline, and completed modifications to previous baselines. This is accomplished through the systematic recording of approved changes, scheduled incorporation dates, and the actual changes incorporated.

Configuration Audits

The Functional Configuration Audit (FCA) is the formal examination of the functional characteristics of a configuration item to verify the item satisfies specification requirements. The Physical Configuration Audit (PCA) is the examination of the "As Built" configuration against the specifications. By accomplishing audits Configuration Management insures that unauthorized changes have not been conducted. This becomes especially true if the locations of courseware (use and storage) are variable.

COURSEWARE CONFIGURATION MANAGEMENT

The primary functions of Courseware Configuration Management are to maintain the instructional and technical integrity of the courseware and give direction to identify, document and control changes using a systematic approach. The continuity of the system is maintained by applying Courseware Configuration Management to the design, development, implementation and maintenance phases of the system, insuring that all changes are controlled, communicated and recorded.

One needs to be able to identify the current configuration of the courseware at any given time, as well as all past configurations of the courseware to:

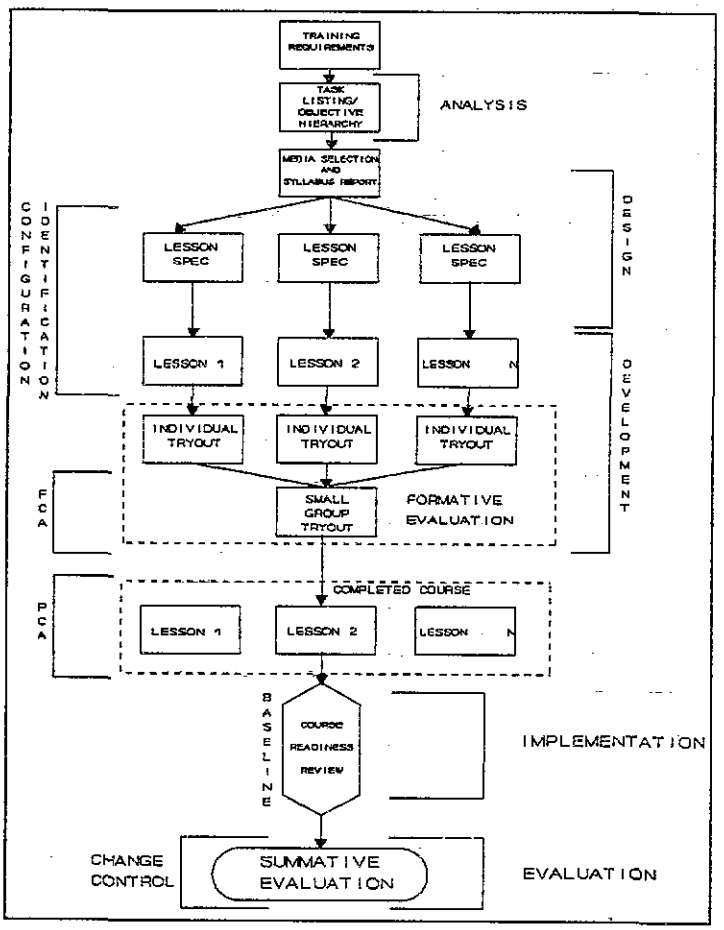
a) Ensure the student courseware meets the training objectives

b) Know what courseware is being received from development

c) Establish what courseware will comprise a baseline

d) Control courseware changes

e) Document the decisions made to modify courseware



Courseware Configuration Management
Figure 4

Courseware Configuration Management needs to ensure compatibility between courseware material and the current Aircrew Training Device/Aircraft configurations. Protection against unauthorized changes is ensured with all courseware under the control of Courseware Configuration Management where proposed changes are analyzed for impact and coordinated with all activities prior to authorizing the change.

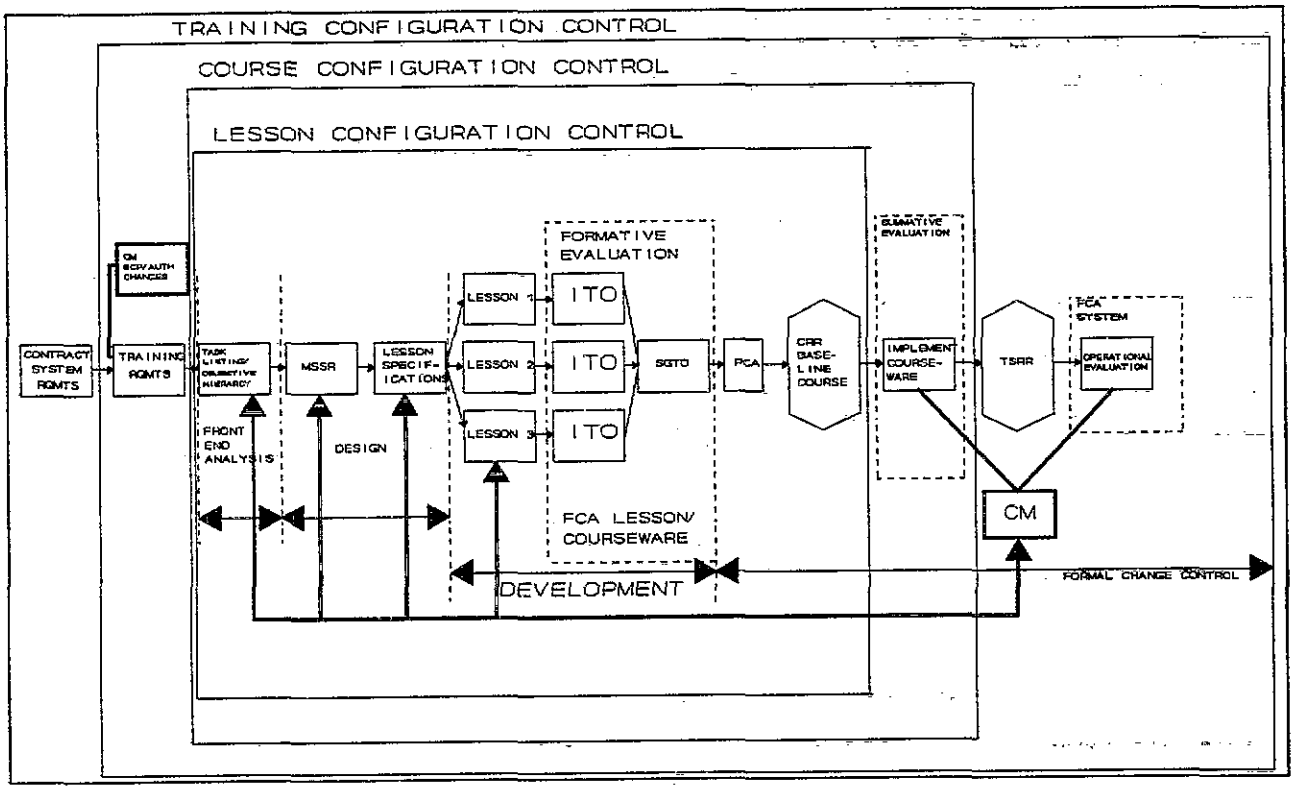
Development of Courseware Configuration Management

The Configuration Item selection reflects an optimum management level throughout the Aircrew Training System program life cycle span. This level is one at which the contracting agency specifies and accepts individual elements of a system. The selection process separates the elements of a system into individually identified subsets for the purpose of managing their development. Choosing too many Configuration Items increases the cost of control and too few creates the risk of too little control. It would be difficult to manage a course as a Configuration Item because of the need to control the inherent characteristics of each lesson and the need to control each Configuration Item's interface with other Configuration Items. A change to one lesson in a course may affect changes to additional lessons in the same course or other courses. Each lesson has many internal components, (Instructor Handout, Student Handout, Quiz Package and Slides), making it too cumbersome and costly to treat each component as a Configuration Item.

Since Lesson Specifications are written to document the characteristics of each lesson and audits are performed against the Lesson Specifications, it was determined that all components of an individual lesson would be considered one Configuration Item and managed at the lesson level. Identification to this detail requires that each lesson have a unique identifier code.

Through the development, review, and approval process lessons are being finalized and baselined at each Course Readiness Review to serve as approved and defined points of departure for controlling subsequent changes. Changes are always traceable between the previous and the latest approved baseline.

Each course is broken down into multiple lessons to form a logical block of instruction. Since each lesson is managed as a configuration item a review is held only at the course level. The Course Readiness Review is conducted to support implementation decisions on a course by course basis establishing that each course is ready to be released for instruction. The acceptance of courseware at each Course Readiness Review certifies the Functional Audit for that course. Again successful completion of



Change Control Process
Figure 5

each Course Readiness Review results in the contractor assuming the responsibility for the full Aircrew Training System operation, maintenance, and instruction for that course which includes the student guarantee. This is where change control starts.

To prepare for each Courseware Readiness Review, a Functional Configuration Audit (FCA) and a Physical Configuration Audit (PCA) are performed on each lesson and course. The FCA is conducted utilizing the Individual Tryout and the Small Group Tryout data to validate that each lesson within a course and each total course perform as intended according to the Lesson Specifications. At this time it is validated that all formative evaluation comments have been incorporated and the lesson is ready for implementation in the classroom. This is accomplished with qualified government Subject Matter Experts and contractor Courseware Configuration Management. The PCA is the formal examination of the completed lesson against the Lesson Specification and Media Selection and Syllabus Report (MSSR). As each lesson is accepted at the PCA it is placed under configuration control pending baseline establishment.

As each lesson is validated, the current configuration identification is established. Just prior to implementation the configuration of each lesson is documented. This includes the lesson number and title, each component of the lesson, number of pages in each component, number of graphics in the text, number of slides, and the baseline date. A library working copy and archive copy are filed at this time. The library working copy will reflect the current, updated version and the archive copy will reflect an ongoing historical record of the lesson.

The successful completion of a Course Readiness Review identifies the baseline for a course. Courseware Configuration Management baselines are established using the following steps to prepare for the Course Readiness Review:

- Prepare draft of lesson
- Perform internal quality control review
- Review with customer
- Incorporate Formative Evaluation comments into preliminary version
- Conduct internal configuration audits
- Present to customer at Physical Configuration Audit and get preliminary baseline approval with comments and/or exceptions
- Resolve customer comments, exceptions and release final version of document by Course Readiness Review

Following Course Readiness Review all change control is under configuration management and the Summative Evaluation process begins.

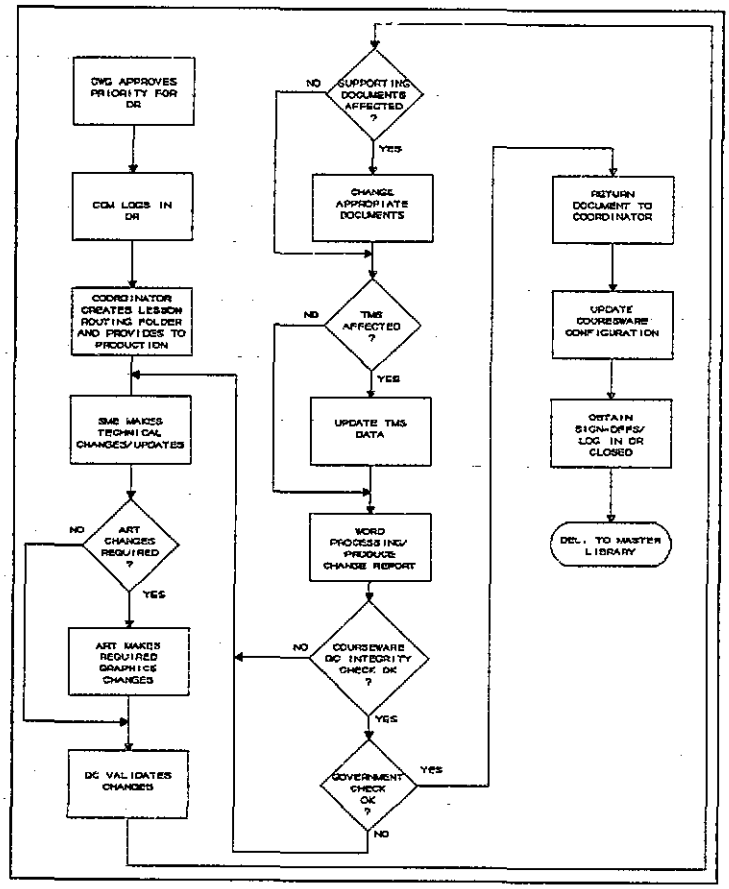
TRAINING MANAGEMENT SYSTEM

From a management point of view, one of the major problems with any instructional system is keeping courseware accurate and up to date. This is especially true in a large system such as an Aircrew Training System.

The Training Management System manages the Objectives Hierarchy, Lesson Specifications, system codes, segment designators, test questions and unit listings of the Media Selection and Syllabus Report.

The design and development of courseware and the tracking capability of the Training Management System aids in identifying tasks, objectives and courseware materials to be revised. Changes may affect many aspects of the system. Coordination must be accomplished to allow for instructor planning and preparation, scheduling, instructional time, self study activities, appropriate practice of specific skills and the evaluation of performance and feedback.

The Training Management System data base provides the means to store, track, and make changes to the information required for instructional programs and prints reports for all documents that a change affects.



ISD Change Process
Figure 6

The Training Management System tracks student progress, schedules appropriate lessons and courses, tracks and maintain the status of courseware revisions and implementation of these revisions.

THE CHANGE PROCESS

Courseware Configuration Management procedures identify and track every aspect of revision that a change affects. Requirements for a configuration change can result from aircraft and training device modifications, technical order changes, mission requirement changes, regulation and procedure changes, tactic changes, and instructional changes from Summative Evaluation. Once a course is baselined at the Course Readiness Review, no changes can be made to a lesson without approval. The Configuration Working Group is the approval authority for changes. Courseware Configuration Management will interface with the customer and obtain customer agreement before any changes are implemented into the system.

All changes to the system are initiated by a Design Request (DR). Figure 6 depicts the Instructional System Design change process. As the courseware is revised/updated, Courseware Configuration Management will update the baseline documentation and maintain detailed records of changes.

Using the automated data base of the Training Management System, Configuration Management can identify all segments of a lesson affected by the change. For example, if the lighting system requires a change in the form of an additional switch, the Training Management System will track and identify each lesson segment that references the lighting system. Using this information, configuration management will identify all pages, graphics, and slides affected by the change.

All changes can be tracked by system codes, objectives, and crew positions. For example, the effect of the lighting system change can be accomplished by using a specific System Code. A report is generated with the system code heading the page and all lesson segments and test questions affected will be listed. For example; inputting a System Code into the Training Management System identifies segments where the Lighting System is taught:

FXP-200-01-A
FXP-202-02-E
FXP-600-01-C

In the event there is an objective change, the Training Management System will list every segment where that objective is taught and every test question effected. For example:

1.0 Perform Cockpit Checklist, given a C-130 aircraft and applicable checklists

Questions where the objective is tested:

Lesson	Question
FXP-T01-01	18
FXP-T01-02	21

Courseware Configuration Management uses a checklist to ensure that all supporting documentation has been changed to support lesson change.

LESSON REVISION CHECKLIST

DATE: _____

LESSON #: _____

LESSON TITLE: _____

LESSON SPEC CHANGE	NO	YES
MSSR CHANGE	NO	YES
OBJECTIVE CHANGE	NO	YES
TMS CHANGE	NO	YES
CSD CHANGE	NO	YES

SME _____

ID _____

Sample Check List
Figure 7

Organizational Benefits

The need for Courseware Configuration Management to be within the Instructional Systems Development function has evolved. Initially one individual was assigned to develop the necessary plan and procedures. Following the first Course Readiness Review, the need to increase Courseware Configuration Management resources became apparent and an additional person was assigned. Following the second Course Readiness Review it was determined that Courseware Configuration Management should report directly to the Instructional System Design Manager. It was also determined that the Curriculum Management function and the Media Selection and Syllabus Report/Training Management System interface should report to the Courseware Configuration Manager. Because of the necessity for courseware development and production to integrate with the C-130 Aircrew Training System it was also determined that the interface between Courseware Configuration Management would be strengthened by the Courseware Configuration Manager reporting directly to the Aircrew Training System Configuration/Data Manager for all related matters.

The implementation of this latest organizational concept has resulted in a significant reduction of courseware rework and improved product acceptance by the customer.

LESSONS LEARNED

1) A detailed courseware development plan with schedules must be defined allowing sufficient time for quality, Curriculum Management and Courseware Configuration Management inspections/audits on courseware being delivered prior to and through the Course Readiness Review.

2) Courseware Configuration Management personnel and procedures must be in place at the beginning of the development cycle. Individuals should be identified and given responsibility for developing and controlling the events that take place with courseware during the development/production cycle, leading to baseline establishment during Course Readiness Review.

3) There must be detailed procedures to handle changes to design criteria which occur following design criteria freeze. These procedures should have processes for changing design criteria, due to requirements and/or regulation changes, that will allow for a steady flow of events until completion.

4) Precise procedures and guidelines must be identified for acceptable revisions during Formative Evaluation to prevent the endless cycle of subjective revisions.

5) The importance of configuration managing all aspects of courseware, not only lessons but also the Media Selection and Syllabus Report, Lesson Specifications, Objectives Hierarchy and all other supporting documents as well must be stressed early on in the program.

6) Due to the number of lessons and their interrelationships, an automated tracking system is essential. An automated tracking system with a skeletal data base should be operational during the development phase.

ABOUT THE AUTHORS

Debra Ann McFee is the Courseware Configuration Manager for the Allen Division for the C-130 Aircrew Training System. Her responsibilities include management of the baseline and delivering 1400 lessons and keeping the baseline current with other components of the Aircrew Training System. She has been with the Allen Division for two and a half years and prior to the C-130 Aircrew Training System, she worked in San Diego on various helicopter programs as a training analyst and projects coordinator. She has a Bachelors Degree in English from San Diego State University and will receive her Masters Degree in Human Resource Development this fall.

Mr. Robert Luckett is the Link Training Service Division (LTSD) Configuration/Data Manager for the C-130 Aircrew Training

System. He is primarily responsible for the configuration and data management program and concurrency requirements of the training system. He has held the position of *configuration/data manager since 1986 upon* retirement from the Air Force. His background includes establishment of the HQ MAC Developmental Engineering Prototype Site (DEPS) for C-130 Flight Simulators where he managed the development and implementation of hardware and software updates, including configuration control. In addition, he has been involved in systems acquisition, Integration and Test and System Engineering for the B-52 and C-130 Flight Simulators and training system modifications. His experience totals over twenty years in *engineering, software development and* configuration management of flight simulation systems.