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F-4J/N INSTRUCTIONAL SYSTEM DEVELOPMENT: PHASE I.(U)

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This project was one in a continuing series of studies to upgrade Naval aviation aircrew training programs and at the same time to study the methodology, effectiveness, and resource requirements of Instructional Systems Development (ISD). It was a Phase I effort encompassing ISD steps from hierarchy development through training support requirements analysis. Project goals were to support the Marine and Navy Fleet Readiness Squadrons

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in their training program development efforts and to study the utility of the 6.2 ISD model in an application to an existing aviation system. The latter goal included gathering information on the strengths and weaknesses of the model, making recommendations for modifications to the model, and collecting resource utilization data. Input data came from a validated list of pilot and RIO tasks which was furnished by the government. Tasks from this list were analyzed into a hierarchical structure of supporting skills and knowledge. This analysis formed the basis for the development of instructional objectives. Preferred and alternate media were selected for each of the objectives. Objectives were then grouped into lessons and the lessons sequenced to form the pilot and RIO syllabi. Finally, a training support requirements analysis was performed to estimate resource requirements for development, implementation, revision, and maintenance of the two training courses. Problems encountered during this program were discussed and recommendations for changes to the ISD model were presented.

SUMMARY

This report covers the Phase I activities of a project for development of ISD-based training programs for Marine and Navy F-4 pilots and Radar Intercept Officers (RIO). In addition to developing specified end-products to be used in subsequent ISD phases, it was an effort to evaluate the utility of the emerging 6.2 ISD model by identifying its strengths and weaknesses. Project activities were conducted on-site at MCAS, Yuma with government-furnished subject matter experts providing input to major tasks under the direction of Allen Corporation ISD personnel.

Major tasks completed during this project were objectives hierarchy development, media selection, syllabus development, and training support requirements analysis. Each of these activities is summarized below.

OBJECTIVES HIERARCHY DEVELOPMENT

A job analysis was conducted prior to contract award to Allen Corporation. This survey provided a listing of tasks selected for training. These tasks were the input to objectives hierarchy development. During hierarchy development, tasks were analyzed to identify subtasks which were components of the major tasks. Behavioral objectives were developed for each subtask and, along with the major tasks, were arranged in hierarchy formats to show their interrelationships, i.e. superordinate, coordinate, and subordinate relationships.

MEDIA SELECTION

Preferred and alternate instructional media were selected for each objective identified during hierarchy development.

Selections were made on the basis of an algorithm in which the following variables were considered: (1) level of expected student behavior, (2) level of content taught, (3) amount of practice required for mastery, (4) minimum display requirements, and (5) amount of memorization required. During the next step, syllabus development, media selections for the objectives were used to determine the preferred medium for each lesson.

SYLLABUS DEVELOPMENT

Objectives were grouped to form lessons. First, flight lessons were formulated using objectives selected for flights during media selection. Next, objectives requiring simulators were grouped to form lessons to support the previously formed flight lessons. Finally, ground school lessons were structured to support the simulator and flight lessons. After the ground school objectives were grouped into lessons, media selections were reviewed to determine if media for all objectives in a lesson were the same. If not, adjustments in media and/or lesson content were made to select the preferred medium for each lesson.

The resultant syllabus embodied an individualized instructional system in which the predominant medium was slide-tape presentation. Other media included workbooks, videotapes, simulators, and the aircraft. Lessons were sequenced to facilitate acquisition and retention by proceeding from ground school instruction to hands-on practice in a simulator, to practice in the aircraft.

TRAINING SUPPORT REQUIREMENTS ANALYSIS

The final task of this project was to estimate cost, facilities, and personnel requirements to develop, implement, revise and maintain the training program outlined in the syllabus. Development cost estimates were based on a survey of commercial and government organizations. This survey yielded costs and personnel requirements for lessons in each of the selected media. Similar requirements for revision of materials were also determined. Facilities requirements included that required by materials development personnel and for implementation of the training course.

CONCLUSIONS

The general conclusion of this project was that the ISD model used provides a viable approach to ISD implementation. A number of problems were encountered, which resulted in suggestions for modifications to the model. The experience gained during this project and the resultant recommendations will assist in the further refinement of the 6.2 model.

PREFACE

The Naval Training Equipment Center has a continuing interest in the use of ISD techniques to upgrade aircrew training programs and in the process to develop and refine a model for future ISD programs. This F-4 program followed four similar ISD programs (SH-2F LAMPS, A-6E TRAM, EA-6B ICAP, and E-2C HAWKEYE) in which different ISD methodologies were used by the contractors involved. As a result of these programs, a standard ISD model was developed. The F-4 program is the first program in which the model has been implemented by a contractor other than those involved in the previous ISD programs. The work was performed by the Allen Corporation of America under Contract N61339-77-C-0081. A multi-phase ISD effort was planned. The Phase One analysis was completed and is described in this report.

The operational goal of this project was to develop the framework for pilot and RIO training programs, which could be expanded into instructional materials for implementation in subsequent phases. The research and development goals were to: (a) evaluate how well an independent contractor, using the detailed ISD specification and associated Data Item Descriptions, could implement the model, (b) identify strengths and weaknesses of the model, (c) obtain recommendations for modifications to the model and (d) acquire cost, scheduling, and manpower data for future ISD planning.

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INTRODUCTION

BACKGROUND

This project is the latest in a series of programs sponsored by the Naval Training Equipment Center (NAVTRAEQUIPCEN) to develop, refine, and standardize techniques used in Instructional Systems Development (ISD). The goal of these programs is to define an ISD model which will provide a standardized approach to developing training programs for operators and maintenance personnel and at the same time to upgrade the quality of aircrew training on selected aviation systems.

The first four ISD programs in the series were carried out simultaneously by different contractors under broad ISD guidelines specified by NAVTRAEQUIPCEN. The purpose of providing only broad guidelines for discrete processes and end products was to allow the different contractors flexibility to utilize their own techniques and procedures. Under the four contracts the analysis steps in the ISD process up through lesson specifications were carried out for four different aircrew training courses. The aircrewmen for which the ISD process was initiated were the pilot, NFOs, and FT of the E-2C Hawkeye, the pilot and ECMOs of the EA-6B Prowler, the pilot and sensor operator of the SH-2F LAMPS, and the pilot and NFO of the A-6E TRAM.

Each of the four programs required the development of training programs for two different types of crewmembers: (1) pilot training which has a large manipulative skills component supplemented with cognitive instruction; and (2) NFO training, which primarily involves instruction in interpretation and decision-making processes. The programs also encompassed a wide range of aircraft types including an attack aircraft (A-6E), an electronic countermeasures aircraft (EA-6B), an airborne early warning and surveillance aircraft (E-2C), and an anti-submarine helicopter

(SH-2F). These four programs with their variety of aircrew types and aircraft missions provided the information from which a basic Navy model for ISD was developed. In addition, a large amount of data on the manpower and costs required to do large ISD programs was collected.

The second step in the series of ISD programs was the formulation of a model using as a data base the procedures employed by the different contractors in the four previous programs. The purpose was to analyze the strengths and weaknesses of the different approaches to ISD and to synthesize the strengths of the models into one model which would become the Navy standard for training program development. The use of the model in future programs would facilitate management by contract technical monitors and would insure a uniformly high quality product. The resultant model has been referred to as the "6.2 Model". The most recent version of the model is delineated in Military Specification MIL-T-29053, dated 19 October 1977, and is entitled "Training Requirements for Aviation Weapon Systems".

The F-4 program which is the most recent in the series of ISD programs, emerged as the result of two needs. One was the recognized shortcomings of the F-4 pilot and Radar Intercept Officer (RIO) training courses. The second was the need to evaluate how effectively a contractor, not involved in the earlier ISD programs, could apply the "6.2 Model" to an existing aircrew training program. Related to this second need was the continuing requirement to collect data on ISD manpower and cost requirements.

Specific deficiencies in the two F-4 training courses were identified in the problem analysis. It was noted that objective performance standards and standardized criteria and evaluation methods have not been defined for academic, simulator, or flight training. This lack of standardization and specific evaluation criteria significantly inhibits efforts to improve the training.

Furthermore, an extremely low wash-out rate suggests that the exit level skills of the trainees are not being assessed with adequate precision. Hence, optimal remedial action, appropriate to students and/or the training program is hampered. It was also noted that the capabilities of existing training devices are constraining to the current training programs.

The selection of a contractor, familiar with ISD procedures but without specific experience in the application of the model, was intended to serve two purposes: (1) an evaluation of the clarity and utility of the Data Item Descriptions (DIDs) and the specification, i.e. determining how accurately the model could be interpreted and implemented by the contractor; and (2) a source of recommendations for modifications that will improve the procedures in future ISD programs.

The analysis phase of the F-4 ISD program, which is discussed in this report, was applied in that the end products constituted the first steps in the process of developing an ISD-based training program and will be used as the basis upon which the design and development phases will be formulated. It was research in that it was the first application of a rigidly specified model by a contractor other than those who had developed the steps and procedures which were incorporated into the model.

STATEMENT OF THE PROBLEM

The primary goals of the analysis phase of the F-4 ISD program were to implement the ISD model in accordance with Specification N215-264 and to prepare and deliver the specified end products in accordance with applicable DIDs. Analyses were performed for both the Navy and Marine training courses and the F-4 J and N models. The starting point for this contract was the task of developing objectives hierarchies and Specific Behavioral Objectives (SBOs) from the Task Listing. This listing, which was developed by the

Marine ISD team at MCAS, Yuma under the guidance of Courseware, Inc. was supplied to Allen Corporation at the beginning of the contract.

The procedure specified by NAVTRAEQUIPCEN was to have Marine and Navy F-4 pilot and RIO subject matter experts (SMEs) carry out those tasks in the ISD process which required knowledge of F-4 operations, tactics, and procedur[illegible]. This was done under the technical guidance of Allen C[illegible] tasks in which expert knowledge was not required were carried out primarily by Allen Corporation personnel. The major tasks for which deliverable end products were specified were:

1. Objectives Hierarchy and SBO Development
2. Media Selection
3. Syllabus Development
4. Training Support Requirements Analysis (TSRA)

SYSTEM DESCRIPTION

THE AIRCRAFT. The F-4 is a two-place, supersonic, long-range, all-weather fighter built by McDonnell Douglas Corporation. It is designed for intermediate and long range high altitude interceptions using missiles as the principal armament and for intermediate or long range attack missions to deliver airborne weapons/stores. The aircraft is powered by either two single rotor, axial flow, variable stator turbojet J79-GE-8 or J79-GE-10 engines with afterburners. It is capable of carrier operations.

The degree of sophistication in modern weapons systems has necessitated the employment of two-man crews in many of the current fighters to minimize the probability of operator overload. Although there is a clear division of labor between the pilot and RIO duties, they must function as an efficient team to carry out the missions of the F-4. The training program for both crew positions must, therefore, stress individual duties, as well as, contain a strong emphasis upon the teamwork required. The most successful fighter teams are those who work together continuously and know each other's reactions, strengths and weaknesses.

THE MISSIONS. The F-4 has two primary missions, air-to-air interceptions and air-to-ground delivery of airborne weapons/stores. In addition, the F-4 performs armed escort and reconnaissance missions. The primary weapons systems used to carry out these missions are the bombing equipment, the data link system, the direct radar scope camera, electronic countermeasure equipment, gunnery equipment, and the missile control equipment. Since the F-4 has been in the Navy/Marine inventory for a number of years, a large amount of experience in executing the above missions in combat, practice, and training environments has been accumulated.

THE TRAINING PROGRAM. The existing Navy and Marine transition courses are the results of many iterations and refinements over the years since the F-4 was introduced. The Marine syllabus includes training to 60 percent (combat capable) with the remainder of training to 100 percent proficiency (fully combat qualified) taking place in tactical group training at operational squadrons. Graduates of the Navy syllabus are 80 percent proficient with 20 percent left for tactical group training at operational squadrons. A summary of the total training for Marine F-4 pilots and RIOs is shown in Table 1. Included is the training to 60 percent proficiency at MCAS, Yuma, plus the additional training provided at duty squadrons. Table 2 provides a further breakdown of ground school training which currently takes place at VMFAT-101, MCAS, Yuma. Tables 3 and 4 are breakdowns by sorties/hours and simulator periods/hours of the Combat Capable Training portions of the pilot and RIO syllabi.

Trainees for the pilot transition course come from four Advanced Jet Training programs. RIO trainees come from the Advanced Naval Flight Officer school. Students for the refresher

TABLE 1. SUMMARY OF BASIC MARINE TRANSITION AND CONVERSION TRAINING FOR F-4 PILOTS and RIOs

Weeks	Course	Activity
1-3	Ground school and flight simulator training	Training group*
4-6	Air-to-air and air-to-ground courses	MAWTU*
7-26	Combat capable training	Training group*
27-38	Combat ready training	Tactical group**
39-46	Combat qualification training	Tactical group**
47-54	Full combat qualification training	Tactical group**

* Takes place at FRS

** Takes place at operational squadron

TABLE 2. BREAKDOWN OF TRANSITION GROUND SCHOOL AND SIMULATOR/FLIGHT TRAINING AT MCAS, YUMA

Course	Duration
Ground School	2 weeks
Aircraft Systems	
Cross-Country Packets	
Aircraft Preflight	
Plane Captain Signals	
Safety	
Aerodynamics	
Emergency Procedures	
Course Rules	
Aircrew Teamwork and Responsibilities	
Basic Radar	
Navigation Computer	
Airborne Missile Control System	
Flight Planning	
Performance Data	
Flight/Simulator Training	1 week

TABLE 3. BREAKDOWN OF THE COMBAT CAPABLE TRAINING PORTION OF THE PILOT SYLLABUS

STAGE	FLIGHT SORTIES/HOURS	SIM. PERIODS/HRS	TOTAL TRAINING
Basic Qualification		Entry level skills	
Familiarization	4/4.8	8/12.0	12/16.8
Instrument	4/6.0	-	4/ 6.0
Formation	3/3.9	-	3/ 3.9
FMLP	1/0.8	-	1/ 0.8
All Weather Intercept	7/8.4	12/18.0	19/26.4
Missile Fire	1/1.5	1/ 1.5	2/ 3.0
Aerial Ref.	2/2.6	-	2/ 2.6
Ground Attack	9/9.0	-	9/ 9.0
Vis. Nav.	1/1.3	-	1/ 1.3
BAM	6/6.0	1/ 1.5	7/ 7.5
Fighter Intercept	2/2.4	2/ 3.0	4/ 5.4
Fighter Weapons	7/5.6	-	7/ 5.6
	47/52.3	24/36.0	71/88.3

TABLE 4. BREAKDOWN OF THE COMBAT CAPABLE TRAINING PORTION OF THE RIO SYLLABUS

STAGE	FLIGHT SORTIES/HOURS	SIM. PERIODS/HRS	TOTAL TRAINING
Basic Qualification		Entry level skills	
Familiarization	1/ 1.2	8/12.0	9/13.2
Instrument	5/ 7.5	-	5/ 7.5
Formation	1/ 1.3	-	1/ 1.3
FMLP	1/ 0.8	-	1/ 0.8
All Weather Intercept	10/12.0	12/18.0	22/30.0
Missile Fire	1/ 1.5	1/ 1.5	2/ 3.0
Aerial Ref.	2/ 2.6	-	2/ 2.6
Ground Attack	9/ 9.0	-	9/ 9.0
Vis. Nav.	1/ 1.3	-	1/ 1.3
BAM	5/ 5.0	1/ 1.5	6/ 6.5
Fighter Intercept	2/ 2.4	2/ 4.0	4/ 6.4
Fighter Weapons	7/ 5.6	-	7/ 5.6
	45/50.2	23/31.0	68/87.2

pilot and RIO courses fall into two categories, those who have not flown in an F-4 for 6-18 months and those who have not flown in an F-4 for more than 18 months. The training which these pilots and RIOs receive is a subset of the total transition course. Instructors Under Training (IUT) receive a special six-week IUT course in addition to refresher ground school and simulator training.

During transition training at MCAS, Yuma, trainees are assigned collateral duties which require an average of two hours per day. These jobs include assignments in operations, administration, maintenance, intelligence, and logistics and embarkation. Other duties include operations duty officer, squadron duty officer, maintenance duty officer, and legal investigations. Due to these collateral duties trainees are not expected to put in a "full training day". In the day-by-day schedule produced as part of the F-4 ISD program allowances are made for these collateral duties.

Some trainees, but not all, may attend additional schools while undergoing FRS training. These schools are attended if the periodic requirements for completing the schools occur during FRS training. Among these schools are Survival, Escape, Resistance and Evasion (SERE) School, Flight Instruments Refresher Course, and Water Survival Training.

The combat capable training courses are designed to produce fully NATOPS qualified pilots and RIOs. Trainees are evaluated in oral and open and closed book exams, in normal and emergency procedures using the COT and WST, and in flight.

SECTION II
INSTRUCTIONAL SYSTEM DEVELOPMENT

BACKGROUND

Traditionally, training programs within the military have been generated in-house by a number of instructor personnel tasked with the difficult problem of sorting through all available information and developing an approach to the classroom presentation of an assigned content area. The resulting instructor guides (outlines) and student handouts are, by necessity, based on information within each individual's realm of experience. This experience is largely based on prior instruction and specialized operational missions. Of particular significance in such an approach to training is a failure to conceptualize the entire system in perspective. This results in a piecemeal, poorly-coordinated buildup of instructional units with retrofitting as the method of necessity for curriculum development. Furthermore, the Subject Matter Experts (SMEs) approaching the task usually do not have the benefit of expertise in the principles and application of instructional technology. The problem is complicated by the rapid turnover in instructor personnel. Often too, an attempt is made to piece together the in-house training materials, typically instructor guides (outlines), with separately developed technical materials provided by a contractor to complement existing hardware. The classroom instructor is ultimately left with the task of integrating the curriculum while performing within the confines of the existing policy and procedure of the training command.

As a result of this piecemeal procedure, most instructional programs could be characterized as having one or more of the following problems:

- Critical content is underemphasized or is left out.
- Instruction and testing are oriented toward general content knowledge rather than toward specific knowledge related to operational performance.

- Learning outcomes and evaluation criteria are poorly defined.
- Instructional methods and media are selected with little regard for relating subject matter content to media capabilities.
- Subject matter content is instructor-specific and changes as instructors change.
- There is little, if any, distinction between content and instructional design experts, i.e. content experts do everything.
- Evaluation and update procedures are rarely formulated.

ISD evolved in response to these symptoms, as well as, the increasing demand for greater efficiencies in a time of tightening resources. It is an attempt to derive orderly procedures for the design, development, implementation, and evaluation of instructional systems, and to provide operational guidelines for carrying out the procedures.

Many models have been formulated over the past 20 years. Most have contained analysis, design, development, implementation, and quality control phases tied together in a sequential flow. Some have been more prescriptive than others. Some have failed; others have been partially successful; but not one has received general acceptance. Although the progress has been slow, ISD technology is developing as data on the various methods are collected.

The model being implemented in the F-4 program represents a large improvement over earlier approaches. It contains well-defined procedures for some tasks, while others are less defined. There are many areas for potential improvement in the model. Identifying some of these areas is one of the goals of this program.

ASSUMPTIONS

The following assumptions underlie the ISD model which was used in this program.

- The resultant training courses should teach knowledge and skills which are required on the job.
- The courses when implemented should be efficient in terms of resource requirements.
- The instructional program should be based on clearly-defined objectives.
- Selection of instructional methods and media should be based on a mapping of method and media characteristics into the training requirements of the objectives.
- Solid testing, evaluation, and revision procedures are essential to success.
- Subject matter content can be best supplied by personnel experienced in system operation. To insure optimal use of their expertise, training specialists should channel this knowledge of the system into the appropriate ISD formats.

METHODS/PROCEDURES

The "6.2 Model" is the state-of-the-art in ISD. It is the most precisely defined and procedurally accurate approach to ISD yet developed. The detailed specifications for the model follow a sequential flow beginning with task listing procedures and terminating with instructor training for implementation (Figure 1). The first step which is not part of the model, is the problem analysis. The purpose of the problem analysis is to provide background information on the strengths and weaknesses of the existing training system (if there is one). Using this information it can be determined if efforts should be made to upgrade the program and, if so, what the approach should be. Not all problem analyses identify ISD as the most appropriate and cost-effective option. Other options are no action at all, updating the media used without doing a full analysis, and performing an ISD analysis on selected portions of the program. In addition, the problem

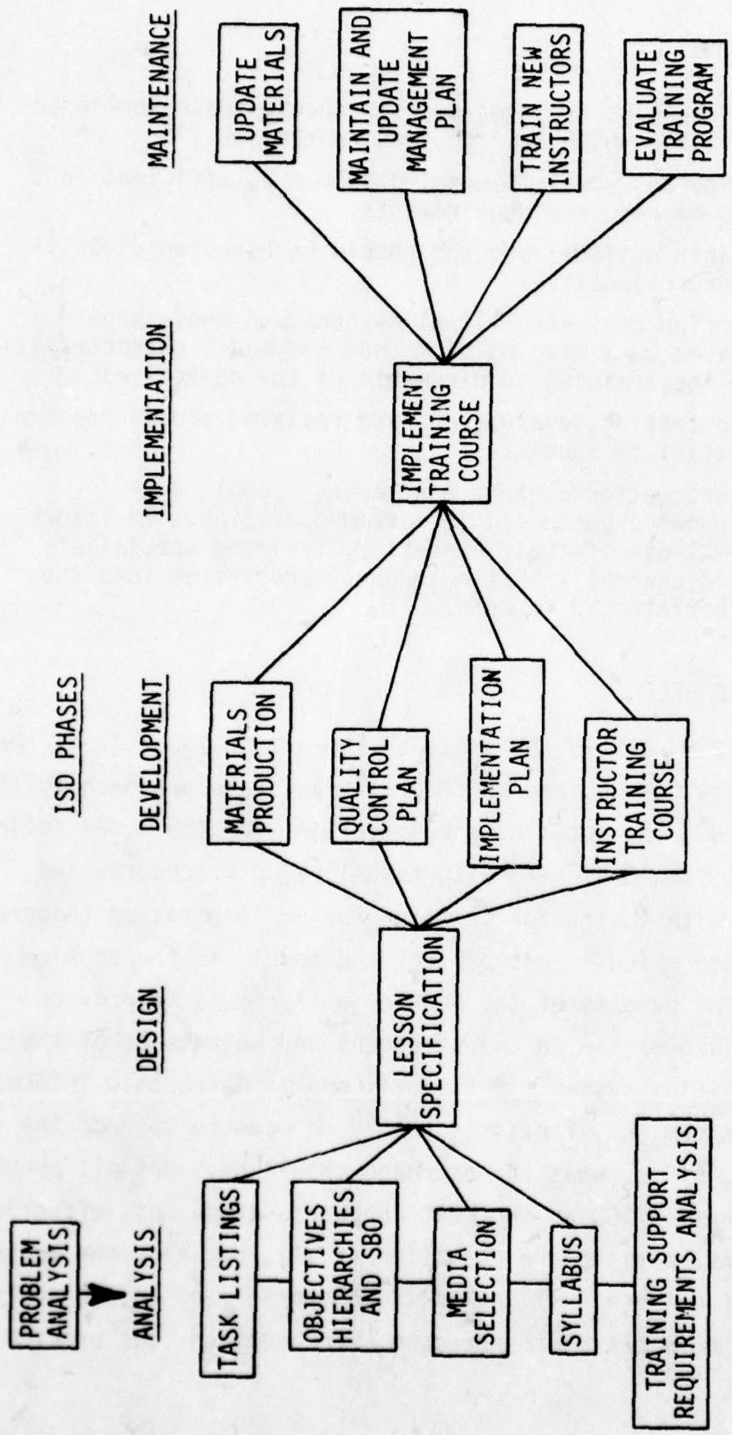

Figure 1. Steps within Phases of the 6.2 ISD Model

analysis provides background information concerning training program users and available training assets. This information assists the ISD contractor in evaluating the total environment in which the upgraded training program will be designed and implemented.

The first step in the ISD model is to develop a task listing. This step helps insure that all tasks that should be included in the training program are identified. The task listing is used in a job analysis survey which is administered to personnel who are qualified in the system on which the ISD program is being executed. During the job analysis survey, these personnel are questioned on the criticality of each task to successful performance, the frequency with which the task is performed on the job, the difficulty of the task, where the task was learned (i.e., in a school or on the job) and where the task should be taught. The results of the job analysis survey are used to determine which tasks should be included in the training program and the emphasis which should be placed on those tasks selected for training (i.e., indepth versus refresher training).

Once the task listing has been validated and tasks have been selected for training, the tasks are used as the basis for developing objective hierarchies and Specific Behavioral Objectives (SBOs). This step involves analyzing tasks from the task listing in greater detail to identify all skills and knowledge which are prerequisite to performing the tasks identified in the task listing. The structure of the hierarchies is such that all the component objectives of a major task are arranged from the simplest and most fundamental knowledge up to the most complicated skill. Each entry in the hierarchies is an SBO which specifies decisions that must be made, pieces of information that must be learned, procedures that must be executed, or skilled actions which must be performed.

For each SBO, conditions under which the objectives must be performed and the minimum acceptable performance standards are specified. By laying the objectives out in hierarchy diagrams, the subordinate, superordinate, and coordinate relationships among the objectives can be clearly identified. The objectives hierarchies and SBOs provide the fundamental data base on which the training program will be structured. They also are the direct inputs into the next two steps in the ISD process, media selection and syllabus development.

Media selection involves determining which of the candidate media is best suited for providing instruction for each of the SBOs identified in the previous ISD step. The output of the media selection process is a list of acceptable instructional media for each objective. Acceptable media are listed in order of preference. The goal of this process is to select media which will enable the best possible trainee performance while minimizing costs. The procedures to be employed in media selection have yet to be standardized in the 6.2 model and are, thus, still evolving. In the F-4 program media were selected on the basis of the level of behavior expected of the student, the level of content being taught, the number of instances the student should see, the minimum display requirements, and the amount of memorization required. Other, more conventional, media selection models use procedures in which the display and fidelity requirements of each objective are mapped into the display and fidelity characteristics of candidate media. The current version of the ISD model, MIL-T-29053, does not specify a specific procedure to be used. Rather it stipulates that an explicit media selection model shall be provided for approval by the contracting agency.

After lists of acceptable instructional media have been specified for the objectives, the objectives are grouped and sequenced to form the syllabus. Objectives are grouped into lessons and the lessons are sequenced to form units, which contain lessons dealing with the same general subject matter content area. Units are sequenced to form the syllabus. The resultant syllabus should possess three characteristics. First, objectives should be sequenced so that those objectives which are lower in a hierarchy are taught prior to higher level objectives in the same hierarchy, i.e., instruction in the prerequisite skills and knowledges precedes instruction in the more complex skills or decision processes. Second, whenever possible, the sequence should specify early hands-on learning and practice and maintain an integration of academic instruction and skills practice throughout the syllabus sequence. Third, in general, major tasks should be sequenced from easiest to hardest. When feasible, however, those tasks which will require extensive practice should be introduced early in the syllabus to allow the required practice to be integrated throughout the remainder of the syllabus. Applying these three guidelines during lesson organization and sequencing yields a flow of instruction in which trainees first learn operating procedures, then practice the procedures, and finally perform the procedures in more complex situations in which decisions and integration with other procedures are required.

At this point in the sequence of ISD steps that portion of the analysis phase which involves the production of end products which will be converted into instructional materials has been completed. The final step in analysis is preparation of a Training Support Requirements Analysis (TSRA). The TSRA provides an estimate of the personnel, equipment, materials, and services which will be required during subsequent phases in the ISD program. Separate estimates for design, development, implementation, and evaluation and maintenance are provided. The TSRA is used as a planning document for budgeting purposes.

Due to the detail provided on the number of lessons per instructional medium in the syllabus and the cost of production per lesson in each medium, the TSRA can be used to identify relative media costs. By using relative costs, areas of possible cost savings can be determined. For example, the production of slide-tape materials is relatively costly compared to workbooks or mediated interactive lectures. Workbooks and mediated interactive lectures are in most cases alternative choices for slide-tapes. If there are costing constraints for production and revision of materials, some of those lessons for which tape-slide was first chosen may instead be presented in workbooks or mediated interactive lectures.

Another area in which the TSRA provides information is facilities requirements. This is particularly important in the planning for an implementation in which major modifications to existing facilities or the construction of new facilities will be required. In order to have the facilities available when all materials have been developed and the course is ready for implementation, preparation of facilities must begin as early as possible after the initial ISD analyses have been performed. The TSRA is the jumping off point from initial analysis into the much more costly and lengthy design, development, implementation, and revision phases.

The design phase involves the development of lesson specifications for all lessons in the syllabus. A lesson specification contains the subject matter content and outlines the instructional strategy for each objective in the lesson. It is during this step that the information that will be presented in the course is assimilated and the strategies that will be used in the presentation of the lesson and testing of its content are determined. In addition to a statement of the subject matter content of each objective, a lesson specification contains helps that may be used in remembering or applying the objective, the number and types of examples required to support instruction of each objective, the practice and testing requirements, and graphic specifications.

After the design phase is completed, the development phase begins. During the development phase a number of tasks are carried on concurrently. The primary task involves converting the lesson specifications into lesson and testing materials. Authors use the lesson specifications in conjunction with lesson guides which explain how to produce instructional material for each medium being used. Lesson materials are produced in draft form and reviewed by the instructional psychologist. Prototype materials are then produced for small scale tryout. Based on data collected during the small scale tryout, lesson materials are revised for final production.

While the instructional materials and tests are being developed, quality control and implementation plans must be formulated. These plans help insure that implementation, evaluation, and revision procedures are well-formulated and are workable within the training environment. The quality control plan presents the procedures to be followed in continuously assessing the relevance, effectiveness, and currency of the instructional materials and the instructional management system. It provides for such assessment from the earliest materials development stage to the implementation of the training program and throughout the life cycle of the weapons system. The quality control plan addresses three major areas: formative revision, internal quality control (trying out the finished materials with real students in the real training environment), and external quality control (the validity of the training program in terms of its relevance to operational requirements for skilled personnel).

The implementation plan details the procedures and milestones which will be followed during the implementation phase of the ISD program. The plan focuses on training management and administration, personnel requirements, and implementation procedures.

Some of the specific content areas contained in the implementation plan are:

- Instructional system integration
- Equipment storage, maintenance, and utilization
- Student grading evaluation
- Training materials management
- Facilities utilization
- Student scheduling and management
- Schedule contingency plan

The final step during the development phase is the preparation of an Instructor Training Course (ITC). The ITC is designed to teach Fleet Readiness Squadron (FRS) personnel to properly use the instructional system. It provides instruction in the following areas:

- The training organization to include personnel, organization, policies, and student characteristics
- The training program to include syllabus organization and student flow, instructor duties, media used in the training program, student learning center operations, ISD team duties, and an overview of the ISD process.
- Training system operation and scheduling
- Storage, operation, and troubleshooting of media devices.
- Conducting lessons in all media used in the program
- Evaluation of students and instructional materials
- Revision of instructional materials

After all instructional materials have been produced, the quality control and implementation plans have been formulated, and the ITC has been prepared and administered, the implementation phase begins. The length of implementation is a function of course duration and the interval between class convenings. At a minimum it is the length of one class, during which external quality control data is collected on that class. Preferrably its duration exceeds that of one class so that data on multiple classes can be collected and necessary modifications to the training materials and/or the management plan can be made. Most of the "bugs" should be worked out of the new training system during this initial implementation phase.

The final phase in the ISD process is evaluation and maintenance of the training program for as long as it is in use. While this phase is less formal than the previous phases in the concentration on ISD methodology, it embodies a continuation of ISD procedures in the constantly ongoing process of updating the training program. This is a particularly crucial phase since the structure of the program will change and possibly erode if a high quality maintenance program is not provided. The procedures detailed in the quality control and implementation plans and the instructor training course must be maintained. This function may be allocated to a small ISD team which should be well-schooled in ISD procedures in general and in the specifics of the particular training program.

The scope of this F-4 ISD program encompasses the analysis phase of the ISD process. The task listing was generated by MCCTRG-10 ISD personnel under the guidance of Courseware, Inc. It provided the primary input into hierarchy and SBO development, which was the first task of this contract. Subsequent tasks were media selection, syllabus development, and training support requirements analysis. How these tasks were carried out is discussed in Section III, Implementation.

SECTION III
IMPLEMENTATION

ORGANIZATION AND STAFFING

PERSONNEL. Three organizations participated in the F-4 ISD program. These organizations and their roles are as follows:

o Contractor	-On-site training, guidelines, and review of products in accordance with ISD procedures
o MCCTRG-10 ISD Dept. (supplemented by VF-121)	-Supply subject matter experts to provide input on F-4 procedures, tactics, etc. Provide facilities for the project.
o NAVTRAEQUIPCEN	-Project coordination, direction and monitoring

Under provisions of the contract MCCTRG-10 was tasked to provide Marine subject matter experts (SMEs) to the program. Four SMEs participated on a part-time basis for the first 26 weeks of the 32-week program. SMEs were not required for the final six weeks. In addition, three Navy SMEs from VF-121, NAS Miramar, participated on a non-overlapping basis for a total of ten weeks. On-site contractor personnel included an instructional psychologist, who was the on-site supervisor, a former F-4 RIO, who assisted the on-site supervisor in coordinating all project activities and who reviewed outputs from the Marine and Navy SMEs, and a secretary. The program director was located off-site. He made monthly visits to MCAS, Yuma, reviewed all products of the program, and was responsible for liaison with NAVTRAEQUIPCEN. Overall responsibility for the program rested with the Allen Corporation Technical Director. He reviewed all products of the program. The hierarchical organization of the program team is shown in Figure 2.

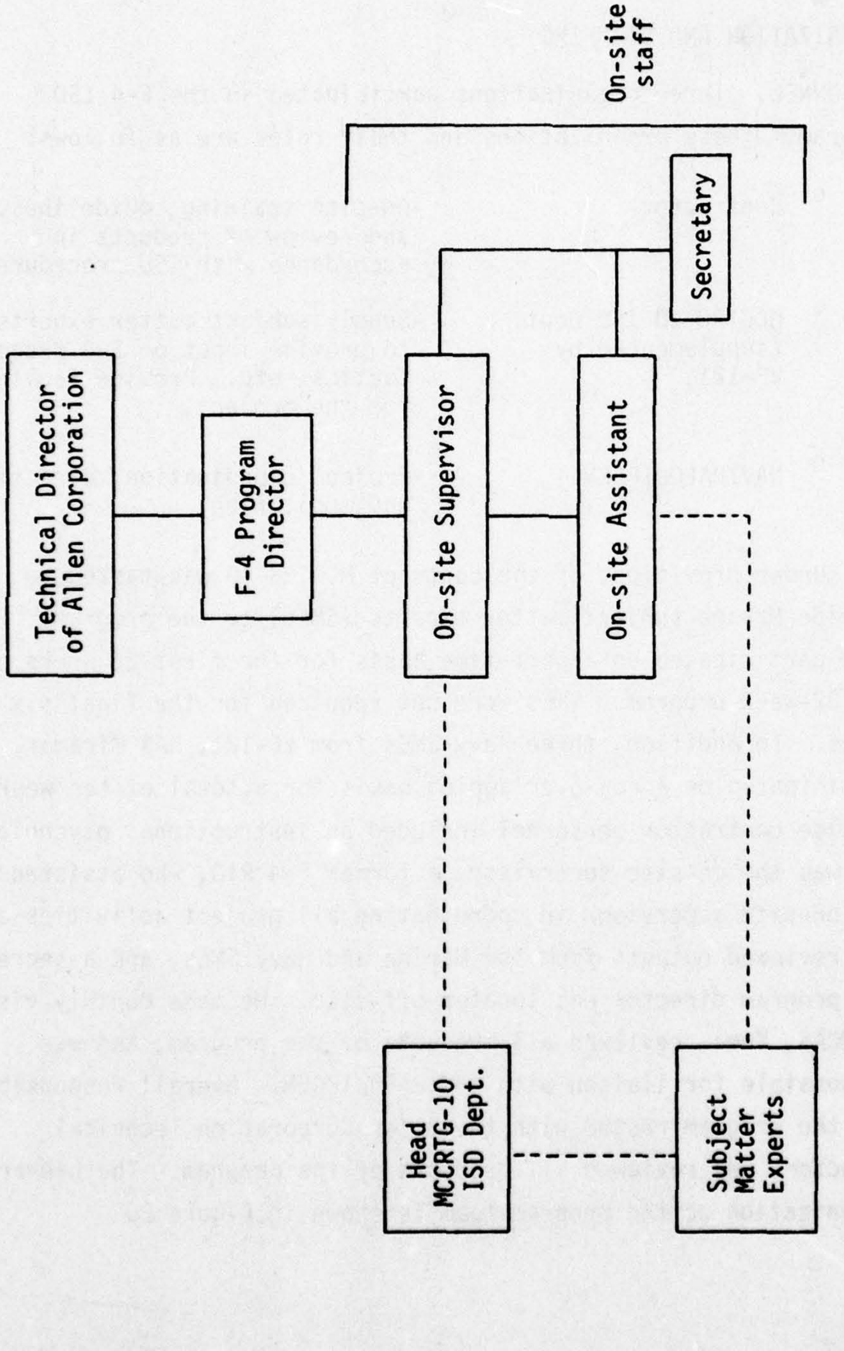

Figure 2. Hierarchical Organization of Program Team

As indicated by the dashed lines in Figure 2, the activities of the Marine and Navy SMEs were governed by the existing military command structure. They reported to the head of the MCCTRG-10 ISD Department, who was responsible for coordination with on-site contractor personnel.

PROJECT SEQUENCING. The sequencing of major project activities was planned at the outset as shown in Figure 3. The project was contractually scheduled to be a 32-week effort. Hierarchy and SBO development was scheduled for 11 weeks. Media selection, syllabus development, and the TSRA were scheduled for four weeks each. The right sides of the hierarchy and SBO development, media selection, syllabus development, and TSRA blocks indicate the submission date for a draft report. In each case the final report for that activity was scheduled four weeks after draft report delivery.

PROJECT ACTIVITIES

INTRODUCTION. In the following sections detailed descriptions of each of the major ISD activities conducted during the project will be discussed. For each activity the following categories of information are included:

- An overview of the purpose of the activity
- A description of the procedures employed
- A description of SME training
- An account of the problems and solutions

The last section contains a summary of the F-4 training courses developed during this program.

OBJECTIVES HIERARCHIES AND SBOs.

Overview. The first major task performed under this contract was the development of objectives hierarchies and SBOs. A hierarchy is a visual layout of the structure of the component objectives which support the performance of a task. It shows

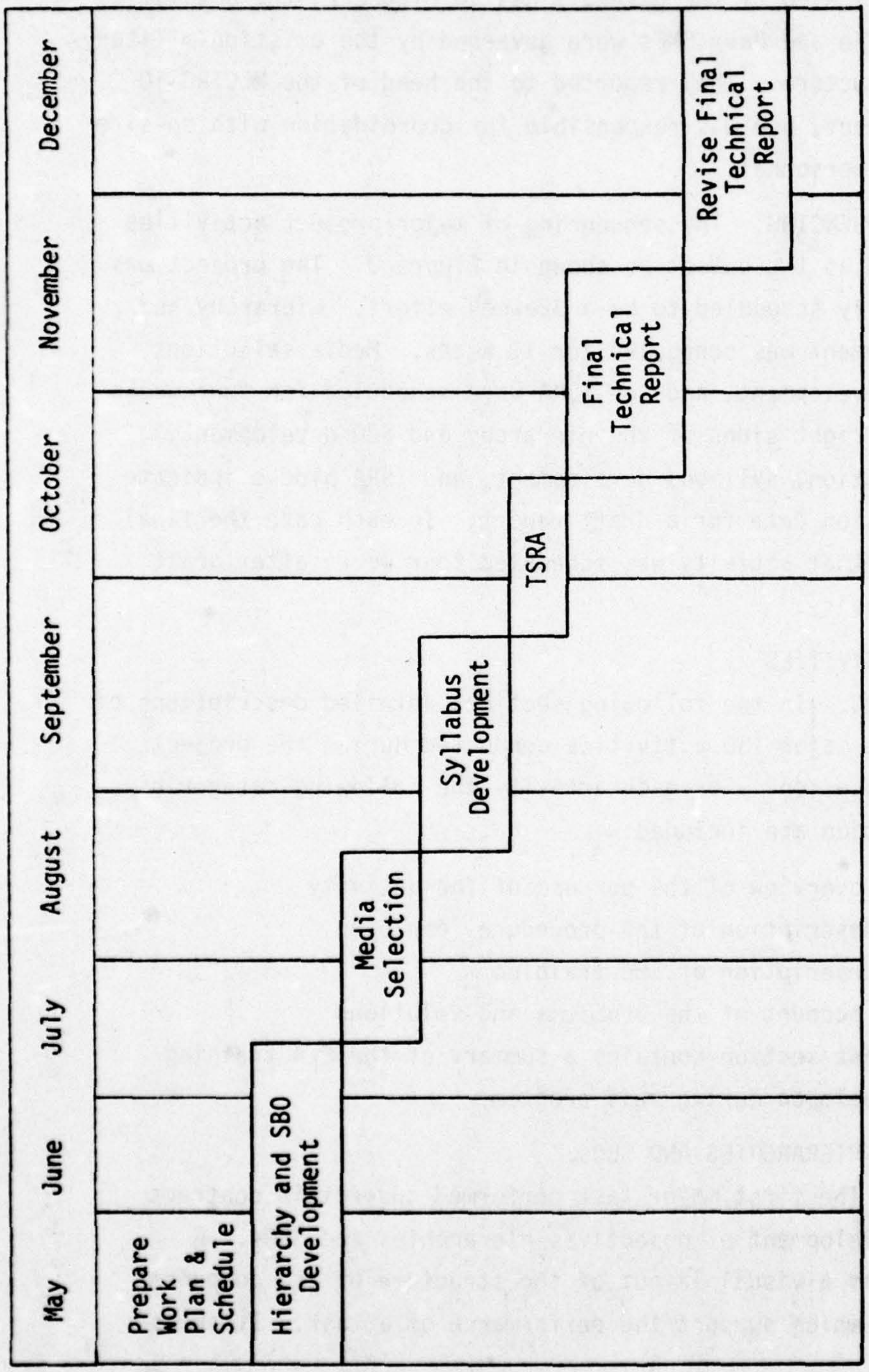

Figure 3. Initial Sequencing of Major Project Activities

subordinate, superordinate, and coordinate relationships among the objectives. The procedures used to develop hierarchies of objectives and tasks provide a systematic way of determining what the student must learn in order to perform his job. They constitute the data base which will be used in the further development of the training program. A training program developed from objectives hierarchies is more likely to be complete in its job and task orientation and free of irrelevant information, which is time consuming to teach but adds little to the student's ability to perform the job.

Procedures. The input to the hierarchy and SBO development process is the validated task listing. It contains the major tasks which have been selected for training during job analysis. For this program the pilot and RIO task listings were furnished by the government. They were structured by missions and segments within missions. There were four missions with ten mission segments per mission. A visual representation of the mission by segment structure of the task listing is shown in Figure 4. The entries in the cells are the mission by mission segment numbers. These numbers formed the basis for the numbering system which was used during hierarchy development.

The procedures used to develop the objective hierarchies are outlined in Figure 5. An elaboration of the steps shown in Figure 5 follows:

Step 1: List major tasks - This step was accomplished during task listing. It is included here to emphasize that the task is the input to the objective hierarchy and SBO development process.

Step 2: Select the most, or next most complicated task for analysis - The following criteria should be used in the selection of the most complicated task:

- Select a task which involves a large part of the job time
- Select a task which requires many sub-procedures for its completion

SEGMENT

Mission No. Name	.1 Pre-mission Planning	.2 Brief	.3 Pre-Launch	.4 Takeoff & Departure	.5 Nav.	.6 Tactics	.7 Refuel	.8 Approach & Landing	.9 Post Mission	.10 Debrief
1.0 Air to Surface	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	1.10
2.0 Air to Air	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	2.10
3.0 Reconnaissance	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	3.10
4.0 Escort	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	4.10

Figure 4. Structure of the F-4 Pilot and RIO Task Listings

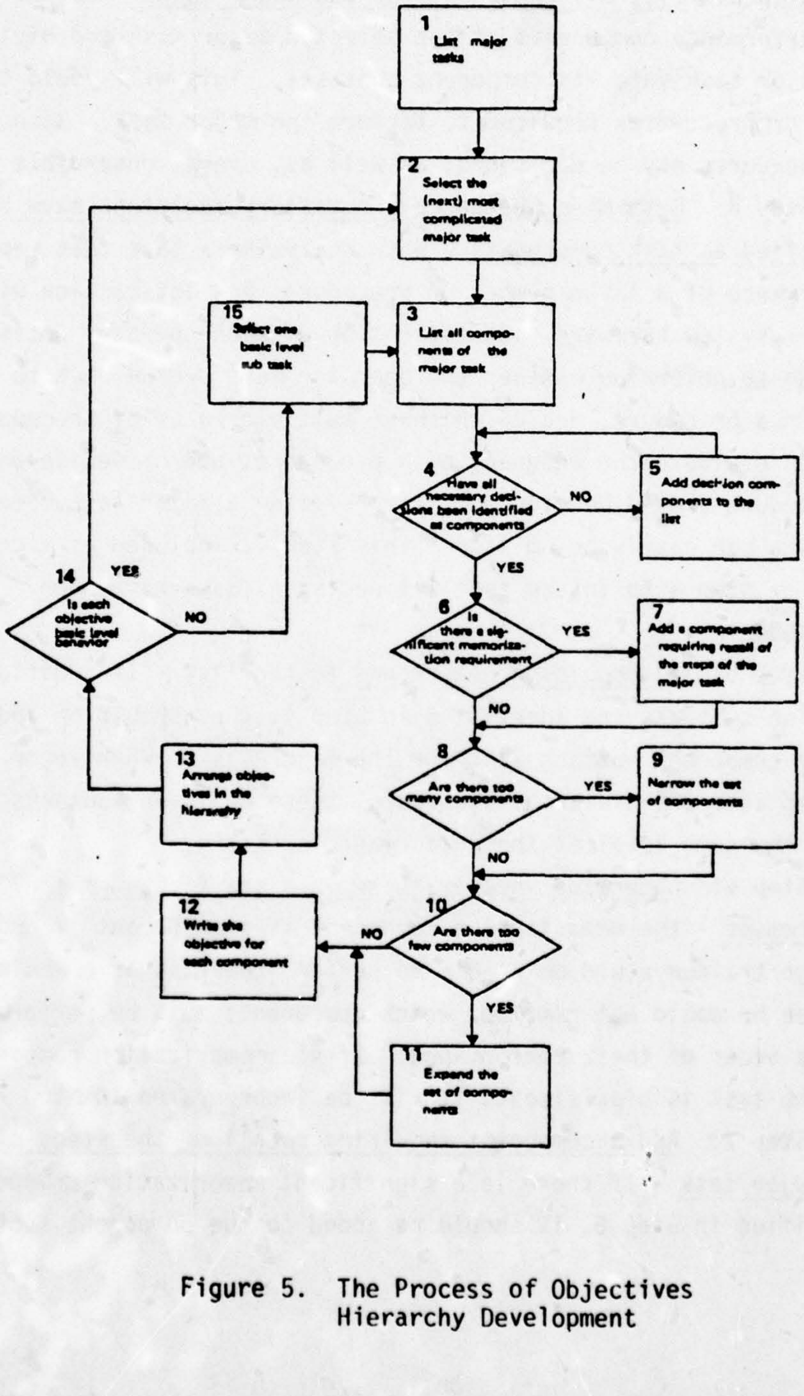

Figure 5. The Process of Objectives Hierarchy Development

- Select a task which tends to be one of the most difficult

Step 3: List all components of the major task - Analyze the performance components of the selected major task and divide the major task into its component subtasks. This will yield the steps or procedures required to perform the major task. Steps or procedures may be decisions, as well as, overt, observable acts.

Step 4: Determine whether all necessary decisions have been identified as task components - When analyzing a task that requires performance of a large number of procedures and interaction with complex system hardware, identification of each operator decision is made to determine whether the operator must decide when to perform a procedure, decide which of multiple rules or procedures to use, evaluate the adequacy of a procedure, and/or decide when a procedure should be stopped. In analyzing a major task, decision subtasks can easily be omitted. This step is included as a cross-check of Step 3 to insure that all decision tasks have been included.

Step 5: Add decision components to the list - If additional decision subtasks are identified in Step 4, they should be added to the component subtask list for the major task. When incorporated into the hierarchy structure, these decision subtasks will be on the same level as the performance subtasks.

Step 6: Determine whether there is a significant memorization requirement - the memorization component is significant if an average trainee would be unable to perform the task as a whole because he could not remember which components must be performed or the order of their performance. If the memorization component for the task is significant, it will be incorporated in Step 7.

Step 7: Add a component requiring recall of the steps of the major task - If there is a significant memorization component identified in Step 6, it should be added to the component subtask list for the major task. When incorporated in the hierarchy structure, the memorization subtask will be at the same level or one level below the performance subtasks.

Step 8: Determine if there are too many components - The component subtask list is examined to determine if any subtask repeats another subtask on the list, is not necessary to the accomplishment of the main task, or is trivial. The component listing should provide the level of detail which will be required when the objectives written from the listing are used as input for the production of segment specifications in the design phase, i.e., the objective name should clearly indicate to a subject matter expert what information will be contained in the segment specification for that objective. If this information is indicated by a higher level objective, an objective below in the hierarchy would be trivial. On the other hand if the objectives in the hierarchy do not identify completely the information that should be contained in segment specifications, additional objectives must be added. The addition of subtask components is discussed in Step 11.

Step 9: Narrow the set of components - The final listing should contain the minimum set of subtasks required to perform the task, consistent with the requirements for segment specifications discussed above. To accomplish this, overlapping and non-essential subtasks should be deleted and where appropriate multiple trivial subtasks should be grouped into a single relevant subtask.

Step 10: Determine if there are too few components - If after having mastered all given subtasks, the trainee would be unable to perform the main task without more than a few simple instructions, one or more subtasks have been omitted. A subtask left out at this point may result in instruction left out later, i.e., lesson and segment specifications will not contain the totality of information required to perform the task.

Step 11: Expand the set of components - If the component subtask listing contains fewer than the minimum number of subtasks required to perform the task, it should be expanded to insure that the completed training program will contain all information necessary to train students to perform the task.

Step 12: Write an instructional objective for each component - An instructional objective contains three elements, the subtask component statement, which is the "action" portion of the objective, the conditions, and the standards. Conditions describe the circumstances under which the subtask will be performed. Types of conditions statements are system configuration, environmental factors, equipment factors, relevant available information, and initiation stimulus. Standards are the criteria for minimum acceptable subtask performance. Types of standards statements are time, accuracy/error rate, degree of conformity with specified procedures, and safety considerations.

Step 13: Arrange objectives in the hierarchy - Objectives are arranged under the superordinate objective that is being analyzed. All are one level below the superordinate objective.

Step 14: Determine whether each objective is a basic level behavior - An objective is a basic level behavior if it is the lowest level behavior that is significant for training. If all objectives are basic level behaviors, the next complicated major task is selected from the task listing and the process is repeated.

Step 15: Select one basic level subtask - If one or more objectives are not basic level behaviors, one objective is chosen and subtask components for that objective are listed. This process is iterated until all of the lowest level objectives have been identified for the major task.

Examples of a hierarchy diagram and an SBO page are shown in Figures 6 and 7 respectively. A detailed description of the numbering and coding conventions used in the hierarchies and

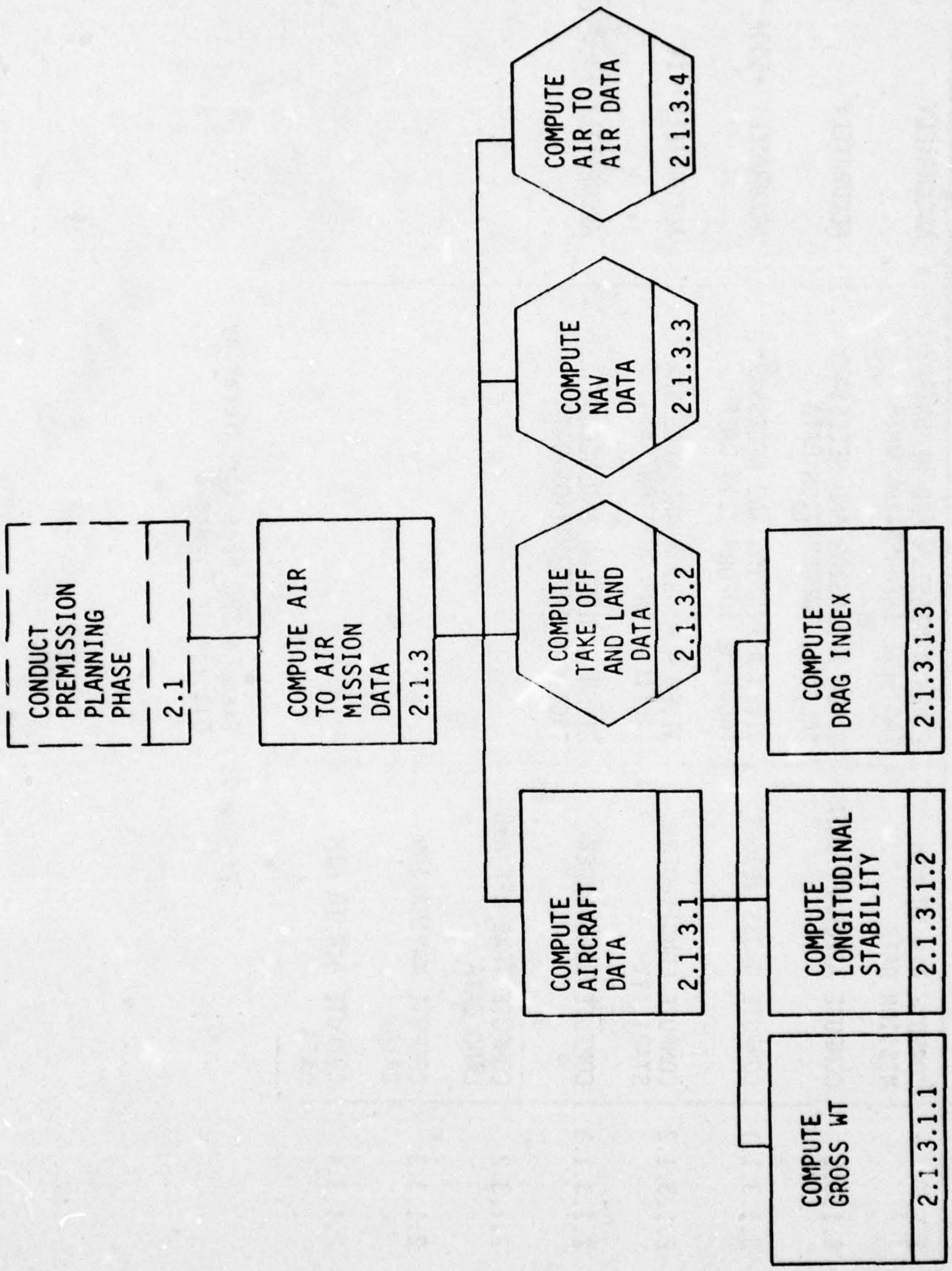

Figure 6. Example Hierarchy Diagram

MISSION: AIR TO AIR
SEGMENT: CONDUCT PREMISSION PLANNING PHASE

SBO #	ACTION	CONDITIONS	STANDARDS
2.1.3	COMPUTE AIR TO AIR MISSION DATA	GIVEN A MISSION AND NECESSARY TACTICAL INFORMATION DATA	ACCURATELY
2.1.3.1	COMPUTE AIRCRAFT DATA	GIVEN A MISSION AND NECESSARY TACTICAL INFORMATION DATA	ACCURATELY
2.1.3.1.1	COMPUTE GROSS WEIGHT	GIVEN A MISSION AND NECESSARY TACTICAL INFORMATION DATA	ACCURATELY +500#
2.1.3.1.2	COMPUTE LONGITUDINAL STABILITY	GIVEN A MISSION AND NECESSARY TACTICAL INFORMATION DATA	ACCURATELY +1%
2.1.3.1.3	COMPUTE DRAG INDEX	GIVEN A MISSION AND NECESSARY TACTICAL INFORMATION DATA	ACCURATELY +3 UNITS
2.1.3.2	COMPUTE TAKE OFF AND LAND DATA		
2.1.3.3	COMPUTE NAVIGATION DATA		
2.1.3.4	COMPUTE AIR TO AIR DATA		

Figure 7. Example SBO Page for Hierarchy Diagram in Figure 6

SBOs plus additional examples are presented in Appendix A.

SME Training. Since a previous contractor, Courseware, Inc., had provided SME training on the hierarchy and SBO development process prior to contract award to Allen Corporation, minimum additional SME training was required. A one-day session was conducted to insure that the procedures being used were in accord with the F-4 ISD specification and that the quality of the end-products was in accord with Allen Corporation expectations. The transition between contractors went smoothly, and there were no substantial differences in approach between Courseware, Inc. and Allen Corporation.

Problems and Solutions. The hierarchy and SBO development process went smoothly with only a few minor difficulties. One of these difficulties involved determining the lowest levels in the hierarchies, i.e., establishing that point beyond which another level of objectives would be trivial and above which the hierarchies would be incomplete if terminated at that point. Although the process of objectives hierarchy development shown in Figure 5 does delineate steps (8, 9, 10, and 11) that are included to assist in determining the appropriate lowest level in the hierarchies, consistently choosing the appropriate level is difficult. In order to help remedy this difficulty, SMEs were instructed to evaluate at what level in each hierarchy the information was complete so that instruction based on the hierarchy structure would not present trivial detail, or leave out instruction which was essential for performance of the terminal task. This was done by having the SMEs think through the training that would be presented to support each enabling objective in the hierarchies. If the objective did not clearly "suggest" all training content required, more objectives were added. If on the other hand, trivial, entry-level objectives were contained in the hierarchies, they were deleted. This approach also assisted the SMEs in understanding the relationship of the hierarchies and SBOs to the development of training materials.

The re-evaluation of the completeness and accuracy of the task listing, which was a natural by-product of hierarchy and SBO development, led to numerous changes in the task listing. This is an illustration of the well-known fact that ISD is a constantly iterative process, that in many cases prior end products require changes as a result of further analyses. Such changes are particularly prevalent during the earlier steps in the ISD analysis phase, during which the data base for training course development is being established. The changes were recorded in a master task listing document.

The conditions and standards produced by the SMEs were in many cases very general and added little to the SBOs. For example, a frequently used condition was "Given an exam" and frequently used standards were "To criterion" and "In accordance with NATOPS" (IAW NATOPS). With additional work by the SMEs, the conditions and standards could have been upgraded.

The more fundamental consideration, however, relates to the utility of specifying conditions and standards at this early point in the analysis phase. The primary reason for including conditions and standards is to insure that the corresponding objective is observable and testable. Given that the objective is a valid prerequisite to performance of a terminal objective, there will be conditions under which it can be evaluated. Also, conditions and standards are partially a function of the instructional medium in which the objective will be learned. In the ISD process, media selection follows hierarchy and SBO development. A precise determination of conditions and standards takes place during the development of segment specifications for the objectives. At this point, media have been selected and testing philosophies have been formulated.

The determination of conditions and standards during hierarchy and SBO development detracts from the primary purpose of structuring hierarchies which provide the framework for the development of the syllabus and the ultimate training program. It is recommended that consideration be given to deleting conditions and standards from SBOs written in conjunction with hierarchy development and emphasizing the importance of including complete, accurate conditions and standards in the segment specifications.

MEDIA SELECTION.

Overview. The next step in the F-4 ISD program was to select appropriate instructional media for each SBO produced during the preceding hierarchy and SBO development step. This step provides a matching of the instructional capabilities of various media with the characteristics of the objective as they relate to presentation and learning strategies. It is important that this mapping of objective requirements onto media capabilities be as accurate as possible within cost and feasibility constraints. This helps insure that trainees are presented information, afforded practice, etc., in an optimal learning environment.

The algorithm used to select media differed from more conventional media selection procedures in that level of expected behavior, level of content, amount of practice required, and the amount of memorization required were explicit criteria for selection. In addition, presentation display requirements, the nucleus of the more conventional media selection models, was included as one of the components of the algorithm.

Procedures. The input to the media selection process was the listing of all SBOs. Each SBO was carried through the selection algorithm to determine the primary and alternate media which should be used. Alternate media were provided for each objective to allow flexibility during later phases of the ISD process when modifications based on cost factors or syllabus organization may be required.

The media selection model used in this program involved asking a series of five questions, the answers to which traced a path through a network to a terminal block which contained a code number for the media selected. The network is shown in Figure 8 and the questions used to determine paths through the network are shown in Figure 9. The question blocks in the network are labelled Q1, Q2, Q3, Q4, and Q5.

The selection process begins at the triangle in the center of the network and goes to question one (Q1). The numbered response to Q1 determines the path that will be followed to the next question. In the same manner, at each of the other four questions (Q2 through Q5) the procedure continues along the path associated with the appropriate answer to each question.

Each path leads to recommended media, which are the terminal blocks M1 through M44 on the network. The media selections corresponding to the numbers in the terminal blocks are presented and defined in Appendix B. In addition, Appendix B contains examples of completed media selection diagrams.

The media selection process was conducted primarily by the project instructional psychologist. SMEs, however, provided significant input particularly relating to the difficulty of the objectives. Questions 2 (amount of presentation or practice) and 5 (memorization requirements), in essence, assess the difficulty of the objective. SMEs were also called upon to answer questions relevant to objective content.

<u>SME Training</u>. Since media selection was primarily a contractor task, no extensive SME training was required. An informal four-hour course was conducted to acquaint the SMEs with the selection

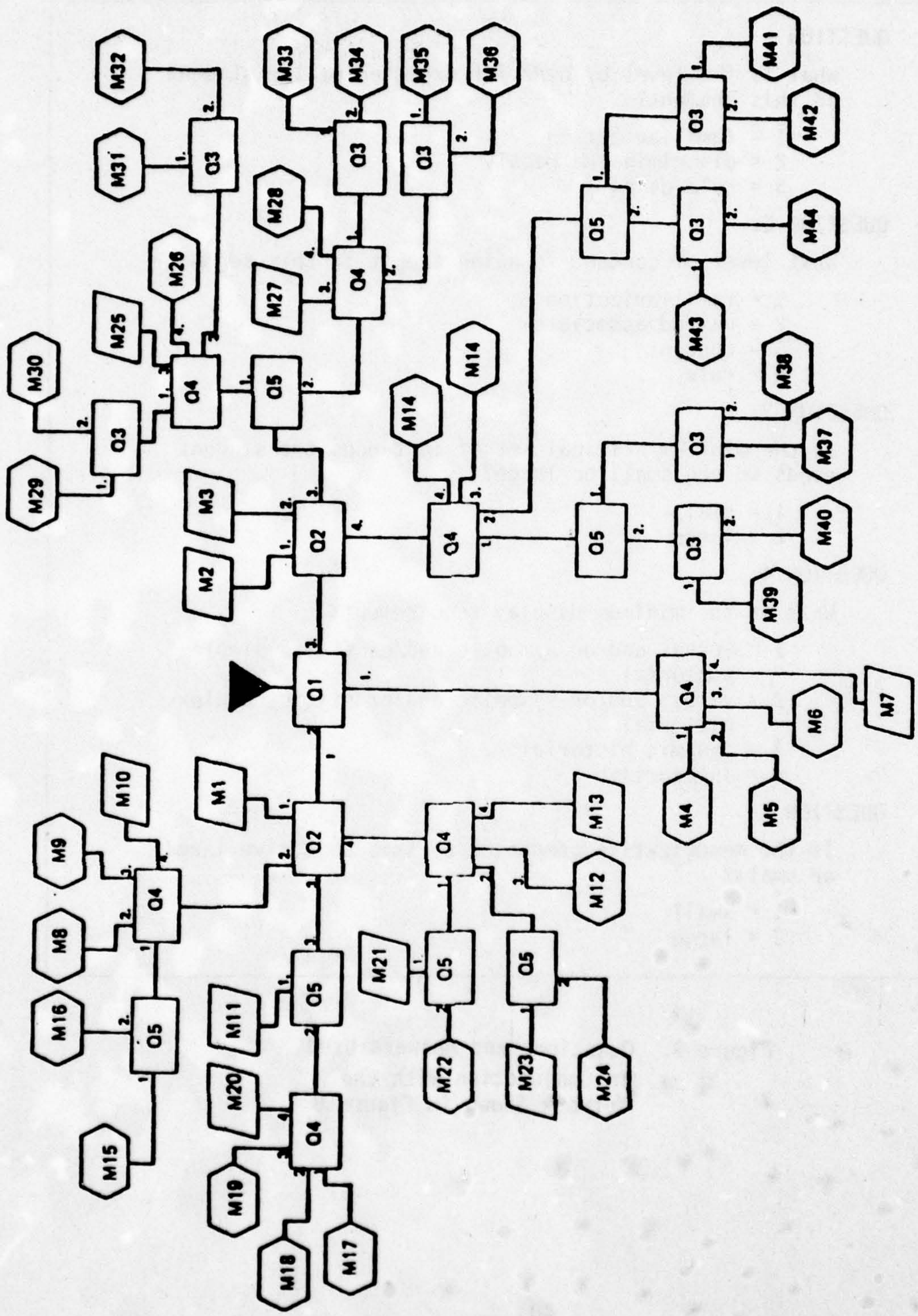

Figure 8. Network Used in Media Selection

QUESTION 1:

What is the level of behavior expected of the student in this segment?

1 = familiarization
2 = discriminated recall
3 = rule-using

QUESTION 2:

What level of content is being taught in this segment?

1 = familiarization
2 = paired associate
3 - concept
4 = rule

QUESTION 3:

Is the minimum critical set of instances the student needs to see small or large?

1 = small
2 = large

QUESTION 4:

What is the minimum display requirement?

1 = verbal and/or symbolic and/or static simple pictorial
2 = verbal and/or symbolic and/or static complex pictorial
3 = dynamic pictorial
4 = interactive

QUESTION 5:

Is the memorization component of this objective large or small?

1 = small
2 = large

Figure 9. Questions and Answers Used in Conjunction with the Network Shown in Figure 8

process and to relate media selection to other steps in the ISD process. It was necessary that the SMEs understand the procedures in the model so that they could answer questions which required subject matter expertise.

Problems and Solutions. The primary problem in applying the media selection model was the ambiguity of some of the responses to the five questions. Without more precise, working definitions than those supplied in the F-4 ISD specification the model could not be applied with consistency or with the accuracy required. In order to remedy this problem, Allen Corporation ISD personnel consulted with the Courseware, Inc. personnel who formulated the selection model. The resultant definitions of the terms made the model workable; however, it was still felt that further clarification was needed. The five questions and elaborations of the possible responses to each are as follows:

Question 1: What is the level of behavior expected of the student in this segment?

1. familiarization: the student will be exposed to the information or skill, but need not be intimately familiar with it and will not be tested.
2. discriminated recall: the student will remember, recall, or recognize something based on previously presented information, e.g., recall operational fuel flow rate.
3. rule using: the student will apply a rule to a given set of inputs to formulate an output, e.g., discriminate among types of threat aircraft.

Question 2: What level of content is being taught in this segment?

1. familiarization: the content level is for basic acquaintance and recognition but will not be a test item.
2. paired associate: this content level involves the teaching of a one-to-one association (presence of A indicates B is occurring) and would require future recall of the content.

3. concept: the content level would show grouped or sets of symbols or events with common critical characteristics or names, e.g., identify an engine fire.
4. rule: this level of content requires the manipulation of a concept, e.g., calculate refueling requirements.

Question 3: Is the minimum critical set of instances the student needs to see small or large?

Essentially the question was interpreted to say, "How often do we have to expose the student to this content during his training cycle in order for him to master the content or how often must a given skill be practiced to insure mastery?"

Question 4: What is the minimum display requirement? That is, how sophisticated must the presentation to the trainee be in order to adequately convey the desired content?

1. verbal and/or symbolic and/or static simple pictorial, e.g., a simple photograph, typed or recorded statement, or drawing.
2. verbal and/or symbolic and/or static complex pictorial, e.g., a complex photograph, typed or recorded statement or drawing.
3. dynamic pictorial, e.g., a moving picture, animated drawing, computer generated image, etc.
4. interactive: Must the presentation media sense student responses and respond appropriately?

Question 5: Is the memorization component of this objective large or small?

This question was interpreted as a discrimination between "small" and "large" based upon content complexity and volume. The more complex objectives involve certain detailed memorization factors, e.g., navigation would contain components requiring "large" memorization. Other objectives that are assisted by supportive documentation such as checklists, were categorized as containing a "small" memorization component.

If this media selection model is to be used in future ISD programs, it is recommended that more precise operational definitions be used in place of those currently supplied. Incorrect interpretations of the five questions and their sets of responses can have significant effects on the media selected. This could lead to teaching objectives in media which are not optimally suited to the learning requirements of the objectives.

The possible set of media which could be selected for use in the F-4 training program was constrainted to the candidate media contained in the model. This constraint led to a "closed" selection process rather than an "open" process in which a much larger set of candidate media could have been considered. For example, among other feasible alternatives for this program are audio tapes with workbooks and continuous loop 8 mm. systems, which can provide either frame-by-frame projection or continuous motion.

The area of media selection is a difficult one at best. There are almost as many selection models as there are media types. As yet, there is no completely satisfactory approach to this problem. This contractor has not developed an alternative approach to media selection; however, within the context of the F-4 model several suggestions can be made. Rather than selecting specific media it is recommended that a class of media be selected, all members of which have similar presentation capabilities. Once a class of media is selected for an objective, trade-off studies can be performed to determine which medium in the class is best suited in terms of specific capabilities and cost factors. Cost is not considered in the present model and should be evaluated during the media selection process. For example, data in the Training Support Requirements Analysis indicate that the relative cost of slide tapes and workbooks are about four to one. Yet slide-tapes and workbooks are similar in instructional capabilities.

In the F-4 ISD specification, media selection and syllabus development are discrete, sequential processes with media selection preceding syllabus development. They are, thus, two independent processes with the results of media selection having minimum impact on lesson organization and sequencing. The structuring of lessons is done on the basis of subject matter content rather than on the basis of media selected for individual objectives. Under the current specification lessons are organized by content. The media for the objectives in the lesson are then examined to determine if more than one medium was selected for the grouped objectives. If so, the predominant medium from those assigned to the objectives in the lesson is selected. This procedure is inefficient since some of the media selected for individual objectives are changed to be consistent with the lesson content requirements. Media selected for objectives, grouped into a lesson on the basis of content and context of training, should fall within the same class. If this does not happen, it is indicative that the lesson has been poorly organized.

It is recommended that media be selected for lessons rather than for individual objectives, thus reversing the order of media selection and syllabus development. Two advantages of this approach are: (1) the process has to be carried out fewer times since there are fewer lessons than there are objectives and (2) once made, media selections will be final rather than subject to change during a subsequent task in the ISD process.

SYLLABUS.

Overview. The development of pilot and RIO syllabi was the last step in the analysis phase which provided input directly into lesson specification development (Figure 1). The other remaining analysis step was the Training Support Requirements Analysis (TSRA) which provided personnel, materials, and services cost estimates for the four remaining phases, but which was not directly related to the subsequent phases in terms of technical steps specified for course development.

Syllabus development was the process of grouping the SBOs from the hierarchy and SBO development step into lessons, and sequencing the lessons to form the pilot and RIO syllabi. The resultant syllabi formed the basis for continued development of the two training courses. Each lesson constituted a discrete block of instruction with the objectives contained in the lesson providing an outline of the subject matter content to be covered in ground school or the skills to be practiced in simulator and flight lessons. The goal of syllabus development was to arrange all objectives so as to facilitate administration, scheduling, sequencing, testing, and learning.

<u>Procedures</u>. Each course was structured into three levels of organization. These levels ordered from smallest to largest are as follows:

- Segment - The instruction required to teach one objective. A segment is comparable to an objective and is worded the same as an objective. During syllabus development the terminology is changed from "objective" to "segment" to indicate that each objective is now thought of as a segment of instruction. During lesson specification each segment will be the starting point for determining the subject matter content and instructional strategy which will be used to teach the objective.

- Lesson - A group of related segments with a required testing point. The F-4 ISD specification contains guidelines for the number of segments which should constitute a lesson. The range is from 3 to 15 objectives. More importantly, a lesson should be composed of segments which form a logical grouping in terms of content and can be taught at one sitting.

- Unit - A group of related lessons with a required testing point. This is the largest subdivision within the syllabus. Units contain lessons grouped on the basis of subject matter content and ordered so that earlier lessons are prerequisite to latter lessons in the same unit. The structure of units thus has a large impact on the effectiveness of training. Students should have mastered prerequisite skills and knowledge before being exposed to more complicated learning situations. For example, maneuvers to be performed in the aircraft should first be discussed in a ground school lesson and practiced in a simulator (if simulator capabilities permit) before being practiced in the aircraft. By using this sequence the trainee is better prepared to make efficient use of the most expensive training device, the aircraft. Finally, in sequencing units within the syllabus, the same guidelines as those used in sequencing lessons within units should be used, i.e., establish prerequisites by units. For example, a unit on basic aircraft maneuvering should precede a unit on air-to-air combat.

The total syllabus development process has two components, organization of segments into lessons and sequencing lessons to form the syllabus. Steps used in organization and sequencing proceeded from flight lessons, to simulator lessons, and finally to ground school lessons. The flight syllabus was formulated first and provided the framework around which the remainder of the syllabus was organized and sequenced. The specification for the F-4 ISD program contained guidelines to be used in developing the flight syllabus. These guidelines were as follows:

1. Determine from the problem analysis data the maximum feasible number of flights that can be contained in the syllabus.
2. Identify any content requirements, ordering requirements, or other constraints which are imposed by readiness training squadrons or higher authority.
3. Extract from the objectives hierarchy all objectives designated during media selection as requiring aircraft flight.

4. Examine the objectives to identify common logical groupings.

5. Sort the pilot and RIO flight objectives into aircraft flights within imposed constraints. Further guidelines for sorting the objectives are listed below:

   (a) Structure the first flight so that it contains the absolute minimum number of objectives required to have a flight.

   (b) In subsequent flights add new tasks so that the flights proceed from easier to more difficult.

   (c) For each flight, group objectives so that there are sufficient objectives to warrant a flight but not so many that each cannot be properly evaluated.

   (d) Include new objectives in each flight.

   (e) Structure flights so that when a new objective is introduced, it is practiced and evaluated in that flight, in several other immediately following flights, and then again at periodic intervals as needed to maintain proficiency.

   (f) Group objectives into flights so that the prerequisite classroom and trainer periods for each flight form a set of instructional blocks which are reasonably unified in subject matter and approximately equal in size.

The guidelines outlined in 1-5 above were closely followed in developing the flight syllabus. Based on problem analysis data, supplemented by current figures on aircraft availability, it was determined that the number of flights in the ISD syllabus should be in accord with the number of flights in the current syllabus. Several squadron constraints were incorporated into the syllabus. These included the following:

1. Completion of the familiarization and flight support ground school and trainer instruction as specified in the Training and Readiness Manual, plus open and closed book exams, prior to the first flight.

2. Completion of carrier qualification ground school and 50 flight hours prior to carrier qualification flights.

3. Ten flight hours in the aircraft prior to the first night flight.

4. Fifteen hours in the aircraft prior to firing the first air-to-air missile.
5. Fifteen hours to include one night flight in the aircraft prior to the first cross-country.

Objectives selected for flight lessons during media selection were extracted from the media selection report. These objectives were examined for common logical groupings, based primarily upon the hierarchy structure.

Due to training requirements and simulator constraints, strictly adhering to sorting guidelines (a)-(f) above was found to be infeasible in many cases. For example, it was judged to be training efficient to include most flight objectives for the air-to-air phase in the first air-to-air flight. This was done because the employment of different tactics and maneuvers is a function of relative aircraft positions and in practice primarily involves decision processes based on the situation. Subsequent flights, then, involved the selection of the appropriate maneuvers and tactics from those introduced in ground school and in the first air-to-air flight. Since most objectives were specified in the first flight, the air-to-air portion of the syllabus was not integrated so that each flight was proceeded by ground school and simulator lessons. Rather ground school lessons were grouped at the beginning of the air-to-air phase followed by a mixing of simulator and flight lessons.

Simulator constraints had a significant effect on formulating the air-to-ground portion of the syllabus. Since the Weapons System Trainer (WST) has no visual system, all air-to-ground practice was specified for flights. As with air-to-air training, air-to-ground, ground school was placed before the flights. The first air-to-ground flight contains most of the air-to-ground objectives, with subsequent flights requiring decision processes based on the tactical situation. The grouping of initial ground school, followed by practice, is sound in terms of learning theory, i.e., provide the student with the information required to select among alternatives, then place him in problem-solving situations which require decisions based upon the information.

Despite the difficulties encountered in following the sorting guidelines for certain portions of the syllabus, both the pilot and RIO syllabi were generally structured in accordance with the guidelines. Starting with the first flight which contains a minimum number of basic objectives the flow proceeds from easier to more difficult. Flights contain enough objectives to warrant a flight, but not so many as to preclude effective performance evaluation. Practice of objectives is spaced so that after initial introduction objectives are practiced in immediately succeeding flights and periodically thereafter. Consistency in subject matter content is maintained from prerequisite ground school, through simulator lessons, to flights. This is the most fundamental principle in the sequencing of instruction. The student should first thoroughly know and understand the procedures required for the performance of a task. This initial academic instruction should be followed when feasible, by ground-based practice to develop task skills. The task skills should then be practiced and refined in the aircraft.

Following the development of the flight syllabus the simulator exercises and ground school lessons were organized and sequenced around the framework provided by the flight syllabus. Guidelines provided in the specification for simulator exercises were as follows:

1. Precede each aircraft flight with a crew coordination trainer exercise during which all objectives to be practiced during the flight are practiced and evaluated.
2. Identify new crew coordination simulator exercises for those objectives which can be performed in a trainer but not in flight, e.g., emergency procedures. After initial practice intersperse these objectives throughout the remaining trainer exercises.

3. Sequence emergency procedures trainers prior to the first flight.
4. Develop individual position trainer exercises to support each crew simulator exercise.

Guidelines for organizing and sequencing ground school lessons were as follows:

1. Use the objectives hierarchies to identify objectives that are prerequisite to the first trainer exercise.
2. Group objectives into a series of lessons following criteria for good lesson structure, i.e., subject matter content, sequencing within lessons, and length.
3. Use the objectives hierarchies to identify objectives which are prerequisites the other simulator and aircraft exercises and group the objectives into series of lessons.

Although the organization and sequencing of simulator lessons and ground school lessons were specified as sequential steps, it was found that executing the two steps in parallel facilitated overall syllabus development. This was true because in many cases, for training efficiency, it was deemed desirable for simulator lessons to be interspersed between ground school lessons rather than between ground school and flight lessons. In other cases ground school lessons directly preceded flight lessons or flight lessons were grouped without intervening ground school or simulator lessons. Deviations from the guidelines for organizing and sequencing simulator and ground school lessons did not result in a departure from the fundamental philosophy of syllabus organization stated above, i.e., instruction in a task should proceed from academic instruction to skills practice in a simulator to skills practice in the aircraft.

The final step in syllabus development was to divide the sequence of lessons into units. By definition a unit which contains a flight should end with that flight, thus the next lesson is the first lesson of the next unit. In the pilot and

RIO syllabi some units contain multiple flights. When no ground school or simulator lessons were scheduled between multiple flights and the same or similar skills were practiced in the successive flights, no divisions between units were specified. Unit boundaries should be based more on subject matter content distinctions rather than upon arbitrary divisions based on instructional media.

SME Training. Extensive SME training was not required for syllabus development. A one-day seminar was conducted to acquaint the SMEs with the guidelines to be used and to formulate specific procedures to be used in developing the pilot and RIO syllabi.

Problems and Solutions. Syllabus development was the most difficult task carried out in this program. The fundamental problem was the lack of agreement among SMEs on the optimal organization and sequencing of objectives. Each SME had a different perspective on how the pilot and RIO syllabi should be structured. This led to lengthy discussions which produced little progress. In order to facilitate the development process, the recently revised VMFAT-101 Training and Readiness (T and R) Manual was used to provide guidance. The syllabus outlined in the T and R manual basically follows the rules of good syllabus structure. By using it as a guide, consensus among the SMEs was achieved, and syllabus development proceeded. The SBOs from hierarchy and SBO development were organized and sequenced using the T and R syllabus as a general guide.

An anticipated problem of any ISD program is FRS acceptance of the finished product. By staying within the general framework of the T and R syllabus, the probability of FRS rejection and/or requirements for major modifications, at least at the syllabus level of training course development, was reduced. This was a desirable by-product of the approach adopted rather than a goal.

The hierarchies and SBOs were mission oriented rather than training oriented. As a consequence many objectives which the SMEs considered essential for training were not included in the hierarchies. The most significant subject matter area for which SBOs were not contained in the hierarchies was systems information. Although training courses developed using ISD techniques do not generally include detailed systems information, it is still essential that certain background systems information, in addition to that which can be gleaned from the mission-oriented SBOs, be taught. Other objectives which were not included in the hierarchies, but which are an important part of training, were aircraft maneuvers, such as touch and go landings and timed turns. Objectives to cover systems information and training maneuvers were included in lessons as the syllabus was developed.

Throughout syllabus development, objectives not contained in the hierarchies were included in lessons. This is to be expected since ISD is a highly iterative process, i.e., as the process proceeds from task to task new insights are developed which improve the end products of previous tasks. As the SBOs were structured into lessons and the lessons were reviewed for completeness, objectives were added to provide complete instruction in certain topic areas. The addition of these supplemental objectives, plus the objectives for systems and training maneuvers, will enhance the quality of the pilot and RIO training courses.

Since media selection preceded syllabus development, in the ISD specification, it was implicit, although not directly stated, that media decisions should affect the grouping of objectives into lessons. This was true for the flight and simulator portions of the syllabus. The start point for these portions was a listing of all objectives which required simulators and/or flights. The organization of ground school lessons, however, was done on the basis of subject matter content and hierarchy structures without regard for selected media, i.e., the overriding criterion for good lesson structure is appropriateness and completeness of content.

Most of the ground school lessons contained objectives for which the same medium had been selected. Other lessons, however, contained more than one medium across the objectives. When this happened, each lesson was examined to determine which medium was the most frequently selected for the objectives in that lesson. Media selected for the remaining objectives in the lesson were then examined to determine if one of the alternate media from the media selection model was the same as the predominant medium in the lesson. In most cases, matches were found and the predominant medium was selected for all objectives in the lesson. In those instances in which no alternate medium matched, the content of the objective was examined to determine whether or not the objective should be repositioned in the syllabus. No objectives were repositioned. For each case the content and context requirements of the objective were judged to be more important than media considerations.

Contract time allotted for syllabus development was only four weeks. This was an unrealistically short period for the amount of work required to structure pilot and RIO syllabi for both the Navy and Marines and to identify differences between the J and N aircraft models. In addition, SME support was less than that needed for the task. As a result, 14 weeks were required to complete syllabus development.

Although validation of the syllabus by the three FRSs at which the training courses will be implemented was not contractually required, it was anticipated that this could be accomplished within the scope and time constraints of the contract. Due to the delay in completion, however, it was not feasible to perform a complete validation. Since lesson specification development started immediately after syllabus completion under another contract, it was decided that validation could be carried out concurrently with the early parts of lesson specification development.

TRAINING SUPPORT REQUIREMENTS ANALYSIS.

Overview. The final task was to perform a Training Support Requirements Analysis (TSRA). The purpose of the TSRA was to estimate the costs of personnel, equipment, materials, and services which will be required to further design, develop, implement, and maintain the pilot and RIO training courses. This information will be used for future planning and budgeting. The detailed analysis is contained in the Training Support Requirements Report.

During the design phase lesson specifications will be produced. Since this phase had been contracted prior to the development of the TSRA, no cost estimates were made. Estimates for all other future phases of the F-4 ISD program were provided using the procedures outlined in the following section.

Procedures. The development phase, which consists of the authoring and production of course materials, is the single most expensive phase of an ISD program. Two basic sources of information were used in the calculation of development cost estimates: (1) syllabus parameters on the number of lessons in each instructional medium and (2) personnel, materials, and service costs required to produce lessons in each medium. By merging these two sources of information, total estimated costs for production were determined.

Syllabus parameters were determined by totaling the number of lessons in each medium. This data is shown in Table 5. Personnel, material, and service costs for the production of one lesson in each medium were assimilated using the format shown in Figure 10. Appendix D contains development costs for each of the media selected for use in the F-4 training course.

INSTRUCTIONAL MEDIUM	NO. OF LESSONS
Ground School	
Slide Tape	77
Random Access Slide	12
Workbook	2
Videotape	1
Mediated Interactive Lecture	3
Simulator	89
Aircraft	293

Figure 5. Number of Lessons in Each Instructional Medium

MEDIA	Finished Materials in one Lesson	PERSONNEL HOURS TO DEVELOP ONE LESSON OF INSTRUCTION									
		SME	Author	Instructional Psychologist/Designer	Instructional Technologist	Production Manager	Writer/Editor	Composer Operator	Proof-Reader	Graphics Specialist	Paste-Up Artist
LECTURE	5 page Lecture Outline										
	8 page Student Worksheet										
	10 Overheads										
WORKBOOK (memory)	20 page Student Workbook										
WORKBOOK (r/c)	60 page Student Workbook										
SLIDE TAPE	60-80 Slides										
	15-20 Minutes Audiotape										
	10 page Student Worksheet										
RANDOM ACCESS SLIDE	120-180 Slides										
	20 Page Student Worksheet										
VIDEOTAPE	15-20 Minute Videotape										
	5 page Student Worksheet										
TRAINER EXERCISE	10 page Instructor Guide										
	5 page Evaluation Checklist										
	5 page Student Worksheet										
A/C FLIGHT EXERCISE	10 page Instructor Guide										
	5 page Evaluation Checklist										
	5 page Student Worksheet										

Figure 10. Format for Recording Materials Development Costs

			Raw Materials per Lesson		Required Services per Lesson			Duplication Services Required		
Photographer	TV Director	Printer (pieces)	Paper (pieces)	Film (20 exp rolls)	Audio Processing ($ per tape)	Videotaping ($ per tape)	Film ($ per slide)	Audio-Tape Duplication ($ per tape)	Videotape Duplication ($ per tape)	Slide Duplication ($ per slide)

Figure 10. Format for Recording Materials Development Costs (continued)

Summarizing across categories within media provided total costs per medium. The total costs per medium were then summed to give a cost estimate for the production of one complete set of course materials.

Since it was understood that all reproduction of materials would be done by the government, no reproduction costs were estimated. Estimates of the number of sets of consummable and non-consummable materials were provided to assist the government in estimating reproduction costs.

In addition to production costs, facilities requirements for the production phase were estimated. Assuming production on-site at MCAS, Yuma, it was determined that the facilities available in the MCCTRG-10 ISD Department are sufficient to support the production effort. Since it was assumed that any company contracted for production would furnish its own equipment, equipment costs for production were not estimated.

The primary cost of implementation will be the acquisition of carrels and components required for the presentation of slide-tape lessons. Determination of the number of carrels required at each Fleet Readiness Squadron (FRS) and each operational and reserve squadron that will use the training materials was based on the number of lessons that will be presented via slide-tapes, the length of the training course, and the projected student flow rate. The costs of fully equipped carrels were based upon current GSA prices for standard equipment purchased by the Navy and included a factor to allow for inflation during the interval before the equipment is purchased.

Facilities required to house the learning centers and to provide space for materials storage, lectures, and briefings were estimated. The results of a preliminary survey of the three FRSs indicated that spaces are available to satisfy the requirements of the new training courses; however, some modifications will be required in setting up the learning centers. These include installation of carpeting, supplemental electrical power, and installation of shelves for materials' storage. Due to the large number of potential users of the training materials in the active and reserve communities, it was not feasible to survey available facilities at the numerous locations. Since space requirements will be minimal, it is conjectured that adequate facilities are available at most locations.

FRS instructor requirements for implementation were estimated. This estimate was based on the projected student flow rate through the training courses, the number of students that will be in training at any one time as derived from a schedule of overlapping classes, and the number and projected utilization of media that require instructors. Included in the estimate was a factor to account for leave, TAD, etc.

The final step in the TSRA was to estimate resource requirements for five-year maintenance and evaluation of the training courses. Revision, maintenance, and quality control activities will be most extensive during the first year of the five-year period. Total requirements for the first year were determined by multiplying the personnel, materials, and services directly tied to initial courseware development and production by .35. Annual requirements for the next four years were determined by applying a factor of .20.

The TSRA results indicated a costly development, implementation, and maintenance program for the F-4 pilot and RIO courses. Total estimated costs for each phase were as follows:

Development	$ 603,047
Implementation	118,266
Five-year evaluation and maintenance	
Year 1	211,066
Years 2-5	482,436
Grand Total	$1,414.815

The Training Support Requirements Report contained information sufficient to make cost trade-offs among the ground school media. Costs for each medium could be compared to determine relative costs. When used in conjunction with a graphical flow chart of the syllabus, which was part of the TSRA, the costs could be related to specific lessons, and potential sources of savings could be identified.

SME Training. Since the TSRA was a contractor task, no formal training was conducted. A two-hour seminar was held to acquaint the SMEs with the contents, purposes, and applications of the TSRA.

Problems and Solutions. Formulation of the TSRA went smoothly with no major problems. Several small problems, however, developed during the course of the analysis. These will be discussed below.

Three production companies were surveyed to collect the data required to complete Figure 10. Among the companies there was a lack of consistency in interpretation of the roles and relative efforts of the different labor categories. This was particularly true for graphics specialist and paste-up artist. One company defined a paste-up artist as one who could also do simple illustrations, with the graphics specialist required for complex illustrations. Another company, however, assigned all illustrations to the graphics specialist, with the paste-up artist serving a supporting role for paste-up work only. In addition to discrepancies in personnel roles and responsibilities, companies differed in hourly wage rates. This is due to different base rates across companies, as well as, different overhead rates.

The values which were entered in the cells in Figure 10 and the wage rates used as multipliers for the personnel hours are averages across the three production companies. The estimates of materials development and revision costs are, therefore, considered to be representative of costs across the industry. Estimates from any given company would be expected to differ somewhat from those in the TSRA. Overall, however, there was considerable agreement among companies, so that individual estimates should not differ radically across good production companies.

During the formative stages of setting up a learning center, NAVTRAEQUIPCEN media specialists perform a thorough analysis of facilities requirements. Included is the amount of space, as well as, the characteristics of the space. It was anticipated that such a preliminary analysis could be performed by Allen Corporation at the three FRSs and at several of the other user squadrons. This was not feasible since the squadrons could not precisely identify the facilities which will be used to house the audio-visual and supporting facilities. Instead, general guidelines were provided. These guidelines were based on requirements of the pilot and RIO courses and good learning center design, considered in terms of general characteristics of the types of facilities available at the different squadrons. A more thorough analysis will be required during the early portions of the development phase of the F-4 ISD program.

Based on information available after syllabus development, the TSRA is an accurate estimate of future resource requirements. The total estimates contained therein, however, may be subject to considerable update as a result of syllabus changes identified during lesson specification development. As discussed above, ISD is an iterative process with subsequent insights affecting the end-products of previous tasks. It is anticipated that future changes will increase the size of the development effort rather than reduce it. The totals may change, however, the costs per lesson will not change. If there are resource constraints for development, the number of lessons contracted should be based on available or anticipated resources, with left-over lessons, if any, being taught in the same medium as in the current F-4 training programs. The selection of lessons to be mediated should be based on the general characteristics of lesson content, such as update requirements, need for visuals, etc. The content of all lessons, however, should be as specified during the ISD program.

TRAINING PROGRAM SUMMARY.

The structure of the proposed training courses is embodied in the pilot and RIO syllabi. The syllabi, rather than being "concrete" products, constitute a working document which will be revised during subsequent phases of the ISD program. Due to the overlap of this contract with a subsequent contract for the development of lesson specifications, syllabus revisions are occurring during the performance period for this contract. Based on a preliminary evaluation of the revisions being incorporated by the SMEs, it is not feasible to discuss in detail syllabus parameters such as length, number of lessons per medium, etc. Rather, an overview in terms of media types, instructional strategies, and utilization of trainers and the aircraft will be provided.

The candidate media were specified in the media selection model; thus the syllabus contains only those media. They are mediated interactive lecture, workbook, slide-tape, videotape, simulator, and aircraft.

The guidelines for syllabus development indicated that the number of flights should be maximized consistent with aircraft availability and projected student flow rate. The ISD syllabus contains essentially the same number of flights as the current syllabus. It is anticipated that this will not change during revisions in subsequent phases of the program.

The primary innovation in the proposed syllabus is the individualization of instruction as opposed to the current "lock step", classroom orientation. The system is individualized in the sense that most ground school lessons are presented in either a slide-tape carrel or in a workbook with a test at the end of each lesson. Students can proceed at their own pace within lessons. Across lessons it is anticipated that self-pacing will be feasible within the constraints of equipment availability and prerequisite requirements.

Self-pacing combined with the more efficient presentation of information in the individualized media should in theory yield a training program whose duration is less than that of non-mediated, paced programs. Due to external constraints such as aircraft and trainer availability and additional duties required of students, current projections are that this will not be the case for the new F-4 pilot and RIO courses. Typical completion time for the Marine 60 percent portion and the Navy 80 percent portion should be about six months. Since the remaining 40 percent and 20 percent respectively are taught at operational squadrons where training is interspersed with normal operations, no estimate of duration for these portions can be made.

The training courses outlined in the pilot and RIO syllabi adhere to the principles of good syllabus structure. That is, lessons are sequenced so as to optimize student learning and retention by integrating ground school instruction with "hands-on" practice in the trainers and the aircraft. Within lessons segments are organized to enhance instructional flow within content areas. It is anticipated that, when implemented, the pilot and RIO courses will produce better qualified, more-standardized F-4 aircrewmen.

SECTION IV

RESULTS AND CONCLUSIONS

Results in terms of the structure of the pilot and RIO syllabi were presented in the previous section. In this section, results and conclusions relevant to the ISD model used in the program and to ISD in general will be presented under five different headings:

- ISD Methods
- ISD Implementation
- ISD Resources
- Documentation Adjustments
- Speculative Observations

ISD METHODS

The ISD model used in this program is the most prescriptive model available in terms of the specification of discrete tasks required to produce an ISD-based training program. Within the tasks many of the procedures contain precisely delineated steps. The goal of "mechanizing" ISD into a straight-forward set of procedures which can be executed by "turning the crank", has been pursued by training technologists for many years. In the 6.2 model this goal has been, at least, partially achieved.

Since the procedures detailed in the model are highly structured relative to other approaches in which broad guidelines rather than detailed procedures are provided, it is easy for a training technologist first applying the model to implement the procedures without considering the intangible, judgment factors which are integral components of ISD. This is not a criticism of the goal of proceduralizing ISD. Rather, it is a caution against taking the procedures at face value without considering the rationale behind the steps. In studying the procedures in light of general principles of learning and real world constraints, insights will be gained which assist in integrating the intangible factors into training program development. Also, additional general procedures and others which are particularly relevant to the system under study will be derived.

In the following paragraphs, conclusions and recommendations pertaining to each major task carried out in the F-4 ISD program will be discussed. Some of the points were considered in Section II, Implementation, while others are presented for the first time in this section.

OBJECTIVES HIERARCHIES AND SBOs. The task of developing objectives hierarchies and SBOs went smoothly. The SMEs understood the techniques and implemented them well. One deficiency in the procedures outlined in the model became evident during the development process. This was the lack of clearly defined guidelines for determining the level in the hierarchies above which detail was not sufficient and below which additional detail was trivial. The source of the deficiency in the specification was the failure to relate objectives to the way in which they will be used during subsequent ISD tasks, i.e., as segments of instruction. In order to remedy the deficiency it is recommended that a description of how objectives will be converted into segments of instruction be included in the instructions for hierarchy and SBO development. As part of this description, guidelines should be provided which define the scope of a segment of instruction, e.g., two to five minutes of ground school instruction for which four to eight supporting visuals will be required; for manipulative tasks, an action which can be evaluated and would be expected to be practiced from two to five minutes during a simulator or flight lesson. By providing such guidelines the level of detail in the hierarchies will be more uniform. More importantly, however, this consistency will contribute to more efficient syllabus organization and to less revision during the development of lesson specifications.

The examples presented above are not intended to be specific guidelines. They are based on limited experience gained during the early stages of lesson specification development. Data from this and other programs should be gathered and analyzed to determine appropriate parameters which define a typical segment of instruction.

The conditions and standards portions of each objective serve no function during hierarchy development. They may serve some function during media selection, given a selection model into which they are incorporated. At this point in ISD model formulation, it is not clear how they would be used for media selection. Certainly the model specified for the F-4 ISD program did not utilize conditions and standards.

To formulate conditions and standards well is time consuming for the SMEs and detracts from the primary task of identifying and structuring training objectives. Even well-thought out conditions and standards are not optimal at the hierarchy stage of training system development. Such conditions and standards can be specified only after media have been selected and testing philosophies have been established. In the present ISD model media selection follows hierarchy development, with the formulation of testing philosophies taking place during lesson specification development. It is recommended that the requirements for conditions and standards during SBO development be eliminated. This will allow hierarchy development to proceed more quickly and will allow the SMEs to concentrate on their expertise, knowledge of the aircraft. Detailed conditions and standards would continue to be formulated as part of lesson specifications as outlined in the ISD model.

A primary deficiency in the F-4 hierarchies is the lack of objectives which cover systems information and training-only objectives. This resulted from the mission orientation of the task listing. When the task listing was expanded into hierarchies and SBOs, the mission orientation was maintained. Some systems information, particulary emergencies, is contained in the hierarchies; however, the amount and detail of the information is significantly less than that which is acceptable to the F-4 training community. To remedy this situation systems objectives were added during syllabus development. Efforts were made to insure that the supplemental objectives were relevant to mission performance and were not tangential from an ISD point of view, but were sufficiently detailed to satisfy the training community.

Training objectives were also added during syllabus development. These were primarily performance objectives which are required in the training environment but which would not be reflected in mission-oriented SBOs. Examples of these objectives are touch and go landings and timed turns.

It is recommended that systems and training-only objectives be identified during the development of hierarchies and SBOs. Most of these objectives can be incorporated into the hierarchies as prerequisites to objectives identified as mission objectives. Others may not clearly relate to the mission objectives and will, therefore, constitute a second category of objectives. The fundamental concern is that the identification and structuring of objectives be as complete and accurate as possible, at as early a stage in the ISD process as possible.

MEDIA SELECTION. The media selection model specified for use in the F-4 ISD program is not required in the most recent specification of training requirements for aviation weapons systems, MIL-T-29053. Rather, the contractor is given the latitude to select a model within certain constraints, subject to contract technical monitor approval. The current model is presented as one alternative which satisfies the specified constraints. This latitude afforded future ISD contractors provides an indication that NAVTRAEQUIPCEN ISD personnel view media selection as a part of the ISD model which needs improvement.

This contractor has not formulated a media selection model which is any more prescriptive than the F-4 model or the numerous other models described in the literature. There are, however, several recommendations which will improve the model used in the F-4 program. More precise definitions of the questions and responses need to be included in the description of how to use the model. These definitions should be accompanied by a number of worked examples which span the range of types of objectives which will be traced through the media map.

The number of candidate media identified in the model should be broadened to reflect other feasible devices which are available. Since some media are similar in terms of instructional capabilities, these can be grouped into media classes with further differentiation based on cost and dependability.

If the F-4 media model is used in future programs, it is recommended that delivery of multiple copies of a completed media map for each objective not be required. Since media selection is altered somewhat during syllabus development and since the size of deliverable volumes is prohibitive, media selection should be considered an interim step not requiring a formal deliverable end-product. Media decisions will be summarized after the syllabus has been developed.

Finally, media selection should be a part of syllabus development rather than a preceding step. Performance objectives need to be identified so that simulator and flight lessons can be organized. Ground school media, however, need not be selected until after the ground school lessons have been organized. These lessons should be structured on the basis of subject matter content, not on the basis of media selected for each objective. This procedure will eliminate the duplication of effort in which media are selected for each objective but some of which are changed as a result of syllabus organization.

SYLLABUS. The guidelines for syllabus development provided in the specification are good. They are idealized and cannot always be strictly followed due to external constraints, such as training policies and simulator capabilities. They are, however, quite workable within the unique constraints of different training situations.

Several recommendations have resulted from use of the syllabus development procedures in the F-4 ISD program. The specification that *the syllabus should contain the maximum feasible number of* flights is not in accord with traditional ISD philosophy. In most cases the maximum feasible number of flights will be the number in the existing syllabus. One goal of ISD is to decrease flight time while increasing the quality of training provided. The number of flights should be based upon the number of objectives which require flight instruction and practice, and the amount of practice required to master the objectives. Admittedly, this guideline is not stated in operational terms such as the existing guidelines. It is, however, more realistic and consistent with the goals of ISD.

The specification states that flights should proceed from "easier to more difficult" by adding new objectives to each flight.

Taken literally this statement can be misleading. As new objectives are added, flights become more complex, but not necessarily more difficult. Students may have mastered earlier objectives so that the addition of new objectives does not increase difficulty. It is recommended that "easier to more difficult" be changed to "simpler to more complex." In addition, it should be recognized that within the total syllabus, a flight to flight increase in complexity may not occur, even though the general flow is from simpler to more complex. For example, in the F-4 pilot syllabus, air-to-air training precedes air-to-ground training. The final flight in the air-to-air portion of the syllabus is "more complex" than the first flight in the air-to-ground portion.

One of the syllabus guidelines states that a flight lesson shall be the last lesson in a unit which contains a flight and that the next lesson is by definition the first lesson in the next unit. This is often the case. In other instances, however, it is more logical for units to contain multiple flights if the objectives to be practiced in the flights are essentially the same and if there is no ground school or simulator instruction separating the flights. If subject matter content is uniform, including multiple flights in the same unit when there is intervening ground-based instruction should also be allowed. This will enhance continuity within units and provide more flexibility to structure units of approximately equal size.

The problem in syllabus development encountered in this program (See Section II, Implementation) did not result from a basic deficiency in the specification being followed. The process of developing a syllabus requires a large judgment component within the specified development guidelines. Judgment varies across individuals, thus, the SMEs had difficulty agreeing on the best way to structure the syllabus. This is to be expected in any ISD program, particularly in one for a system which has been in the inventory for a number of years.

TRAINING SUPPORT REQUIREMENTS ANALYSIS. The format provided in the specification for collecting production personnel and cost data was very useful. The personnel, materials, and services categories were inclusive for the media specified in the media selection model. Other costs, however, were not specified in sufficient detail or were not mentioned at all. Also, the funding sources for the different costs need to be identified. This enables contracting personnel to differentiate between costs which will come from ISD resources and those which will come from other resources.

Equipment categories should be more precisely identified. This will assist in more accurate and complete costing and will allow for distinctions between government-furnished and contractor-furnished equipment. For example, categories of equipment required during production include materials production gear, reproduction, and typewriters and composers. Similarly, a breakdown of facilities in terms of intended use is desirable.

In the specification, no cost category is included for the formulation and production of implementation and quality control plans and an instructor training course. These are important parts of the production phase and should be included in the production cost estimates. Also, costs incurred by the contracting agency should be included.

Revision estimates for the first year after implementation are determined by applying a factor of .35 to materials production costs. A factor of .20 is used for each of the other out years. The limited data from other ISD programs suggests that a more accurate factor may be .20 for the first year and some lesser factor for subsequent years. More data needs to be collected to determine the appropriate factors to be used in revision cost estimates.

ISD IMPLEMENTATION

Implementation of the ISD model was successful and occurred as planned with only minor deviations as discussed in other sections of this report. There are, however, three general issues concerning the manner in which ISD is implemented. The first issue, contractor versus military SMEs, did not arise during this program. The last two issues, the quantity and quality of military SME support and end product acceptance by the training community were issues raised in this program. All three issues will be discussed below.

SOURCE OF SMEs. Other ISD programs have used contractor SMEs exclusively, military SMEs exclusively, or combinations of both. Arguments for the two extremes essentially boil down to quantity and quality of work produced versus latest system knowledge and program acceptance. The limited data available indicate that contractor SMEs can be expected to produce more and better end products than military SMEs in a given time period. On the other hand, military SMEs are more likely to be versed in current system operating procedures and tactics. In addition, training programs produced by military SMEs are more likely to be accepted than those produced by contractor SMEs, i.e., if the producer and user are one in the same, there is a higher probability of acceptance.

The selection of an option cannot be based solely on a trade-off of the above factors. Also to be considered are qualifications of military SMEs who will be assigned, the level of commitment once assigned, and the ISD phase to which they will be assigned. The former two considerations will be discussed in the following section on the structuring of a team of military SMEs.

The effect of ISD phases is a function of the different types of input required during the different phases. The basic structure and subject matter of the training program is determined during the analysis and design phases. In order to insure that the outputs of these phases are technically correct and are acceptable to the training community, it is important that military SMEs be assigned. They may be supplemented by contractor SMEs to improve productivity, but must be heavily involved.

During development of training materials a heavier emphasis may be placed on the use of contractor SMEs/authors, who are well-schooled in production procedures. The contractor SMEs will refine the products of the earlier phases but will make no substantive changes without input from military SMEs. By recognizing this division the capabilities of the different personnel will be more effectively utilized.

ASSIGNMENT OF SMEs. It is desirable for SMEs assigned to ISD programs to be instructors in a training squadron or to have had recent instructor experience. These personnel can provide greater knowledge of squadron training policies and general training techniques than can those without instructor experience. In addition, their close association with the training community enhances the probability of squadron acceptance.

A recurring problem in ISD programs is the failure to assign enough SMEs or to assign SMEs whose other duties significantly detract from their contribution to the ISD program. Ideally, an ISD department should be formed within the training squadron. SMEs should be assigned full time to the program with other duties reduced to an absolute minimum. Assignment to ISD should be on a long term basis to maintain stability and continuity within the ISD team. This would reduce turnover and the resultant inefficiencies which have caused problems in previous ISD programs.

The ISD department must have a strong leader who is responsive to the ISD requirements and who is willing to work closely with the contractor. Since ISD is relatively new and is not currently in the mainstream of training activity, there is a tendency for looseness in the ISD team. This leads to work inefficiencies, lack of interest, and waste of time.

A related problem is the status accorded ISD and the SMEs involved in an ISD program. In general, ISD assignments are not considered career-enhancing and are not given as rewards for a good record of military performance or good performance in the weapons sytem. Such a situation can lead to morale problems and low productivity.

A summary of considerations to be implemented in the formation of military SMEs into an ISD team, the structuring of the team, and the status of the team is as follows:

- Make the ISD team an integral part of the training department rather than a separate entity.
- Assign SMEs who are current instructors in the training squadron.
- Make SME assignments on the basis of merit with the clear understanding that participation in the ISD program is a promotion which will allow those assigned to have a large impact on the future of the weapons system training program.
- Select a team leader who is responsive to ISD requirements and who will provide strong direction to the ISD team while working closely with contractor specialists.
- Assign SMEs full time with extra duties kept to a minimum.
- Select SMEs who are expected to remain at the duty station for the duration of the ISD program.
- Assign a full complement of SMEs based on requirements from previous similar ISD programs and manpower projections for the current program.

Relative to other ISD programs, overall SME support for the F-4 program was good. The ISD department was created and staffed with four Marine SMEs prior to contract award. Initial selection and organization of SMEs was, therefore, not required. Despite the advantage of early organization there were some problems with SME support. These problems were as follows:

1. There was insufficient participation by Navy SMEs. Navy SMEs from VF-121, NAS, Miramar, were assigned on an intermittent basis with no SME participating more than 45 days. This situation caused a lack of continuity in Navy input and complicated the process of identifying Navy/Marine differences.
2. Marine SMEs were assigned other duties, such as flights and simulator lessons. This significantly reduced the amount of time devoted to ISD work.
3. In addition to time lost due to other duties, there were inefficiencies caused by a lack of motivation. Usually this was a transient problem. During syllabus development, however, this became a significant problem which ultimately caused the program to fall behind schedule.
4. The ISD department was not part of the FRS. Although this organizational structure did not significantly hamper the program, it did effect communication between the SMEs and FRS training personnel, i.e., members of the training squadron did not as freely interact with the SMEs as was desired. It appeared that the ISD SMEs were considered "outsiders" by the instructors.
5. The number of SMEs assigned (4) was less than that specified in the F-4 master plan (6 Marine, 2 Navy). Although the four SMEs assigned, supplemented by Navy SMEs as discussed above, generally performed well, additional SMEs would have improved program progress and quality.

ISD PROGRAM ACCEPTANCE. The third major issue to be discussed is the readiness of the Navy training communities to accept training programs produced through the use of ISD. This issue has two facets: (1) the reluctance to change the way "it has always been done." This is particularly true for a weapons sytem, such as the F-4, which has been in the inventory for many years and for which training doctrine has been precisely defined; (2) the tendency for the ISD program to degrade over time with a return to earlier training techniques.

To help insure that ISD training programs will be accepted and implemented as developed, the ISD procedures must be carried out within the framework of existing training policy, i.e., working through the ISD procedures per se, does not insure viability of the end product. It must be remembered that the inertia of any well-established system works against changes. Change must, therefore, be closely worked out with those who perpetuate the inertia. In the case of an aircrew training system, current training personnel, as well as policies from higher authority are the primary sources of inertia.

In applying ISD technology to an existing weapons sytem, ISD specialists must work closely with training personnel. In doing so, the development process becomes one of "give and take." Some aspects of the emerging training program, which are formulated using ISD procedures, will be unacceptable to the training community or will counter existing rigid policies. These aspects must be modified to achieve acceptance. On the other hand, existing training procedures may be better than or enhance training procedures resulting from an ISD analysis. In this case, the outputs of the ISD analysis will be upgraded. Although intangible and not definable in concrete procedural steps, this high degree of interaction during training program development is a primary key to ultimate success.

Once an ISD program has been implemented, the ISD effort has not ended. On the contrary, a new phase of ISD has begun. During the remainder of the life cycle of the weapons system, the ISD-based training program must be changed and updated as the weapons system changes and as data on the effectiveness of the training program is accumulated. To do this a nucleus of training personnel schooled in ISD procedures and knowledge in the training program must be maintained. In addition, resources must be provided to produce and implement changes as they are identified. Without a continued emphasis on ISD, even the best-formulated training program will fall into disarray.

As ISD procedures continue to be refined, a mechanism is being formulated to cope with the acceptance issue. This involves structuring ISD programs so that all relevant parties are included from program inception through implementation and maintenance. Relevant parties range from CNO down through the user squadrons and include high level commanders, government educational specialists, facilities and equipment specialists, contracting agencies, contractors, FRS instructors, and procurement personnel. This structure will provide command emphasis to ISD programs and will assist in coordinating the activities of the many agencies involved.

General acceptance of ISD will be a gradual process. The organizational concept discussed above will facilitate the process. The biggest boost for ISD, however, will be a history of successful programs.

ISD RESOURCES

The main resource used in this project was labor. Labor expended by category and task is summarized in Section V, Resource Utilization. These manhour figures are accurate as will be discussed below, however, the figures for some of the tasks do not provide good guidelines for future planning purposes.

Since the development of objectives hierarchies and SBOs began prior to contract award, manhour expenditures for this task do not indicate the labor required to perform the entire task. Records maintained by the previous contractor for the initial portion of objectives hierarchy and SBO development were incomplete and were not included.

About 50 percent of the hierarchies were developed under Allen Corporation direction. Existing hierarchies were reviewed by the SMEs and Allen personnel and in many cases were revised. It is estimated that the total SME time required to learn the procedures and to produce the hierarchies and SBOs was 600 manhours. An additional 100-200 professional manhours was expended by the previous contractor in the early stages of hierarchy development.

Manhours required for media selection are good estimates for future planning, given use of the same selection model. The revised 6.2 Specification allows latitude in the choice of a media selection model. In future ISD programs, therefore, other models may be used which require more or less effort than the one used in this program.

SME support was lacking during syllabus development. This caused more calendar time than anticipated to be spent on this task. The increased calendar time led to the expenditures of more contractor professional manhours than would have been required if SME support had been ample.

In a previous section, several suggestions for streamlining the model were presented. In doing so, certain efficiencies would be gained in implementing ISD; however, it is difficult to estimate the amount which would be gained. The labor expenditures for the four primary contract tasks, plus project administration and reporting, are considered to be about the minimum for an ISD program of this size. It is projected that the increased efficiency resulting from streamlining the model would increase the quality of the products rather than significantly reduce manpower requirements.

Another significant resource was that required to prepare and duplicate the many deliverable end-products specified in the contract. Clearly, monthly progress reports and the final report draft and final versions are necessary to enable the contract technical monitor to track progress and to get an overview of project activities. It is recommended that requirements for the submittal of the other major end products (Hierarchy Report, Media Report, Syllabus Report, and TSRA) be modified in future contracts. These recommendations are as follows:

1. Delete the Media Report and provide a summary of media selections in the Syllabus Report.
2. Require final versions only rather than draft and final versions of each of the four documents.
3. If the Phase I contract includes lesson specifications, make the Syllabus Report a working document subject to review by the contract technical monitor with the syllabus included in the Lesson Specification Report. This will eliminate the need for Syllabus Update Reports during lesson specification development. Since the present contract did not include lesson specifications, this recommendation is not pertinent to F-4 ISD. In other ISD programs, however, Phase I has included lesson specifications.

The net result of these recommendations for Phase I activities is that one version of the Hierarchy Report, Syllabus Report, and TSRA will be required. The Hierarchy Report contains the data base for the remainder of training program development and should be submitted for review, as well as being provided in multiple working copies for use in subsequent phases of the program. The Syllabus Report and TSRA are the final products prior to lesson specifications. If Phase I terminates with these products, rather than continuing through lesson specifications, both are required as wrap-ups to Phase I activities.

DOCUMENTATION ADJUSTMENTS

In the discussion of ISD Methods in this section recommendations for changes to the ISD specification were presented. These recommendations are summarized below:

1. In the discussion of procedures used in hierarchy development provide better guidelines for determining how deep a hierarchy should be. It is suggested that in addition to the current guidelines the lowest appropriate level in a hierarchy be defined in terms of the amount of instruction required to teach a base level objective in ground school.
2. Delete conditions and standards as requirements for SBOs.
3. Augment instructions for hierarchies and SBOs so that when developed the hierarchies and SBOs contain systems and training-specific objectives, as well as, mission objectives. The systems and training-specific objectives can be included within the framework of the mission objectives without altering the mission orientation.
4. Incorporate media selection into syllabus development and select media by lesson rather than by objective. This would eliminate the need for a separate media report and may require reformulation of the selection model.

5. Restate syllabus guidelines as follows:

   a. Base the number of flights on the number of flight objectives and amount of practice required for each rather than specifically specifying the maximum feasible number of flights.

   b. Sequence flights from "simple to more complex" rather than from "easier to more difficult."

   c. Structure units on the basis of content rather than specifying that a flight is the last lesson of any unit that contains a flight. This will allow multiple flights containing the same or very similar objectives to be included in the same unit.

6. Expand the guidelines for the TSRA as follows:

   a. Identify the government funding sources for different costs. This will help contracting personnel determine which costs will come from ISD funds and which will come from other sources.

   b. Further define equipment and facilities categories in detail comparable to that provided for materials production.

   c. Include costs for technical work and documentation required under the 6.2 specification, such as implementation and quality control plans and an instructor training course.

   d. Consider revising the multiplication factors used to estimate revision costs.

   e. Break revision costs down so that costs for evaluation and revision specifications are distinct from costs for materials production during revision.

   f. Sum manhour requirements to derive the number of personnel required in each labor category.

7. Increase the detail in the DID for the final report, so that the general scope of each section is well-defined. Currently, many of the section headings do not clearly indicate the general content areas expected to be covered. Another approach is to make the DID more general, thus allowing contractors greater flexibility in formulating the report.

SPECULATIVE OBSERVATIONS

A great deal was accomplished during the first phase of the F-4 ISD program. A detailed, prescriptive ISD model was studied, interpreted, and implemented by a contractor not involved in the formulation of the model. Although certain deficiencies were identified as a result of experience during implementation, the model essentially stood on its own and provided definitive guidance through the sequence of ISD tasks. The viability of the model was not challenged. Recommendations for upgrading the model, as well as, more general ISD considerations were presented in previous sections. Several additional points will be discussed below.

A large data base was collected and manipulated in this program. At times there were information management problems due to the size of the data base. A possible solution to this problem is the use of a computerized system which contains algorithms for production of the data base (i.e., guides SMEs through hierarchy and SBO development) and for manipulation of the data base (e.g., assists in organizing and sequencing objectives into a syllabus). It is understood that computer routines for this purpose have been or are currently being developed. The application of these routines to aircrew ISD programs should be studied.

In this report and reports on other ISD programs, considerable discussion has been devoted to the quality, source, and number of SMEs participating in ISD programs. Very little discussion, however, has been devoted to the composition of the contractor ISD team. Particularly relevant are the qualifications of the professional personnel who work closely with the SMEs in producing the various ISD end-products.

The guidelines provided by NAVTRAEQUIPCEN for the selection of personnel emphasize educational and training application.

Clearly these are important criteria, particularly for the program manager. To supplement the more theoretical training personnel an invaluable asset to the contractor team is a person(s) knowledgeable in military training doctrine and in the weapons system under study or a similar system (i.e., a retired or discharged SME). This type of person is able to relate to the military SMEs and to solicit input from the SMEs that otherwise may be overlooked. The ability of contractor personnel to relate to military personnel is an intangible, yet very important, component of a successful implementation of ISD procedures. In addition, he is able to review subject matter content for completeness and accuracy, thus complimenting other reviews for adherence to ISD specifications.

One final broad consideration is the readiness of the Navy training communities to accept ISD-based training programs. At the present they are not ready to accept ISD in its purest form. The question then arises whether ISD needs to change or the training communities need to change. The answer is that both need to adjust, ISD to military doctrine which has evolved over time and much of which is sound, and the training communities to the benefits inherent in a thorough, systematic training analysis. Current training can and is being improved through the application of ISD, but only to the degree that ISD is responsive to the needs of the training communities. Increased acceptance of ISD will come as in-service ISD capabilities are developed and as the structure for administration and control of ISD programs is refined.

SECTION V

RESOURCE UTILIZATION

This section presents an account of the resources used during the F-4J/N ISD program. There are separate categories for personnel, time, and facilities and equipment. The purpose for collecting and summarizing resource data is to expand upon like data collected by NAVTRAEQUIPCEN from other ISD programs. This data can be used to establish a reliable basis for planning in future ISD applications. More specifically, the data contained herein provides resource requirements for implementation of the 6.2 ISD model. Since this model is the one currently being refined as a standard for future Navy ISD programs, resource requirements from the F-4 program are particularly relevant for future planning.

PERSONNEL

Principal on-site technical contributors to the F-4 ISD program were an Instructional Psychologist (IP), who provided instruction and guidance in ISD techniques, a Production Manager (PM), who coordinated ISD and administrative activities, and Subject Matter Experts (SMEs). Four SMEs were initially assigned to the program. The number of SMEs actually working on the program varied throughout, ranging from three to six. The number of manhours expended for each personnel category by ISD step is shown in Table 6.

TABLE 6. MANHOURS EXPENDED BY ON-SITE ISD TECHNICAL PERSONNEL

ISD STEP	IP	PM	SMEs
Hierarchies and SBOs	124	250	200
Media Selection	115	85	42
Syllabus	385	300	401
Training Support Requirements Analysis	75	15	0
TOTAL	699	650	643

The data presented in Table 6 reflect actual time spent on each task. Other tasks, such as project administration, preparation of progress reports and memos, etc., are not shown.

At the time of contract award to Allen Corporation, the development of objectives hierarchies and SBOs was approximately 50 percent complete. The manhour totals for this task in Table 6 are, therefore, estimated to be about half those required to develop the full set of hierarchies and SBOs for the F-4.

The total on-site contractor personnel hours are shown in Table 7. These figures contain the totals from Table 6 plus manhours for secretarial and administrative functions.

TABLE 7. TOTAL PROJECT-RELATED MANHOURS
SPENT BY ON-SITE CONTRACTOR PERSONNEL

STAFF	MANHOURS
Instructional Psychologist	904
Production Manager	960
Administrative Assistant/Secretary	1,063

Total hours of off-site personnel by category are shown in Table 8. The categories are technical, management, and support. Technical hours include assistance with and review of on-site activities and preparation of reports. Management hours include contract management, organization and review of contract deliverables, and liaison with the contract technical monitor. Support hours include typing and general secretarial assistance in support of off-site technical and management efforts.

PERSONNEL CATEGORY	MANHOURS
Technical	440
Management	575
Support	185

The overall manhour expenditures were in accord with those originally projected; however, individual task requirements differed from the original projections. Since the development of objectives hierarchies and SBOs began prior to contract award, completion of this task required fewer manhours than projected. Media selection also required less time than projected. Syllabus development was a difficult task. The difficulty of the task combined with a shortage of SME support during this portion of the contract caused more contractor hours to be used. As a result, the milestone for syllabus completion was not met. This will be discussed further in the next section. Finally, the Training Support Requirements Analysis was completed as projected.

TIME

A summary of the projected versus actual elapsed time for each ISD step is shown in Figure 11. The program was on or ahead of schedule through media selection. As discussed in the "Problems and Solutions" section under "Syllabus Development," problems were encountered which precluded the completion of syllabus development as scheduled. These problems were the brief amount of time allotted for syllabus development, the inherent difficulty of the task, the lack of agreement among SMEs, a lack of adequate SME support, and the multiple syllabi which had to be developed. Failure to complete the syllabi on or near schedule caused the Training Support Requirements Analysis (TSRA) and the Final Report to be delayed.

At the outset it was recognized that the schedule requirements for this program were demanding. Times allotted to the four major tasks were: hierarchies and SBOs (including SME training) - 11 weeks; media selection - 4 weeks; syllabus development - 4 weeks; and TSRA - 4 weeks. Four weeks each for media selection and the training support requirements analysis were sufficient to complete the tasks. As discussed above, the four weeks scheduled for

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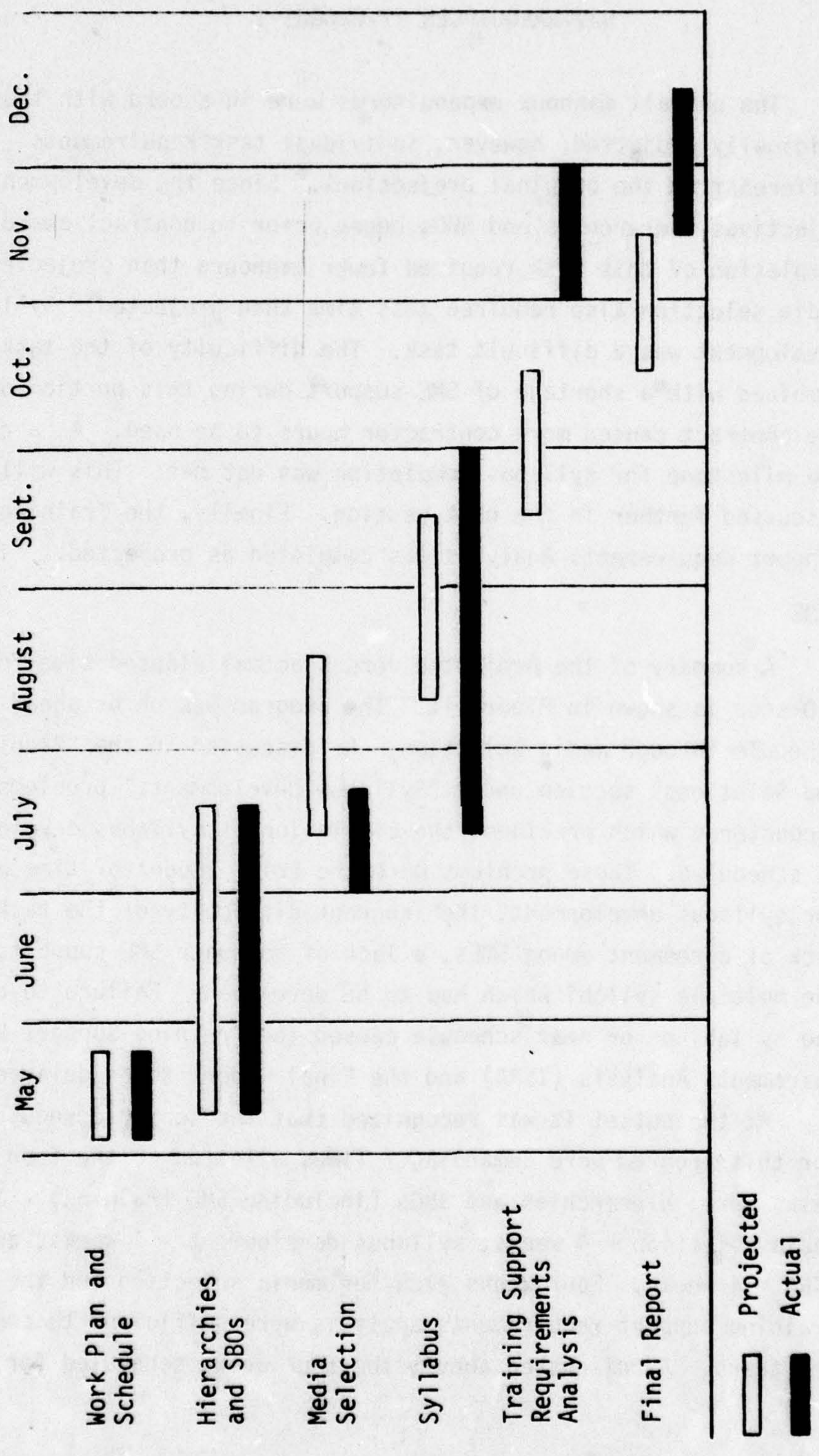


Figure 11. Projected and Actual Progress on Each Major Task in the F-4 ISD Program

syllabus development was not sufficient for a program of this size in which multiple syllabi are required. It is recommended that in similar future ISD programs, a minimum of ten weeks be scheduled for this task. With adequate SME support, it is hypothesized the syllabi required in the F-4 ISD program could have been completed in ten weeks.

The objectives hierarchies and SBOs were completed on schedule; however, this was partly a function of their having been started prior to contract award. For future planning purposes, it is recommended that in programs of this size, in which SMEs are the primary developers, a minimum of 15 weeks be allowed for SME training and the development of objectives hierarchies and SBOs.

FACILITIES AND EQUIPMENT

All facilities and equipment were government furnished and were adequate for the program. The four assigned SMEs from MCCTRG-10 occupied their normal workspaces in two offices. A large conference room was available for use by SMEs who supplemented the four permanently assigned and for group meetings, training sessions, etc. Two offices with desks were provided for contractor personnel. One was used by technical personnel. The other was used by the administrative assistant/secretary and also contained filing cabinets and a work table. All rooms adjoined thus enhancing interaction among all personnel involved in the program.

Reproduction capability was marginal when contract work began. During the contract, however, this capability was upgraded by the government and was quite satisfactory for the remainder of the contract. Government furnished typewriters were IBM Mag Card IIs, which significantly facilitated production of the numerous large documents required under the contract.

It should be noted that the facilities and equipment were a very positive factor for both the SMEs and contractor personnel.

They provided a good working environment both in terms of space and capabilities.

The contractor provided consumable supplies and a telephone on-site. All off-site activities took place in contractor facilities. Since end products of the four major tasks were produced on-site, off-site activities primarily involved review, accounting, and management functions for which few resources were required.

APPENDIX A

STRUCTURE OF OBJECTIVES HIERARCHIES

This appendix is an extract with minor modifications from one section of the Objectives Hierarchy Report (CDRL Item E005). It presents a description of the organization of the hierarchies, the numbering system, and the symbols used.

STRUCTURE OF OBJECTIVES HIERARCHIES

The hierarchies and SBO's were structured around the four F-4 missions: (1) Air to Surface, (2) Air to Air, (3) Reconnaissance, and (4) Escort. Each of the four missions was partitioned into the same ten mission segments:

1. Premission Phase
2. Brief Phase
3. Prelaunch Phase
4. Takeoff/Departure Phase
5. Navigation Phase
6. Tactical Phase
7. Refueling Phase
8. Approach/Landing Phase
9. Post Mission Phase
10. Debrief Phase

It was from this basic structure of four missions by ten mission segments that the hierarchies and SBO's were developed.

The numbering of the SBO's indicates the hierarchical relationships among the SBO's which make up the hierarchy diagrams. The first number specifies one of the four missions cited above while the second number indicates one of the ten mission segments within the mission, e.g., 1.1 is mission one (Air to Surface), mission segment one (Premission Phase). The subsequent digits in the SBO numbers are derived from the structures of the hierarchies and relate the prerequisite, lower-level component skills and knowledge to the higher level skills and knowledge.

The hierarchies are numbered from top to bottom and within a branch at the same level from left to right. Each subordinate objective in a hierarchy has a reference number which includes the complete reference number from its superordinate objective in the hierarchy and an added entry (Figure A-1). If multiple objectives are immediately subordinate to the same objective, the reference numbers for all of them will be identical in all but the last entry. The final entries for the subordinate objectives are sequentially assigned numbers beginning with 1.

In Figure A-1 the first hierarchy for Mission Segment 1.1 is shown. In order to conduct premission planning the pilot must "Gather Data for Mission" (1.1.1), "Select Pubs for Gathering Mission Data" (1.1.2), "Compute Air to Surface Mission Data" (1.1.3), "Record Data for Mission" (1.1.4), and "Evaluate Data on Mission Planning" (1.1.5).

Three different types of blocks are shown in Figure A-1. The dashed rectangular block at the top of the page (1.0) indicates that the page is a continuation of another hierarchy page. The objective within a dashed block is that objective which is immediately superordinate to the objectives on the current hierarchy page.

The first solid rectangular block following a dashed rectangular block (1.1 in Figure A-1) is always an objective which has been carried over from a previous page, i.e., there was insufficient room on a previous page to adequately analyze the objective, therefore, it was continued on a subsequent page. Other terminal solid rectangular blocks on a page are not analyzed further on a subsequent page. (1.1.4.1 and 1.1.4.2 in Figure A-1).

The "hex" box is used to indicate an objective which is further analyzed on a succeeding page (1.1.1, 1.1.2, 1.1.3, and 1.1.5 in Figure A-1). The objective in a "hex" box is contained in the top solid rectangle on a subsequent hierarchy page. The superordinate objective to it is included in the dashed rectangle at the top of that page.

Figure A-2 is a further analysis of the hex box 1.1.2 in Figure A-1. Note that the immediately superordinate objective 1.1

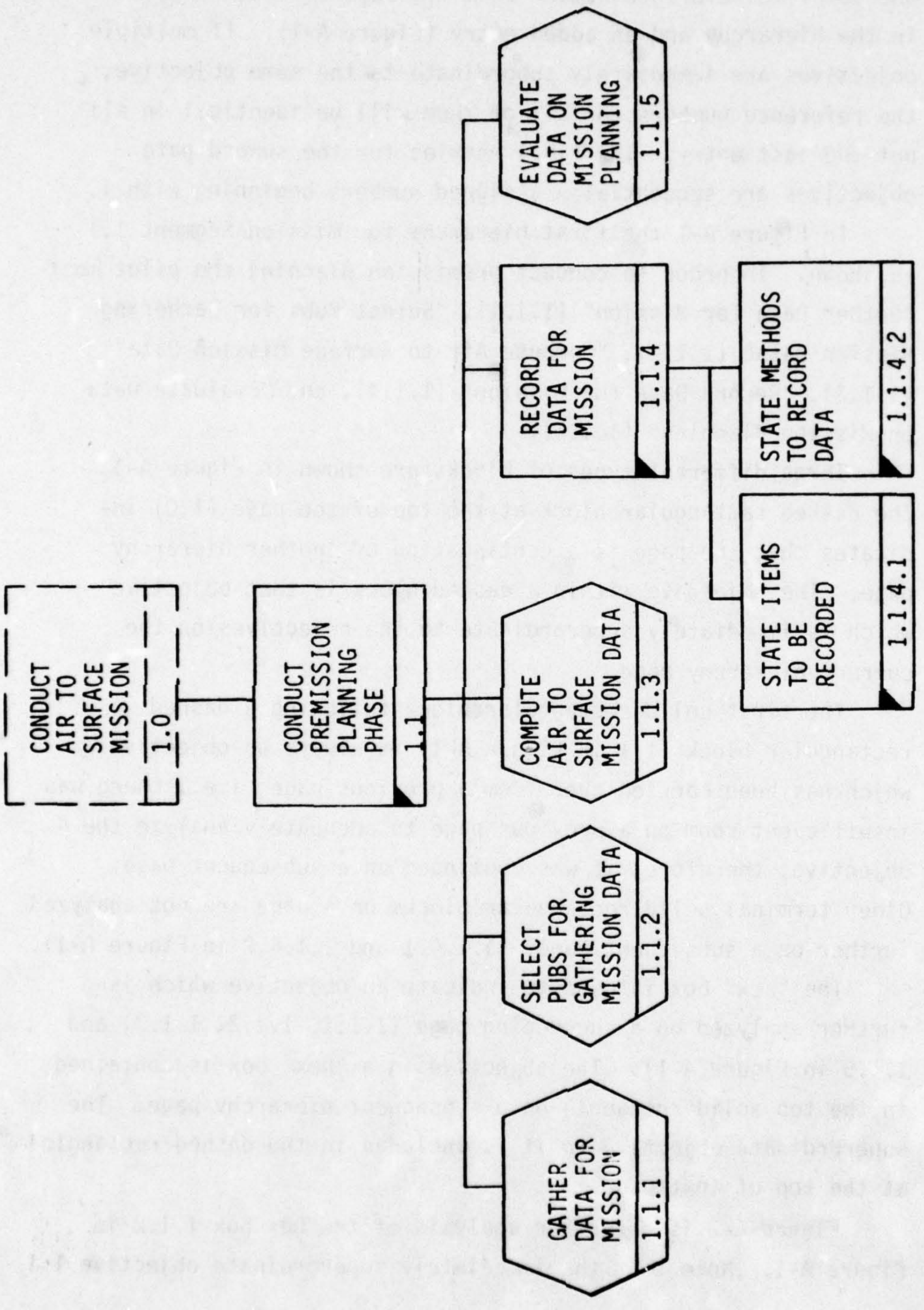


Figure A-1. Example Hierarchy: First Hierarchy in Premission Planning Phase of Air to Surface Mission

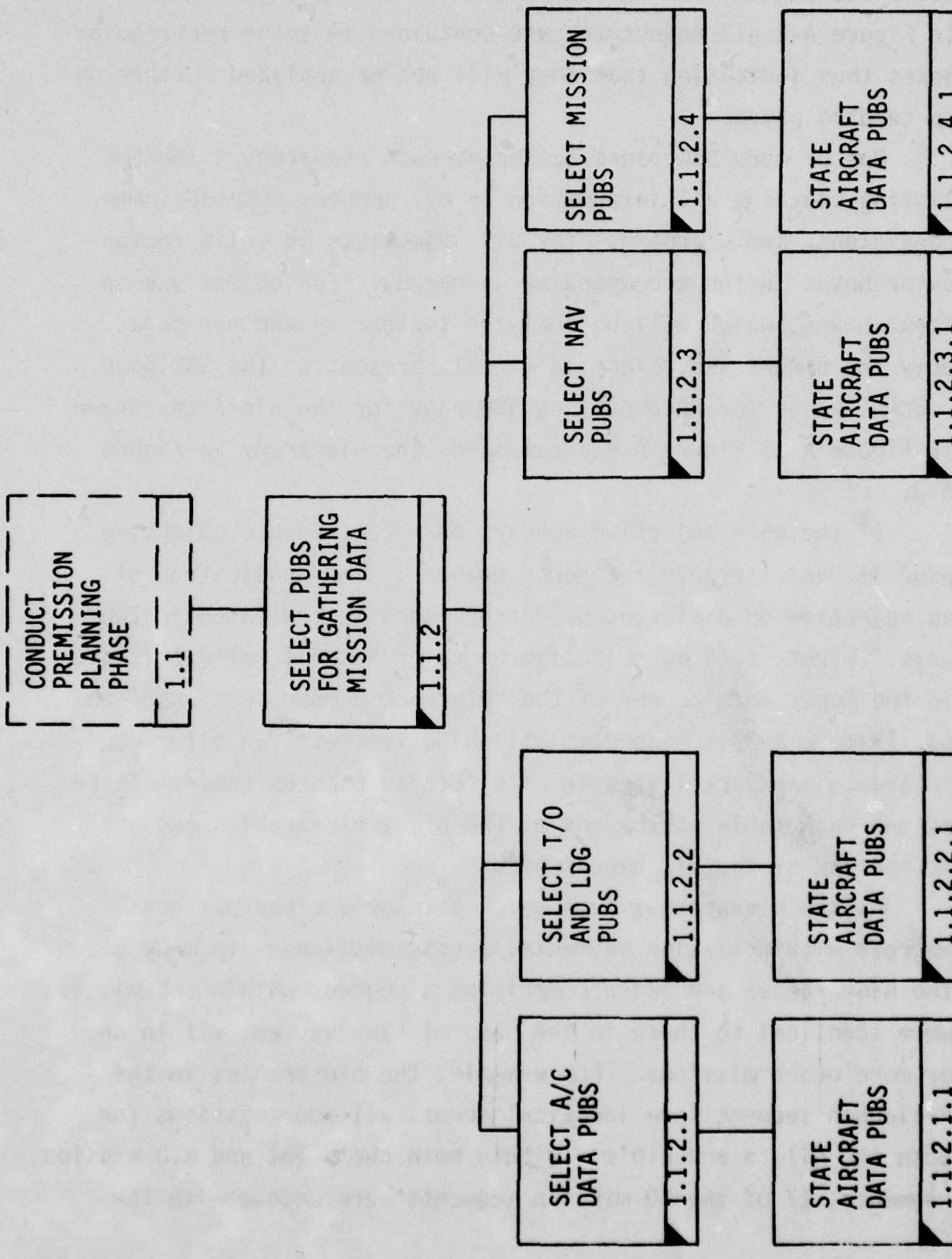


Figure A-2. Example Hierarchy: Continuation Hierarchy from Hex Box 1.1.2 in Figure A-1

is contained in the dashed rectangle at the top of the page and that 1.1.2 which was a hex box in Figure A-1 is the first solid rectangular box following the dashed rectangular box. In Figure A-2 all objectives are contained in solid rectangular boxes thus indicating that they will not be analyzed further on succeeding pages.

One or more SBO pages accompany each hierarchy. The SBO listing contains all information (i.e., number, complete name, conditions, and standards) for all objectives in solid rectangular boxes in the accompanying hierarchy. For objectives in "hex" boxes, which will be analyzed further on another page, only the number and objective name is present on the SBO page. Figure A-3 is the accompanying SBO page for the hierarchy shown in Figure A-1; Figure A-4 accompanies the hierarchy in Figure A-2.

If the same objective appears on more than one objective page it has alternate reference numbers. The duplication of an objective on different hierarchy pages is indicated in two ways. First, such an objective contains a small solid triangle in the upper left corner of the reference number section of the box (Figure A-2). Secondly, all objectives with an alternate reference mark are listed in an alternate numbers table. There is one such table at the end of the pilot hierarchies and one at the end of the RIO hierarchies.

As the hierarchies were being developed clear patterns emerged within mission segments, across missions. In many cases the hierarchies and SBO's comprising a segment within one mission were identical to those in the same mission segment within one or more other missions. For example, the hierarchies in the Prelaunch segment were identical across all four missions for both the pilots and RIO's. Within both the pilot and RIO mission segments, 17 of the 40 mission segments were unique with the

MISSION: AIR TO SURFACE
SEGMENT: CONDUCT PREMISSION PLANNING PHASE

SBO #	ACTION	CONDITIONS	STANDARDS
1.1	CONDUCT PREMISSION PLANNING PHASE		
1.1.1	GATHER DATA FOR MISSION		
1.1.2	SELECT PUBLICATIONS FOR GATHERING MISSION DATA		
1.1.3	COMPUTE AIR TO SURFACE MISSION DATA		
1.1.4	RECORD DATA FOR MISSION	GIVEN DATA GATHERED AND COMPUTED	IN ACCORDANCE WITH NATOPS, TACMAN AND LOCAL SOP FOR STANDARD FORMAT
1.1.4.1	STATE ITEMS TO BE RECORDED	GIVEN DATA AND EXAM	TO INCLUDE ALL REQUIRED INFORMATION
1.1.4.2	STATE METHOD TO RECORD DATA	GIVEN DATA AND EXAM	TO INCLUDE ALL REQUIRED INFORMATION
1.1.5	EVALUATE DATA ON MISSION PLANNING		

Figure A-3. Accompanying SBO's for the Hierarchy in Figure A-1

MISSION: AIR TO SURFACE
SEGMENT: CONDUCT PREMISSION PLANNING PHASE

SBO #	ACTION	CONDITIONS	STANDARDS
1.1.2	SELECT PUBLICATIONS FOR GATHERING MISSION DATA	GIVEN DATA NEEDED DURING PRE-MISSION PLANNING	AS REQUIRED BY TACMAN FORMATS AND BRIEFING GUIDES
1.1.2.1	SELECT AIRCRAFT DATA PUBLICATIONS	GIVEN DATA NEEDED DURING PRE-MISSION PLANNING	AS REQUIRED BY TACMAN FORMATS AND BRIEFING GUIDES
1.1.2.1.1	STATE AIRCRAFT DATA PUBLICATIONS	GIVEN A WRITTEN/ORAL EXAM	TO CRITERION
1.1.2.2	SELECT TAKE OFF AND LANDING PUBLICATIONS	GIVEN DATA NEEDED DURING PRE-MISSION PLANNING	AS REQUIRED BY TACMAN FORMATS AND BRIEFING GUIDES
1.1.2.2.1	STATE AIRCRAFT DATA PUBLICATIONS	GIVEN A WRITTEN/ORAL EXAM	TO CRITERION
1.1.2.3	SELECT NAVIGATIONS PUBLICATIONS	GIVEN DATA NEEDED DURING PRE-MISSION PLANNING	AS REQUIRED BY TACMAN FORMATS AND BRIEFING GUIDES
1.1.2.3.1	STATE AIRCRAFT DATA PUBLICATIONS	GIVEN A WRITTEN/ORAL EXAM	TO CRITERION
1.1.2.4	SELECT MISSION PUBLICATIONS	GIVEN DATA NEEDED DURING PRE-MISSION PLANNING	AS REQUIRED BY TACMAN FORMATS AND BRIEFING GUIDES
1.1.2.4.1	STATE AIRCRAFT DATA PUBLICATIONS	GIVEN A WRITTEN/ORAL EXAM	TO CRITERION

Figure A-4. Accompanying SBO's for the Hierarchy in Figure A-2.

remaining 23 segments being duplicates of the 17 unique segments.

Due to the high degree of redundancy across mission segments, the pilot and RIO hierarchies contained only those which were unique. For both the pilot and RIO hierarchies Mission 1.0 (Air to Surface) is presented in its entirety, i.e., all ten mission segments are included. For the remaining three missions 2.0 (Air to Air), 3.0 (Reconnaissance), and 4.0 (Escort) only those mission segments whose hierarchies differ from those in the corresponding mission segment in Mission 1.0 were presented.

APPENDIX B

MEDIA DEFINITIONS AND SAMPLE SELECTION DIAGRAMS

This appendix contains the media for each of the terminal blocks in the selection diagram, definitions of each of the candidate media, and examples of the selection process.

CANDIDATE MEDIA

Each path in the diagram shown in Figure 8 leads to recommended media (labeled M1 through M44) for presenting the behavioral objective. These recommended media are shown in Figure B-1. In most cases primary and alternate media are recommended. However, in some cases one or more possible answers to a question are inappropriate for any objective that has entered a certain pathway. In these cases (such as Media #1) the terminal blocks indicate that the combination of answers to questions violated a principle of media selection. The remedial solution is to review the path and correct the inconsistency.

MEDIA DEFINITIONS.

The instructional media contained in the model are:

- Mediated Interactive Lecture
- Workbook
- Slide Tape Presentation
- Random Access Slide Presentation
- Videotape Presentation
- Computer Assisted Instruction
- Trainer Exercise
- Aircraft Flight

Each of the media is defined below.

Mediated Interactive Lecture (MIL) - The major portion of the instructional material in an MIL is presented verbally by an instructor to a group of students. A MIL requires two hard copy products, student worksheets and visual aids. The student worksheet includes a set of lesson objectives, the generalities for each objective, necessary charts, tables, and figures, and a set of

<u>Media #1</u>

Familiarization level content should not be taught at a recall level.

<u>Media #2</u>

Familiarization level content should not be taught a rule-using level.

<u>Media #3</u>

Paired associate level content should not be taught at a rule-using level.

<u>Media #4</u>

First Choice: Workbook
Second Choice: Mediated interactive lecture

<u>Media #5</u>

First Choice: Mediated interactive lecture
Second Choice: Slide-tape presentation

<u>Media #6</u>

First Choice: Videotape
Warning: It may not be worth the expense

<u>Media #7</u>

It is probably a waste of time and resources to teach this objective at a familiarization level.

<u>Media #8</u>

First Choice: Slide tape
Second Choice: Mediated interactive lecture

<u>Media #9</u>

First Choice: Videotape
Second Choice: Mediated interactive lecture

<u>Media #10</u>

Why is an interactive presentation needed to teach discriminated recall level behavior?

Figure B-1. The Meaning of Each of the 44 Terminal Blocks in the Media Selection Network

Media #11

You may want to combine this objective with the classification level objective dealing with this content.

First Choice: Workbook
Second Choice: Mediated interactive lecture

Media #12

First Choice: Videotape
Second Choice: Mediated interactive lecture

Media #13

Why do you need an interactive simulation to teach a discriminated recall level behavior?

Media #14

First Choice: A simulator or the actual equipment and a worksheet.
Second Choice: CAI simulation

Media #15

First Choice: Workbook
Second Choice: Slide tape
Third Choice: Mediated interactive lecture

Media #16

First Choice: CAI (memory)
Second Choice: Workbook
Third Choice: Slide tape

Media # 17

First Choice: CAI (memory)
Second Choice: Slide tape
Third Choice: Slide tape

Media #18

First Choice: CAI (memory)
Second Choice: Slide tape
Third Choice: Workbook

Media #19

First Choice: Videotape
Second Choice: Mediated interactive lecture

Figure B-1. The Meaning of Each of the 44 Terminal Blocks in the Media Selection Network (continued)

Media #20

Why do you need an interactive presentation to teach a discriminated recall level behavior?

Media #21

You may want to combine this objective with the workbook portion of the rule-using level objective dealing with the content.

First Choice: Workbook
Second Choice: Mediated interactive lecture

Media #22

First Choice: CAI (memory)
Second Choice: Workbook
Third Choice: Slide tape

Media #23

You may want to combine this with the workbook portion of the rule-using level objective dealing with this content.

First Choice: Slide tape
Second Choice: Workbook

Media #24

First Choice: Videotape
Second Choice: Mediated interactive lecture

Media #25

First Choice: Videotape
Second Choice: Mediated interactive lecture (with VT).

Media #26

First Choice: Simulator
Second Choice: CAI simulation
Third Choice: Videotape

Media #27

First Choice: Videotape
Second Choice: Mediated interactive lecture (with VT).
NOTE: Be sure you have a separate objective to teach the large memory component of this objective at the discriminated recall level.

Figure B-1. The Meaning of Each of the 44 Terminal Blocks in the Media Selection Network (continued)

Media #28

First Choice: Simulator
Second Choice: CAI Simulation
Third Choice: Videotape

Media #29

First Choice: Workbook
Second Choice: CAI
Third Choice: Mediated interactive lecture
Fourth Choice: Random access slide-workbook

Media #30

First Choice: CAI
Second Choice: Random access slide-workbook
Third Choice: Workbook
Fourth Choice: Mediated interactive lecture

Media #31

First Choice: Random access slide-workbook
Second Choice: CAI
Third Choice: Mediated interactive lecture
Fourth Choice: Workbook

Media #32

First Choice: CAI
Second Choice: Random access slide-workbook
Third Choice: Mediated interactive lecture
Fourth Choice: Workbook

Media #33

First Choice: Workbook
Second Choice: CAI
Third Choice: Mediated interactive lecture
Fourth Choice: Random access slide-workbook

Media #34

First Choice: CAI
Second Choice: Random access slide-workbook
Third Choice: Workbook
Fourth Choice: Mediated interactive lecture
NOTE: Be sure you have a separate objective to teach the large memory component of this objective at the discriminated recall level.

Figure B-1. The Meaning of Each of the 44 Terminal Blocks in the Media Selection Network (continued)

Media #35

First Choice: Random access slide-workbook
Second Choice: CAI
Third Choice: Mediated interactive lecture
Fourth Choice: Workbook
NOTE: Be sure you have a separate objective to teach the large memory component of this objective at the discriminated recall level.

Media #36

First Choice: CAI
Second Choice: Random access slide-workbook
Third Choice: Mediated interactive lecture
Fourth Choice: Workbook
NOTE: Be sure you have a separate objective to teach the large memory component of this objective at the discriminated recall level.

Media #37

First Choice: Workbook
Second Choice: CAI
Third Choice: Mediated interactive lecture
Fourth Choice: Random access slide-workbook

Media #38

First Choice: CAI
Second Choice: Random access slide-workbook
Third Choice: Workbook
Fourth Choice: Mediated interactive lecture

Media #39

First Choice: Workbook
Second Choice: CAI
Third Choice: Mediated interactive lecture
Fourth Choice: Random access slide-workbook
NOTE: Be sure you have a separate objective to teach the large memory component of this objective at the discriminated recall level.

Media #40

First Choice: CAI
Second Choice: Random access slide-workbook
Third Choice: Workbook
Fourth Choice: Mediated interactive lecture
NOTE: Be sure you have a separate objective to teach the large memory component of this objective at the discriminated recall level.

Figure B-1. The Meaning of Each of the 44 Terminal Blocks in the Media Selection Network (continued)

Media #41

First Choice: Random access slide-workbook
Second Choice: CAI
Third Choice: Mediated interactive lecture
Fourth Choice: Workbook

Media #42

First Choice: CAI
Second Choice: Random access slide-workbook
Third Choice: Mediated interactive lecture
Fourth Choice: Workbook

Media #43

First Choice: Random access slide-workbook
Second Choice: CAI
Third Choice: Mediated interactive lecture
Fourth Choice: Workbook
NOTE: Be sure you have a separate objective to teach the large memory component of this objective at the discriminated recall level.

Media #44

First Choice: CAI
Second Choice: Random access slide-workbook
Third Choice: Mediated interactive lecture
Fourth Choice: Workbook
NOTE: Be sure you have a separate objective to teach the large memory component of this objective at the discriminated recall level.

Figure B-1. The Meaning of Each of the 44 Terminal Blocks in the Media Selection Network (continued)

practice item response sheets for each objective. Types of visual aids used in a MIL may include overhead transparencies, slides, or videotapes, depending on the display requirements of the lesson. These aids are used, where appropriate, to present supporting information, sets of examples, and sets of practice items. For a lecture to be adaptive to student needs it must be interactive. An interactive lecture provides the instructor with an outline which requires him to ask the students questions and alter his presentation based on student responses.

Workbook (WB) - The defining characteristic of a workbook is that all instructional components are presented in printed form. The workbook begins with a lesson map, a lesson introduction, and a set of instructions explaining how to proceed. Each segment (corresponding to one objective) begins by presenting the objective, the generality, and the supporting explanation or help. The practice items are designed to require the student to behave at the level designated in the objective. The practice set is accompanied by a feedback and help section.

Slide-Tape Presentation (ST) - A slide-tape presentation shall contain three separate components: (1) a set of slides or photographic frames, (2) audio sections, and (3) a student worksheet. The student worksheet first presents a lesson map, and a set of instructions about where to get the slides and the audio tape, where and how to set them up, and how best to use them. For each segment, the worksheet presents the objective, the generality, necessary charts and tables, and a response form for the practice items. The audio tape shall begin with an introduction. For each objective, the generality is restated and additional supporting information is presented. The slides shall complement the audio tape. A set of practice items is presented next. The student is told to stop the tape after each question, and write his answer on his worksheet. When the tape is started again, it gives feedback and help for that item.

Random-Access Slide Presentation (RAS) - A random-access slide presentation shall contain two components: a set of slides presented via a random-access slide projector, and a student worksheet. This medium allows for visual presentation of large numbers of examples and practice items without sacrificing the freedom of movement (i.e., learner control) lost in the linear ST or VT presentation. The worksheet in the RAS shall present the lesson map, a lesson introduction, and instructions for obtaining the slide set, setting up, and viewing, and how best to use the lesson materials. For each segment, it presents the objective, the generality and some supporting explanation. It then presents tables of numbered example items and practice items. Each table presents a listing of the slide numbers of example, and help, or practice and feedback items. The student can use these tables to check those examples he has viewed, or the practice items he has worked. The practice table also provides space for the student's response. The random-access slides are used to present an expanded version of the generality, the set of examples with helps, practice items, and feedback.

Videotape Presentation (VT) - A videotape presentation shall contain two components: a videotape cassette and a student worksheet. The use of these two components shall be parallel to the use of corresponding components of the slide-tape presentation. The major difference between these two media is the type of display capability. The instructional strategy used is similar in both types of media.

Computer Assisted Instruction (CAI) - In this medium a computer monitors student performance through frequent tests and optimizes trainee learning by branching to the appropriate level of detail. When trainees elicit a strong understanding of the content the computer omits further instruction. When the trainee fails to master a subject the computer branches to more detailed instruction, much as a human instructor does. Due to the high cost of computer assisted instruction, Allen Corporation was instructed to omit CAI from consideration on this training program.

Trainer Exercise - A trainer exercise shall be used to allow the student to practice in a simulated real world environment. The type of trainer used depends on whether cockpit motion is required, and upon the degree of fidelity to the real world required. A trainer exercise shall also include three other components: (1) a student worksheet, (2) a student evaluation sheet, and (3) a trainer feedback sheet. The student worksheet presents the student with the set of lesson objectives, a lesson introduction, and a set of instructions describing what he should do to be prepared for the trainer. The worksheet then presents any information the student will need for mission planning purposes, and spells out exactly what planning he will need to have prepared. The worksheet then outlines in detail the procedures or actions the student should perform. For procedures not previously practiced, the worksheet presents a list of steps to perform. Previously mastered procedures are referred to by name without the accompanying list of steps. In all cases, the worksheet outlines verbally or pictorially the correct result of the action. The student evaluation sheet is used by the instructor to check the student's performance. It describes evaluation instructions, outlines necessary instructor-student interactions, and gives a checklist of all points that should be evaluated. Based on the student's performance, the instructor fills out a trainer feedback sheet. This sheet is formatted so the instructor can check areas where the student needs more practice. Each area references course lessons which deal with the area.

Aircraft Flight (AC) - The instructional materials for flight shall be similar to those for a trainer exercise. These materials include a student worksheet, a student evaluation form, and a flight feedback sheet. The student worksheet outlines the lesson objectives, gives the student necessary data and instructions for mission planning, and describes the general sequence of events that should occur during the flight. The student evaluation sheet and the flight feedback sheet are the same format as those used in the trainer exercise. The student evaluation sheet shall be printed on knee-cards so it can be carried on the flight.

SELECTION PROCESS EXAMPLES

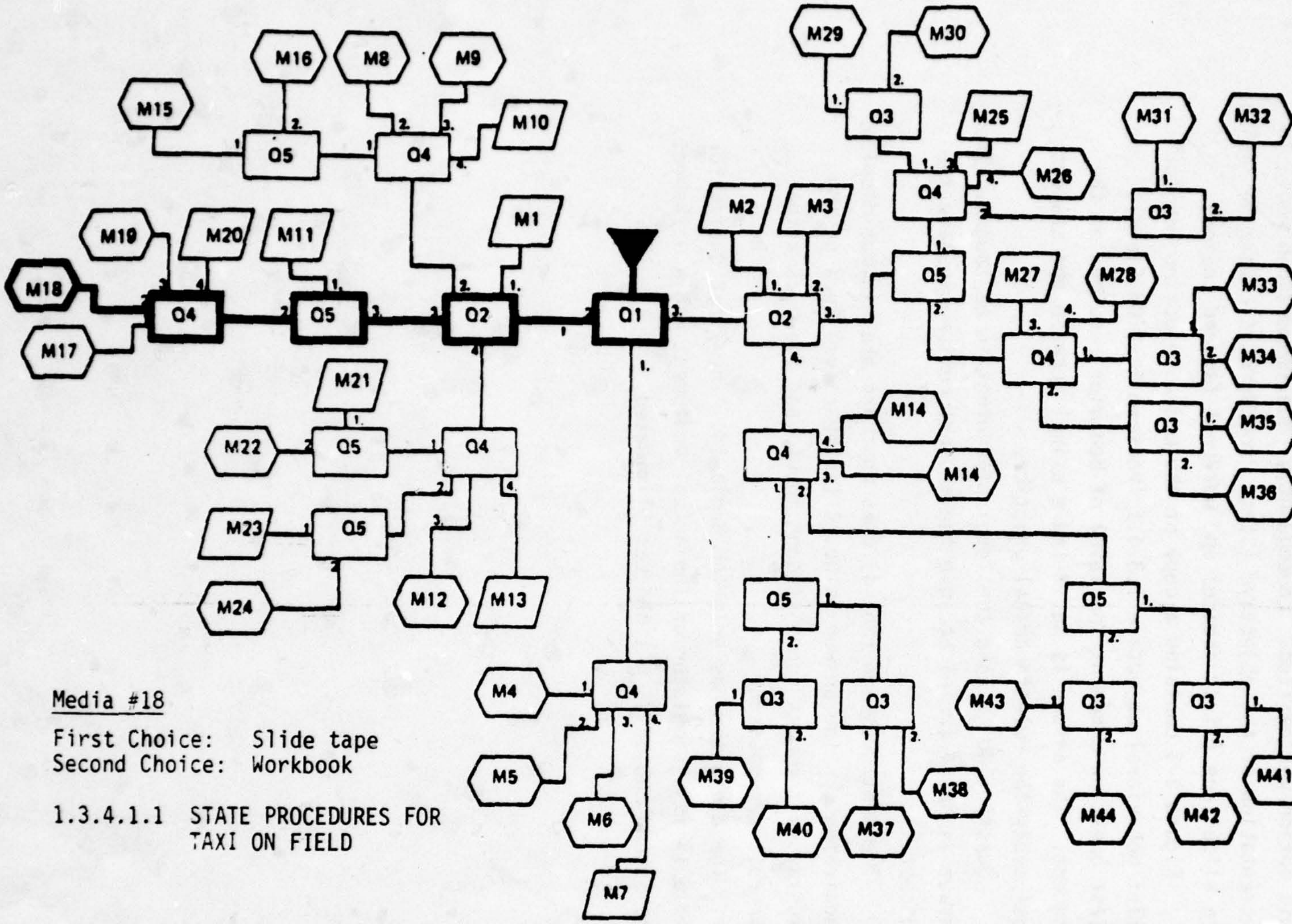
As discussed in Section III, media for presenting each objective were selected by asking a series of five questions. Answers to the questions traced a path through the media selection diagram. Figure B-2 contains a copy of the media selection diagram for pilot behavioral objective 1.3.4.1.1 (State Procedures for Taxi On Field). The dark lines indicate the questions asked about the objective and the pathways chosen based on the answers.

The algorithm starts at the triangle in the center of the page and proceeds to Question 1 (What is the level of behavior expected of the student in this segment?). The answer is No. 2 (discriminated recall) because the student is required to recall and state the procedures.

The algorithm then proceeds to Question 2 (What level of content is being taught in this segment?). The answer is No. 3 (concept) because the student must state the concept or procedures but not manipulate it as in No. 4.

Next is Question 5 (Is the memorization component of this objective large or small?). The answer is No. 2 (large) because there is no checklist for taxi procedures and much information must be remembered to correctly perform taxi operations.

The final question is No. 4 (What is the minimum display requirement?). The answer is No. 2 (verbal and/or symbolic and/or static complex pictorial) because the long list of procedures will require complex static pictorial presentation.



Media #18

First Choice: Slide tape
Second Choice: Workbook

1.3.4.1.1 STATE PROCEDURES FOR TAXI ON FIELD

Figure B-2. Media Selection Map for Objective 1.3.4.1.1

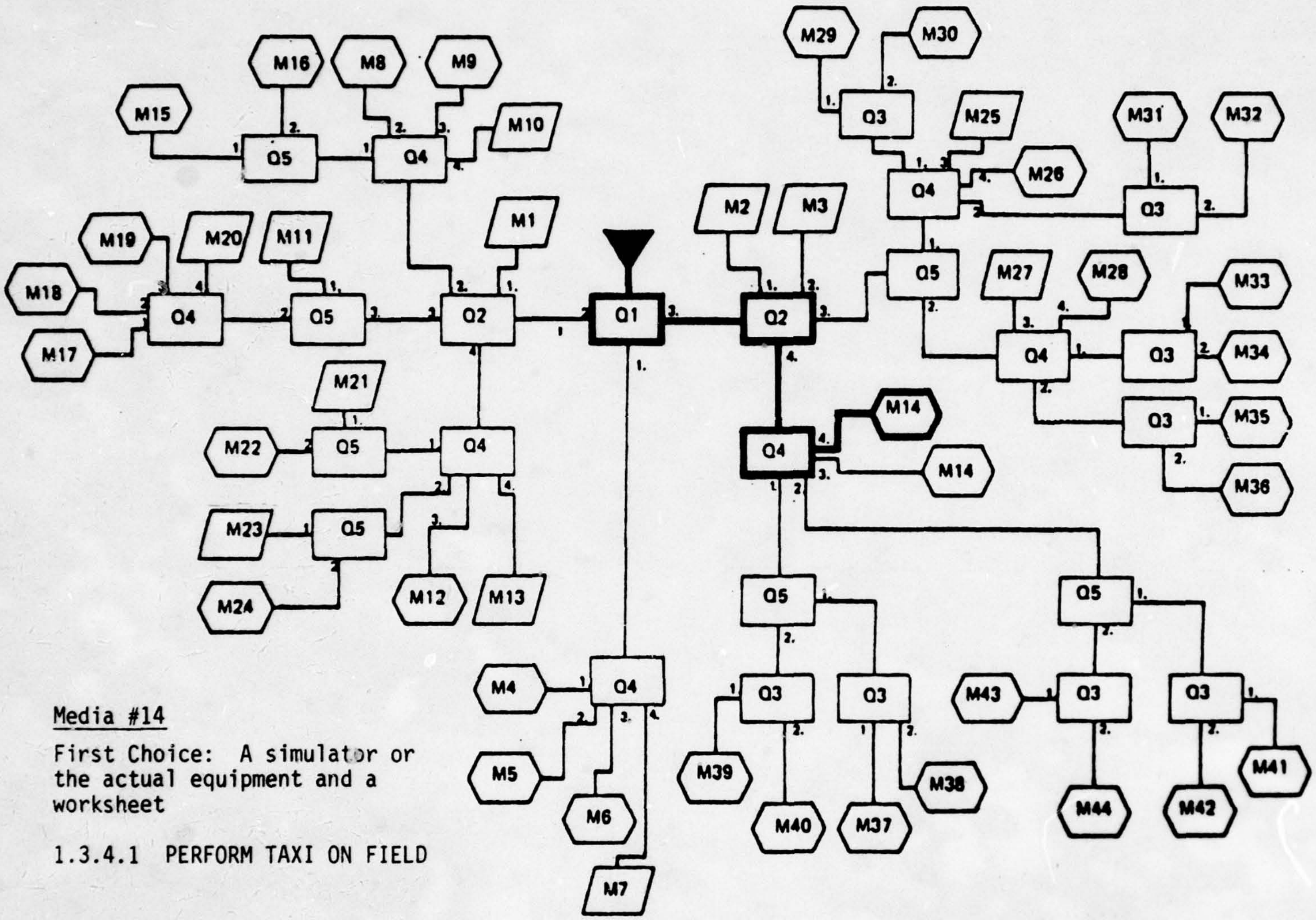
The algorithm has led to Media 18. As shown in Figure B-1, the first choice for Media 18 is CAI. Due to cost considerations this option was omitted. Consequently, the recommended media for presentation of the objective (State Procedures for Taxi On Field) are slide tape (first choice) and workbook (second choice).

Figure B-3 contains a copy of the media selection map for pilot behavioral objective 1.3.4.1 (Perform Taxi On Field). The first question concerns the level of behavior required of the student. The answer is No. 3 (rule using) because the student must apply the rule in actual practice.

Question No. 2 asks the level of content to be taught. The answer is No. 4 (rule) because the student must manipulate the concept.

The last question (No. 4) asks what are the minimum display requirements. The answer is No. 4 (interactive) because the display system must sense student inputs and feedback actual aircraft responses.

The algorithm has selected Media 14. The first choice for Media 14 is a simulator or the actual equipment and a worksheet. The second choice is CAI and was eliminated.



Media #14

First Choice: A simulator or the actual equipment and a worksheet

1.3.4.1 PERFORM TAXI ON FIELD

Figure B-3. Media Selection Map for Objective 1.3.4.1

APPENDIX C

ANALYSIS EXAMPLE

This appendix contains an example which traces objectives from the task listing, through hierarchy and SBO development and media selection, to the syllabus.

ANALYSIS EXAMPLE

In the sequence of Figure C-1 through C-8 on the following pages, three objectives from the task listing are traced through three analysis steps. First they are broken down into their prerequisite skills and knowledges in an objectives hierarchy. Next, media are selected for one of these objectives and two of the prerequisite objectives, using media selection diagrams. Finally, the objectives from the hierarchy are grouped into syllabus lessons.

The task listing page shown in Figure C-1 was the start point for the analysis. Objectives marked with asterisks (*) are those which are analyzed in the subsequent hierarchy. Figure C-2 is the hierarchy containing the superordinate objectives, the objectives of interest from the task listing, and the subordinate objectives identified during the hierarchy analysis. Note that objective 2.6.6.4 (Determine the Optimum Lesson to Use) is at the same level in the hierarchy as the three objectives from the task listing. Although the inclusion of this objective resulted from analysis of the other three objectives at the same level, it was placed as a coordinate objective as per the specification guidelines for hierarchy development. Figure C-3 is the SBO pages for the hierarchy in Figure C-2.

The next step was to select instructional media for the objectives. Figures C-4, C-5, and C-6 are media selection diagrams for three of the objectives in Figure C-2.

Following media selection, the objectives were grouped to form lessons. Two lessons, one ground school and one flight, were formed from the objectives in Figure C-2. The syllabus sheets for these lessons are shown in Figure C-7 and C-8.

F-4 AIRCREW TASK LISTING VALIDATION

PILOT

TASK	CONDITIONS	STANDARDS
2.6.5.1.3 Acquire TGTS using PLM	Given tactical situation	IAW TACMAN
2.6.5.1.4 Acquire TGTS using	Given tactical situation	IAW TACMAN
2.6.5.1.5 Acquire TGTS using radar (rear seat acquisition)	Given tactical situation	IAW TACMAN
2.6.6 Deliver weapon		
2.6.6.1 * Deliver Aim 7	Given tactical situation	IAW TACMAN
2.6.6.2 * Deliver Aim 9	Given tactical situation	IAW TACMAN
2.6.6.3 * Deliver 20mm gun fire	Given tactical situation	IAW TACMAN

Figure C-1. Sample Task Listing Page. Entries Marked with an Asterisk (*). were the Superordinate Objectives for Subsequent Analysis

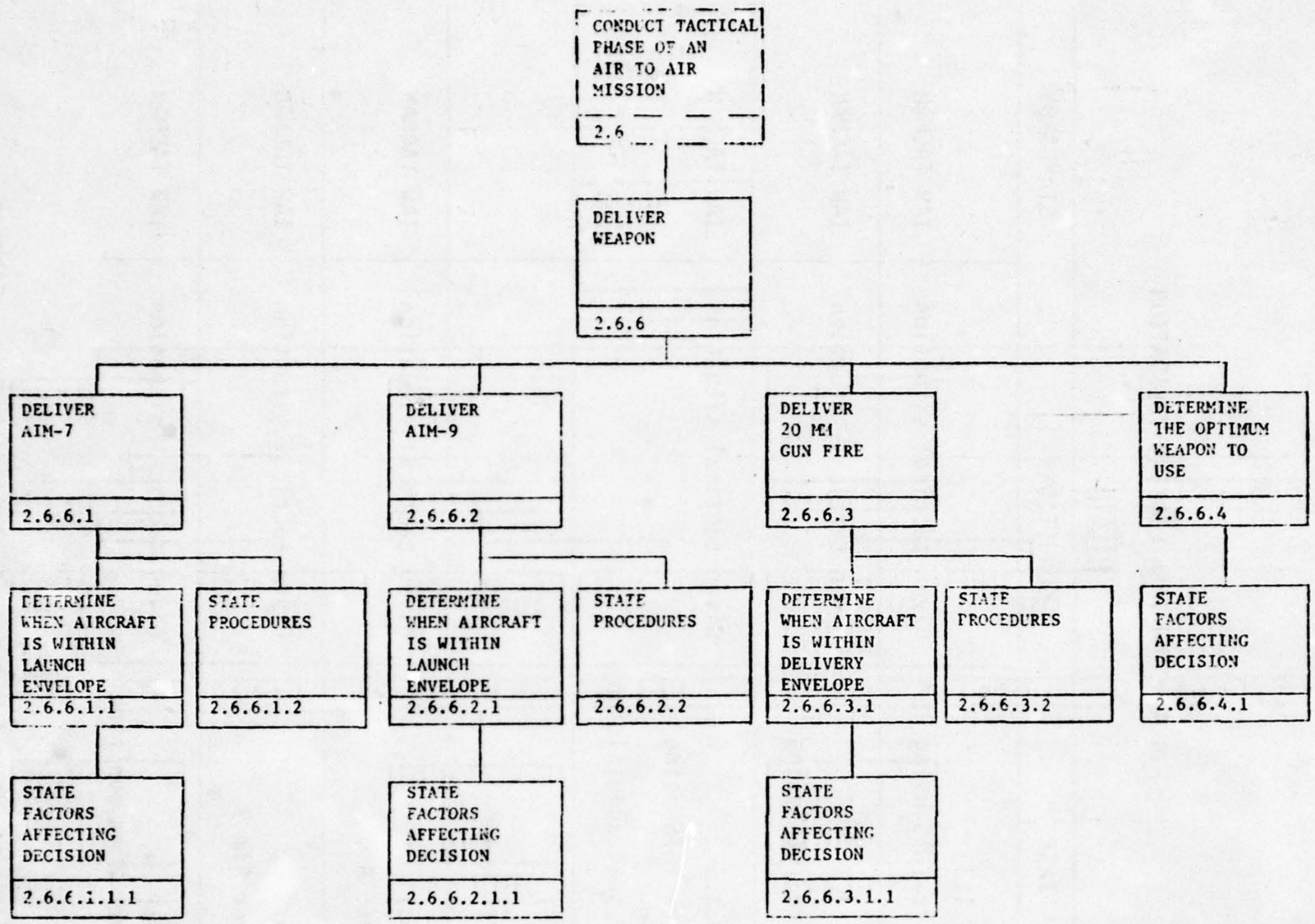


Figure C-2. Sample Hierarchy Page. Entries marked with an asterisk (*) are superordinate objectives from the task listing. Other objectives at or below the level of the marked objectives are prerequisite skills and knowledges.

MISSION: AIR TO AIR
SEGMENT: CONDUCT TACTICAL PHASE

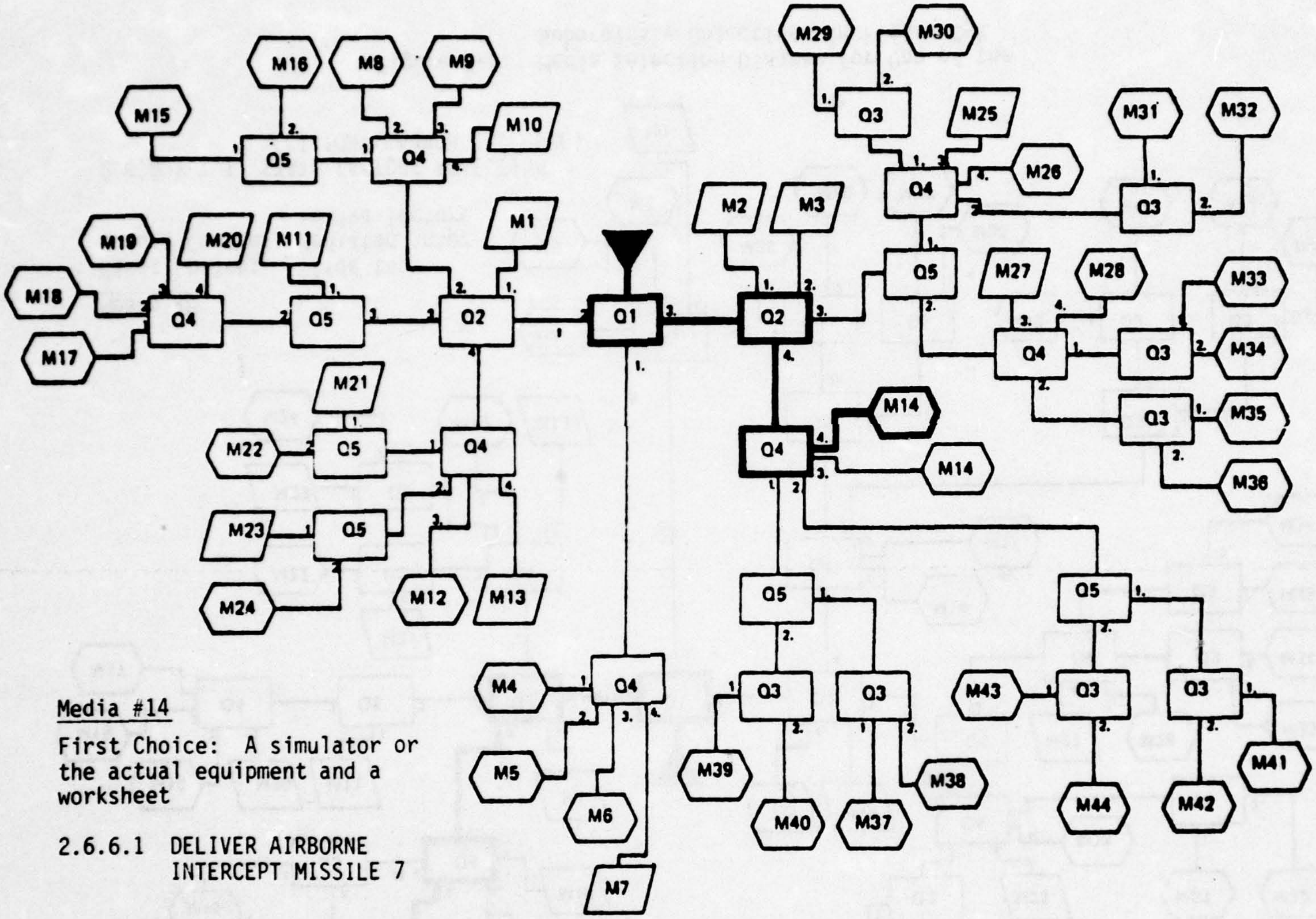
SBO #	ACTION	CONDITIONS	STANDARDS
2.6.6	DELIVER WEAPON	GIVEN TACTICAL SITUATION AND ADVERSARY AIRCRAFT	TO WITHIN LETHAL RADIUS OF WEAPON
2.6.6.1	DELIVER AIRBORNE IN-TERCEPT MISSILE 7	GIVEN TACTICAL SITUATION AND ADVERSARY AIRCRAFT	TO WITHIN LETHAL RADIUS OF WEAPON
2.6.6.1.1	DETERMINE WHEN AIR-CRAFT IS WITHIN LAUNCH ENVELOPE	GIVEN TACTICAL SITUATION AND ADVERSARY AIRCRAFT	IN ACCORDANCE WITH TACMAN
2.6.6.1.1.1	STATE FACTORS AFFECTING DECISION	GIVEN EXAM	TO CRITERION
2.6.6.1.2	STATE PROCEDURES	GIVEN EXAM	TO CRITERION
2.6.6.2	DELIVER AIRBORNE IN-TERCEPT MISSILE 9	GIVEN TACTICAL SITUATION AND ADVERSARY AIRCRAFT	TO WITHIN LETHAL RADIUS OF WEAPON
2.6.6.2.1	DETERMINE WHEN AIR-CRAFT IS WITHIN LAUNCH ENVELOPE	GIVEN TACTICAL SITUATION AND ADVERSARY AIRCRAFT	IN ACCORDANCE WITH TACMAN
2.6.6.2.1.1	STATE FACTORS AFFECTING DECISION	GIVEN EXAM	TO CRITERION
2.6.6.2.2	STATE PROCEDURES	GIVEN EXAM	TO CRITERION

Figure C-3. SBO Page for the Hierarchy in Figure C-2

MISSION: AIR TO AIR
SEGMENT: CONDUCT TACTICAL PHASE

SBO #	ACTION	CONDITIONS	STANDARDS
2.6.6.3	DELIVER 20 MILLIMETER GUN FIRE	GIVEN TACTICAL SITUATION AND ADVERSARY AIRCRAFT	TO WITHIN LETHAL RADIUS OF WEAPON
2.6.6.3.1	DETERMINE WHEN AIR-CRAFT IS WITHIN LAUNCH ENVELOPE	GIVEN TACTICAL SITUATION AND ADVERSARY AIRCRAFT	IN ACCORDANCE WITH TACMAN
2.6.6.3.1.1	STATE FACTORS AFFECTING DECISION	GIVEN EXAM	TO CRITERION
2.6.6.3.2	STATE PROCEDURES	GIVEN EXAM	TO CRITERION
2.6.6.4	DETERMINE THE OPTIMUM WEAPON TO USE	GIVEN TACTICAL SITUATION AND ADVERSARY AIRCRAFT	IN ACCORDANCE WITH TACMAN
2.6.6.4.1	STATE FACTORS AFFECTING DECISION	GIVEN EXAM	TO CRITERION

Figure C-3. SBO Page for the Hierarchy in Figure C-2 (continued)

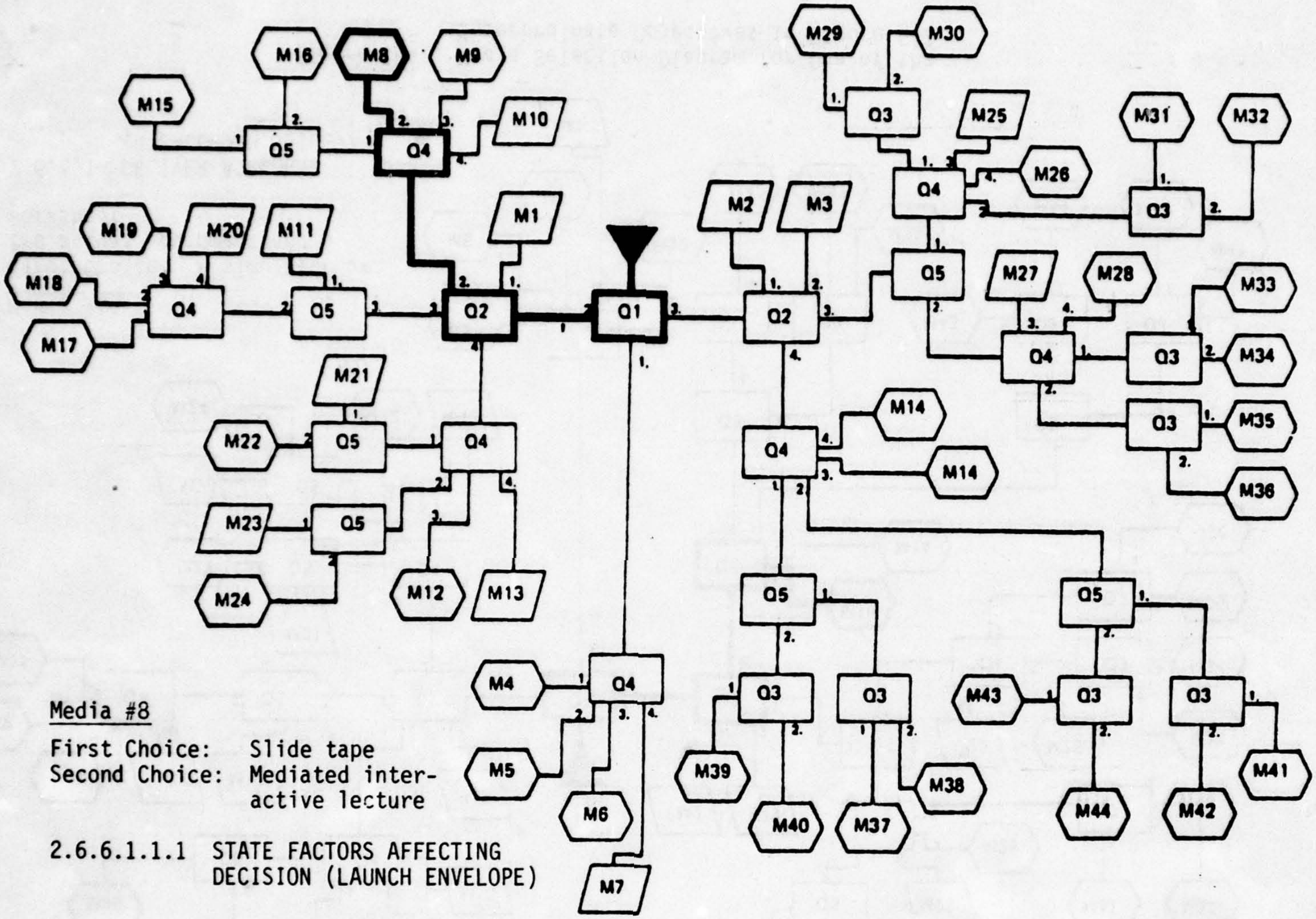


Media #14

First Choice: A simulator or the actual equipment and a worksheet

2.6.6.1 DELIVER AIRBORNE INTERCEPT MISSILE 7

Figure C-4. Media Selection Diagram for One of the Superordinate Objectives in Figure C-2

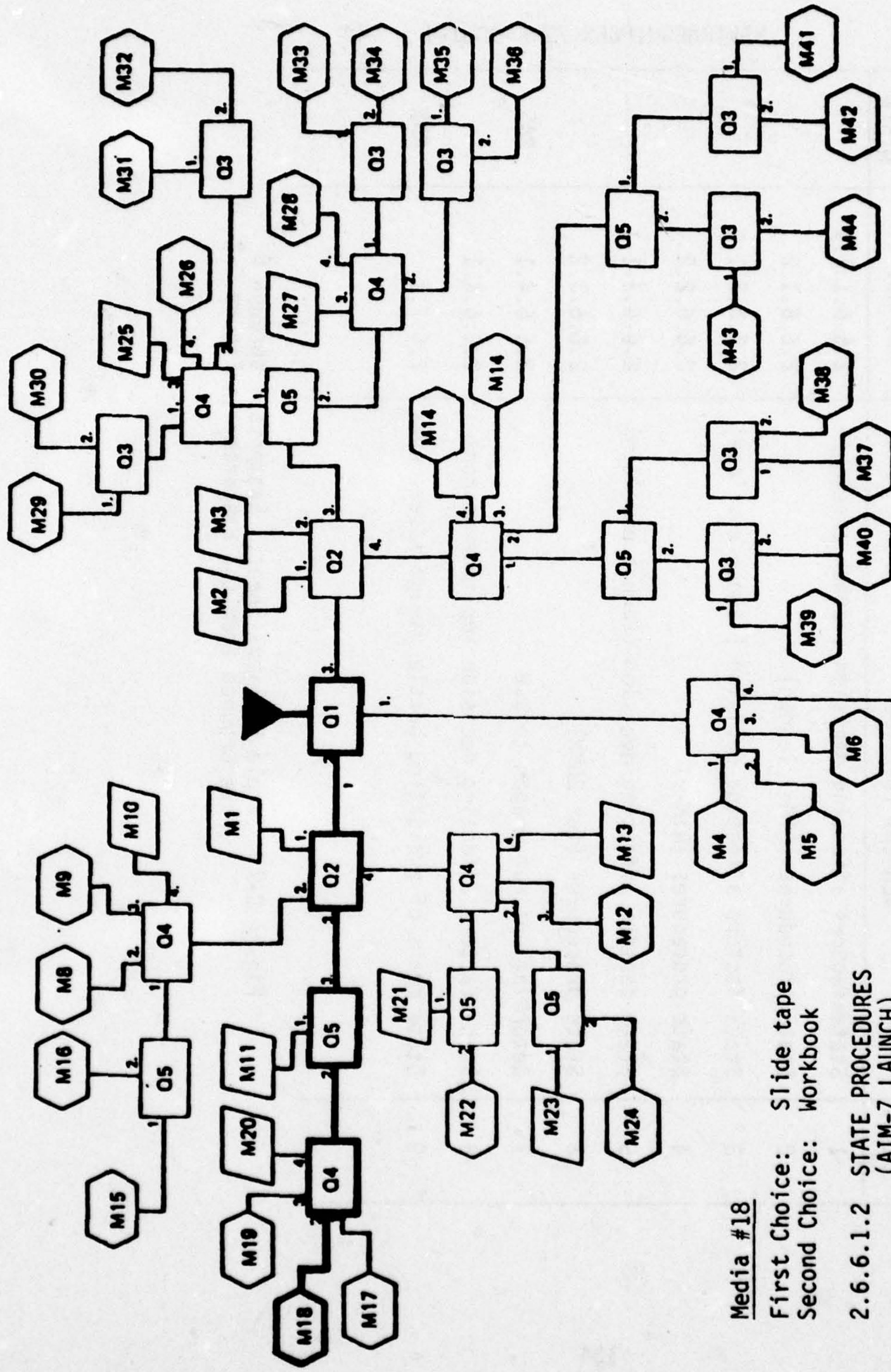


Media #8

First Choice: Slide tape
Second Choice: Mediated interactive lecture

2.6.6.1.1.1 STATE FACTORS AFFECTING DECISION (LAUNCH ENVELOPE)

Figure C-5. Media Selection Diagram for One of the Subordinate Objectives in Figure C-2



Media #18

First Choice: Slide tape
Second Choice: Workbook

2.6.6.1.2 STATE PROCEDURES (AIM-7 LAUNCH)

Figure C-6. Media Selection Diagram for One of the Subordinate Objectives in Figure C-2.

NAVTRAEQUIPCEN 77-C-0081-1

Course, Unit, Lesson: P.17.1

Title: MISSILE SHOOT

Time: .5
Medium: ST
A/C Model: J/N
Organization: M/N

SEG #	SEGMENT TITLE	SBO NO.	SEL. MEDIA
1	State factors affecting decision (launch envelope)	2.6.6.1.1.1	
2	State procedures (AIM-7 launch)	2.6.6.1.2	
3	State factors affecting decision (launch envelope)	2.6.6.2.1.1	
4	State procedures (AIM-9)	2.6.6.2.2	
5	State factors affecting decision (launch envelope)	2.6.6.3.1.1	
6	State procedures (for 20MM)	2.6.6.3.2	
7	Determine optimum weapon to use	2.6.6.4.1	RAS
8	State factors affecting decision (optimum weapon)	2.6.6.4.1	
9	State means of evaluating battle damage assessment	2.6.7.1	RAS

Figure C-7. Sample Syllabus Sheet. Segments 1 through 8 were Grouped from the Hierarchy in Figure C-2

Course, Unit, Lesson: P.17.3

Title: MISSILE SHOOT

Time: 1.2
Medium: F-4
A/C Model: J/N
Organization: M/N

SEG #	SEGMENT TITLE	SBO NO.	SEL. MEDIA
1	Deliver weapon	2.6.6	
2	Deliver AIM 7	2.6.6.1	
3	Determine when aircraft is within launch envelope	2.6.6.1.1	
4	Deliver AIM 9	2.6.6.2	
5	Determine when aircraft is within launch envelope	2.6.6.2.1	
6	Deliver 20MM	2.6.6.3	
7	Determine when aircraft is within launch envelope	2.6.6.3.1	
8	Evaluate results of weapon delivery	2.6.6.7	

Figure C-8. Sample Syllabus Sheet. Segments 1 through 7 were Grouped from the Hierarchy in Figure C-2

APPENDIX D

TRAINING SUPPORT REQUIREMENTS ANALYSIS

This appendix contains extracts from the Training Support Requirements Report (CDRL Item E0011). Sections presented pertain to cost estimation procedures and the figures used in the calculations.

TRAINING SUPPORT REQUIREMENTS ANALYSIS

The following sections of this appendix contain the basic information which was used to estimate costs for development, implementation, revision and maintenance of the F-4 pilot and RIO courses. Since the design phase was under contract, when the TSRA was prepared, no estimate for this phase was calculated. Of particular relevance are the development costs for one lesson in each of the seven media selected for use in the F-4 training courses. As discussed in Section III of this report, the number of lessons per medium has changed as a result of lesson specification development, which began after the original TSRA was produced. Total estimated costs, therefore, have changed, but not the costs per lesson in each medium.

DEVELOPMENT REQUIREMENTS

The development phase consists of the authoring and production efforts. Base rate values for these efforts were developed in the format specified in UDI-H-00040. Table D-1, Personnel Hours and Materials to Develop One Lesson of Instruction, contains the basic data required. Data in Table D-1 were drawn from three civilian production companies and from two civil service (Navy) organizations.

In Table D-1 the SME has been considered to be the author. The Instructional Psychologist has been considered as a part-time program manager with the Instructional Technologist providing most of the direct support and assistance in the authoring and development efforts. The production manager provides the liaison between the graphics, camera, and typing personnel. In addition, he will provide the scheduling of input and output for the storyboard and illustration requirements.

TABLE D-1. BASIC DATA USED TO CALCULATE DEVELOPMENT COSTS

MEDIA	Finished Materials in one Lesson	PERSONNEL HOURS TO DEVELOP ONE LESSON OF INSTRUCTION									
		SME	Author	Instructional Psychologist/Designer	Instructional Technologist	Production Manager	Writer/Editor	Composer Operator	NARRATOR	Graphics Specialist	Paste Up Artist
LECTURE	5 page Lecture Outline		5	.5	1	.5	1	1			
	5 page Student Worksheet		8	.5	2	.5	2	1.5		2.5	.5
	10 Overheads		2		.5	1		.5		30	2
WORKBOOK (memory)	20 page Student Workbook		30	1	4	1	5	5		20	1.2
WORKBOOK (r/c)	60 page Student Workbook										
SLIDE TAPE	60-80 Slides		3	1	2	6				80	5
	15-20 Minutes Audiotape		22	2	8	4	2	6	1.5		
	10 page Student Worksheet		8	1	4	1	2	2		10	2.5
RANDOM ACCESS SLIDE	120-180 Slides		– 6	2	8	12				160	10
	20 Page Student Worksheet		40	2	8	1	4	5		20	5
VIDEOTAPE	15-20 Minute Videotape		12	1	4	2	2.5	3	2	40	
	5 page Student Worksheet		4	.5	2	.5	.5	1		5	1
TRAINER EXERCISE	10 page Instructor Guide		2	.2	.3	.5	.2	2.5		10	2.5
	5 page Evaluation Checklist		1	.2	.3	.5	.2	1			
	5 page Student Worksheet		1	.2	.3	.5	.2	1		5	1
A/C FLIGHT EXERCISE	10 page Instructor Guide		2	.2	.3	.5	.2	2.5		10	2.5
	5 page Evaluation Checklist		1	.2	.3	.5	.2	1			
	5 page Student Worksheet		1	.2	.3	.5	.2	1		5	1

TABLE D-1. BASIC DATA USED TO CALCULATE DEVELOPMENT COSTS (CONTINUED)

Photographer	TV Director	Printer	RAW MATERIALS PER LESSON: Paper & Materials	RAW MATERIALS PER LESSON: Film & Materials	REQUIRED SERVICES PER LESSON: Audio Processing ($ per tape)	Videotaping ($ per tape)		DUPLICATION SERVICES REQUIRED: Audio-Tape Duplication ($ per tape)	Videotape Duplication ($ per tape)	Slide Duplication ($ per slide)
		2	$ 23.00							
		3	37.00							
2.5				$ 20.00						$ 1.00
10		8	92.00	100.00						
40				243.00						.15
					$ 9.45			$ 2.50		
4		4	46.00	45.00						
80				486.00						.15
8		8	92.00	90.00						
2	2					$ 48.00			$ 25.00	
2		2	23.00	23.00						
4		4	46.00	45.00						
		1.5	23.00							
2		2	23.00	23.00						
4		4	46.00	45.00						
		1.5	23.00							
2		2.0	23.00	23.00						

The personnel hours shown in Table D-1 were converted to estimated "loaded" salaries in Tables D-2 through D-7. The Approximate Hourly Rate contains the estimated additions for overhead, G&A (General and Administrative) and profit fees. Tables D-2 through D-7 show the estimated costs, by media, for production of the lessons in the F-4 pilot and RIO syllabi.

Materials and services are indicated in Tables D-2 through D-7 using dollar amounts. The Development Total represents the cost for one reproducible master of finished lesson materials for the given medium. Duplication costs were not estimated since duplication will be carried out by the government.

A survey of available training assets (equipment) conducted during Media Selection and shown in Table D-8, indicates that there is adequate equipment for display of Videotape and adequate simulator/trainer and aircraft availabilities. However, there is a requirement for slide/tape machines. Additionally, it has been determined that MCAS, El Toro and NAS, North Island have adequate Videotape capabilities as well as reproduction capabilities that could be utilized during the development effort. Further research determined that Code N-51, Navy Education and Training Support Center, Pacific has facilities for duplication of 35mm slides. Tasking and scheduling would be required through Code N-4, CNET. Duplication of paper materials could be accomplished through the Navy Publication and Printing Service and tasked through OPTAR. No specific in-service organization appeared to have a total development crew that could be made available for full F-4 training development. It is recommended that the production of all original materials be contracted and that duplication of the originals be done by the government.

The equipment required for development are those items associated with a full graphics and photography capability and include: cameras, lay-up tables, back-light table, photo-copiers, slide/tape machine, audio pulsing and recording machines, etc.

TABLE D-2. COSTS FOR PRODUCTION OF MEDIATED INTERACTIVE LECTURES

PERSONNEL	HOURLY RATE	HOURS PER LESSON TABLE 3	$ PER LESSON
SME/AUTHOR		(15)	
I.P./PROGRAM MGR.	$30.00	1	$ 30.00
I.T./DESIGNER	22.00	3.5	77.00
PRODUCTION MGR.	30.00	2	60.00
EDITOR/PROOF	18.00	3	54.00
TYPIST/COMP.	10.00	3	30.00
NARRATOR	70.00		
GRAPHICS SPEC.	22.00	32.5	715.00
PASTE-UP ARTIST	12.00	2.5	30.00
PHOTOGRAPHER	19.00	2.5	47.50
T.V. DIRECTOR	25.00		
PRINTER	12.00	5	60.00
PERSONNEL TOTAL		55.0	$1103.50
MATERIALS/SERVICES			60.00
DEVELOP. TOTAL			$1163.50

TABLE D-3. COSTS FOR PRODUCTION OF WORKBOOKS

PERSONNEL	HOURLY RATE	HOURS PER LESSON (TABLE 3)	$ PER LESSON
SME/AUTHOR		(30)	
I.P./PROGRAM MGR.	$30.00	1	$ 30.00
I.T./DESIGNER	22.00	4	88.00
PRODUCTION MGR.	30.00	1	30.00
EDITOR/PROOF	18.00	5	90.00
TYPIST/COMP.	10.00	5	50.00
NARRATOR	70.00		
GRAPHICS SPEC.	22.00	20	440.00
PASTE-UP ARTIST	12.00	1.2	14.40
PHOTOGRAPHER	19.00	10	190.00
T.V. DIRECTOR	25.00		
PRINTER	12.00	8	96.00
PERSONNEL TOTAL		55.2	$1028.40
MATERIALS/SERVICES			192.00
DEVELOP. TOTAL			$1220.40

TABLE D-4. COSTS FOR PRODUCTION OF SLIDE-TAPES

PERSONNEL	HOURLY RATE	HOURS PER LESSON (TABLE 3)	$ PER LESSON
SME/AUTHOR		(39.6)	
I.P./PROGRAM MGR.	$30.00	4	$ 120.00
I.T./DESIGNER	22.00	14	308.00
PRODUCTION MGR.	30.00	11	330.00
EDITOR/PROOF	18.00	4	72.00
TYPIST/COMP.	10.00	8	80.00
NARRATOR	70.00	1.5	105.00
GRAPHICS SPEC.	22.00	90	1980.00
PASTE-UP ARTIST	12.00	7.5	90.00
PHOTOGRAPHER	19.00	44	836.00
T.V. DIRECTOR	25.00		
PRINTER	12.00	4	48.00
PERSONNEL TOTAL		184	$3969.00
MATERIALS/SERVICES			334.00
DEVELOP. TOTAL			$4303.00

TABLE D-5. COSTS FOR PRODUCTION OF VIDEOTAPE

PERSONNEL	HOURLY RATE	HOURS PER LESSON (TABLE 3)	$ PER LESSON
SME/AUTHOR		(32)	
I.P./PROGRAM MGR.	$30.00	1.5	$ 45.00
I.T./DESIGNER	22.00	6	132.00
PRODUCTION MGR.	30.00	2.5	75.00
EDITOR/PROOF	18.00	3	54.00
TYPIST/COMP.	10.00	4	40.00
NARRATOR	70.00	2	140.00
GRAPHICS SPEC.	22.00	45	990.00
PASTE-UP ARTIST	12.00	1	12.00
PHOTOGRAPHER	19.00	4	76.00
T.V. DIRECTOR	25.00	2	50.00
PRINTER	12.00	2	24.00
PERSONNEL TOTAL		73	$1638.00
MATERIALS/SERVICES			92.00
DEVELOP. TOTAL			$1730.00

TABLE D-6. COSTS FOR PRODUCTION OF TRAINER/SIMULATOR MATERIALS

PERSONNEL	HOURLY RATE	HOURS PER LESSON (TABLE 3)	$ PER LESSON
SME/AUTHOR		(4)	
I.P./PROGRAM MGR.	$30.00	.6	$ 18.00
I.T./DESIGNER	22.00	.9	19.80
PRODUCTION MGR.	30.00	1.5	45.00
EDITOR/PROOF	18.00	.6	10.80
TYPIST/COMP.	10.00	4.5	45.00
NARRATOR	70.00		
GRAPHICS SPEC.	22.00	3	66.00
PASTE-UP ARTIST	12.00	.5	6.00
PHOTOGRAPHER	19.00	2	38.00
T.V. DIRECTOR	25.00		
PRINTER	12.00	7.5	90.00
PERSONNEL TOTAL		21.1	$338.60
MATERIALS/SERVICES		(Guides, Check-lists & Worksheets)	115.00
DEVELOP. TOTAL			$453.60

TABLE D-7. COSTS FOR PRODUCTION OF CHECKLISTS AND WORKSHEETS FOR FLIGHTS

PERSONNEL	HOURLY RATE	HOURS PER LESSON (TABLE 3)	$ PER LESSON
SME/AUTHOR		(4)	
I.P./PROGRAM MGR.	$30.00	.6	$ 18.00
I.T./DESIGNER	22.00	.9	19.80
PRODUCTION MGR.	30.00	1.5	45.00
EDITOR/PROOF	18.00	.6	10.80
TYPIST/COMP.	10.00	4.5	45.00
NARRATOR	70.00		
GRAPHICS SPEC.	22.00	3	66.00
PASTE-UP ARTIST	12.00	.5	6.00
PHOTOGRAPHER	19.00	2	38.00
T.V. DIRECTOR	25.00		
PRINTER	12.00	7.5	90.00
PERSONNEL TOTAL		21.1	$338.60
MATERIALS/SERVICES			115.00
DEVELOP. TOTAL			$453.60

TABLE D-8 . SURVEY OF AVAILABLE TRAINING ASSETS - June 1977

AIR STATIONS	TRAINERS AND MEDIA EQUIPMENT															
	2F88	2F55	15C4	J 2C17	N 2C30	SLIDE PROJ.	MOVIE PROJ.	TAPE REC	FILM STRIP PROJ.	VIDEO TAPE	ECM SUIT. TRANR	OPAQ PROJ	SYNC	TV MON	OVRD PROJ	ACM PROC. TRANR 2C37
El Toro	0	1	1	0	0	27	47	12	0	5	2	2	0	14	7	0
Beaufort	0	1	1	1	0	12	29	8	1	2	1	7	3	2	20	0
Yuma	1	0	1	1	0	11	14	10	3	4	1	4	2	4	8	0
Kaneohi	0	1	1	1	0	34	47	13	1	0	0	6	0	0	12	0
Iwakuni	0	0	1	0	0	10	62	4	0	0	3	4	3	0	8	0
Miramar	1	0	1	1	0	75	106	58	4	1	3	16	0	1	36	1
Oceana	1	0	1	1	0	58	84	53	0	23	3	6	0	25	26	1
Dallas	0	1	1	0	1	12	32	13	1	0	2	6	0	0	14	0
Andrews	0	0	1	0	1	1	2	6	0	2	0	1	0	2	1	0

It is expected that the contracted development company will provide the required equipment.

Facility requirements for development would include sufficient space for camera lay-up (8' x 10'), sound-proof recording (6' x 6'), and for graphic equipment (10' x 20'). Attendant tables, desks and chairs would also be required if on-site production was indicated. The facility should be sufficiently large to allow for heat dissipation from camera lights and to prevent unnecessary noise interference when recording.

Facilities currently being used by the ISD team at MCAS, Yuma will provide sufficient space for materials production. These include two 12 x 10 offices for contractor personnel and two 11 x 11 offices for SME's. Graphics and photographic activities can be housed in a large 24 x 24 room. In addition, a 21 x 10 and a 12 x 11 room can be used as needed by production personnel. All rooms are well-lighted and have sufficient electrical power to support production efforts. A sound-proof recording facility is not available on-site. This facility may be supplied by the narrator if he is a professional with access to a recording facility, or in-service facilities at MCAS, El Toro and/or NAS, North Island may be used. A dark room is available at MCAS, Yuma. Its availability for contractor use could not be determined.

IMPLEMENTATION REQUIREMENTS.

It is estimated that a maximum of 30 instructors will be required to handle a student load of 60 pilots and 60 RIO's per year in a FRS. This estimate is derived from a maximum requirement of 16 flights per day with a different instructor for each flight, and 2 instructors per day for each of the three simulators, the learning center, and the Air Combat Maneuver Range (ACMR). This totals to a maximum of 26 instructors available and allows approximately 15 percent for leave, TAD, etc., thus yielding 30 instructors assigned. It is estimated that each instructor will be available four to six hours per day.

Other personnel requirements such as scheduling. counseling, proctor/monitoring, general administration, and evaluation can be met by the 30 assigned instructors. In addition, a minimum of two enlisted personnel will be required to distribute materials, maintain student records, and service learning center equipment.

The primary equipment required for implementation at each FRS will be audio-visual carrels in which the slide-tape lessons will be presented. A minimum of eight carrels will be required at each FRS. Existing videotape equipment at the three FRS's can be used for the videotape lessons.

Each operational and reserve squadron provided with course materials will require one functioning audio-visual carrel plus one spare. If feasible a complete, centralized learning center may be set up at locations having more than one squadron.

Equipment costs to set up learning centers at the three FRS's are summarized in Table D-9. The current costs are based on GSA prices; the projected costs include a 10 percent inflation factor to account for price increases prior to equipment purchase. The quantity of ST carrels required is eight per FRS with two additional cassette players and projectors per FRS included as on-line spares.

It is recommended that two complete ST carrels be procured for each user squadron rather than one complete carrel plus on-line spares. One operational carrel will supply the training needs of each squadron.

The learning center at each FRS should contain approximately 350-400 square feet to accommodate the carrels, an instructor station, and to allow free movement around the carrels. A separate, but preferably adjoining room will house the lesson materials and will be used for storage and check in and out of materials. This room should be secure to allow for storage of classified materials. It should be a minimum of 100 square feet and contain 200 feet

TABLE D-9. COSTS OF LEARNING CENTER EQUIPMENT FOR THREE FSRs

EQUIPMENT	CURRENT COST	PROJECTED COST (w/inflation)	QUANTITY	TOTAL
ST Carrel	$142	$156	24 (8/FRS)	$ 3,744
Howe TESS carrel	150	165	30 (10/FRS)	4,950
Ecktographic AF-1 or AF-2 projector				
Telex C-140 Cassette tape player	319	351	30 (10/FRS)	10,530
Rear projection module	72	79	24 (8/FRS)	1,896
RAS Carrel				
Howe TESS carrel	142	156	3 (1/FRS)	468
Kodak RA-960 projector	730	803	6 (2/FRS)	4,818
Carrel (for W/B lessons)	142	156	3 (1/FRS)	468
				$26,874

of shelf space for materials' storage. A classroom capable of seating 10-15 students will be needed for lectures and periodic class meetings. Approximately eight briefing rooms will be required for flight briefings. Space for briefings prior to simulator lessons will also be required.

Facilities requirements at other squadrons will be minimum since there will be no more than two carrels and storage space for one set of materials per squadron. Approximately 150 square feet will be required. Materials can be stored in a secure cabinet in this space.

A preliminary survey to determine the availability of facilities at the three FRS's indicated that the required space is available. Specific rooms to be used for the learning centers could not be identified. Based on the general characteristics of rooms that may be converted to learning centers, it is estimated that the following modifications will be required: (1) installation of carpeting in the 350-400 square foot learning center: (2) additional electrical power to provide the 4000-4500 watts required when all carrels are in use: (3) installation of shelves or the procurement of cabinets to provide materials storage space. Classroom and briefing facilities were judged to be sufficient at all FRSs.

FIVE YEAR EVALUATION AND MAINTENANCE

This phase of the ISD effort is concerned with program revision and maintenance requirements. After the training program has been implemented and evaluated, there will be first year revision requirements. During the first year, many revisions will occur and be integrated into the training program. This requires more support personnel during the first year of a five year evaluation and maintenance effort than for the last four years.

Total requirements for first year revisions and quality control activities were determined by multiplying the personnel, materials, and services directly tied to courseware development and production by .35. Annual requirements for the next four years were determined by applying a factor of .20.

RECOMMENDATIONS

It is recognized that the TSRA results have indicated a costly development program for the F-4 Pilot and RIO courses. The estimated manhour requirements are believed to be very accurate for those personnel shown. The dollar amounts approximated for the development personnel are those that a normal, well-skilled professional organization would charge. However, not all organizations utilize the same overhead rate, nor do all organizations have personnel skilled in segregated professions. That is, the Instructional Technologist may also be the Program Manager, the Production Manager may also be the proof reader, and the paste-up artist may be the graphics specialist or photographer. The most obvious cost area is the graphic specialist and photographer in the slide-tape lesson area; however, they are required specialists. It is suggested that, in other areas, personnel who are multi-talented be considered acceptable specialists and that the delineation of personnel categories by title not be utilized in the acquisition of a development team. In some cases, a SME could be utilized for production management or for paste-up work.

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