AD-A093 767 VEDA INC ARLINGTON VA F/G 5/9

F-14 INSTRUCTIONAL SYSTEM DEVELOPMENT PROGRAM.(U)

NOV 80 R R GEARY, F H BRECKE N61339-78-C-0004

UNCLASSIFIED VEDA-53247-80U/P0025 NAVTRAEQUIPC-78-C-0004-1 NL

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REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: NAVTRAEQUIPCEN 78-C-0004-1	2. GOVT ACCESSION NO. AD-A093767
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): F-14 INSTRUCTIONAL SYSTEM DEVELOPMENT PROGRAM.	5. TYPE OF REPORT & PERIOD COVERED: Final Report for period August 1977 — September 1980
	6. PERFORMING ORG. REPORT NUMBER: VEDA-53247-80U/P0025
7. AUTHOR(s): ROBERT R. GEARY, FRITZ H. BRECKE	8. CONTRACT OR GRANT NUMBER(s): N61339-78-C-0004
9. PERFORMING ORGANIZATION NAME AND ADDRESS: VEDA INCORPORATED, 1755 Jefferson Davis Hwy., #708, Arlington, Virginia 22202	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: NAVTRAEQUIPCEN Task No. 6065P8
11. CONTROLLING OFFICE NAME AND ADDRESS: NAVAL TRAINING EQUIPMENT CENTER, Orlando, Florida 32813	12. REPORT DATE: November 1980
	13. NUMBER OF PAGES: 133
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): UNCLASSIFIED
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Program Goals	Support Requirements
Aircrew Training Program Development	Student Course Materials
Learning Objectives Hierarchies	Implementation
Student Syllabus Creation	Quality Control
Media Selection Algorithm	Methodology

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The F-14 Aircrew Instructional Systems Development project consisted of a complete revision of a training system using MIL-T-29053, Training Requirements for Aviation Weapon Systems. This project was the first large scale application and validation of the Military Specification.

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20. Continued

The project consisted of a complete redesign of the F-14 pilot and Naval Flight Officer training syllabi. Starting with an existing task listing, learning objectives were developed and organized into prerequisite hierarchies. These learning objectives were then segregated and grouped to form the training events of the syllabi.

A delivery system was defined on the basis of an in-depth training support requirements analysis. The delivery system was based exclusively on already existing media resources and optimized the use of instructor time by reducing instructor involvement in academics and increasing the amount of simulator training.

The lesson specification as an intermediate step between syllabus event definition and course material production proved to be an efficient design step.

The project resulted in an up-to-date training system designed specifically to meet the unique requirements of the two user squadrons and capable of being maintained by those squadrons. The project also demonstrated the basic validity of the military specification and the corresponding data item descriptions. Several recommendations were made and subsequently incorporated in these regulatory documents.

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SUMMARY

The F-14 Instructional System Development (ISD) project had two major goals. The first goal was to revise the existing F-14 aircrew training system at the Fleet Readiness Squadron (FRS) level. This effort was intended not only to update the content of the FRS training syllabus but also to ensure that a system was designed which was capable of self maintenance. The second major goal of this project was to validate the newly developed military specification (MIL-T-29053) and its accompanying data item descriptions (DID's). This project was the first large scale application of the instructional philosophies and technology described in the Military Specification.

Prior to the start of this project, a task analysis resulting in a listing of all the tasks performed by F-14 pilots and Naval Flight Officers (NFO's) had been completed. This task listing was the basis for the project and the starting point of the ISD process. From this task listing, a group of learning objectives was developed which described all the behaviors, conditions and standards which a student aircrew needed to satisfy in order to achieve the desired training results. The objectives were segregated and grouped into lessons which comprised the events of the training syllabus.

One of the most significant tasks performed as a part of this project was the Training Support Requirements Analysis (TSRA). This task analyzed the existing training system to determine the strong points and deficiencies. The TSRA went on to predict the future resource requirements of the FRS's. Based upon this prediction, the revised training system was designed such that the syllabi were tailored to those resources expected to be available.

Work on this project was performed primarily at VF-124, NAS Miramar, CA. A continuous interface was maintained with the east coast FRS, VF-101 at NAS Oceana, VA. The initial intent in this project was to use the Subject Matter Experts (SME's) at VF-124 and VF-101 to perform a large portion of the lesson development and verification tasks. This proved to be an unachievable goal due to the limited SME availability resulting from a shortage of instructors (SME's) at both squadrons. This problem of limited SME availability has occurred consistently in other projects as well as this one and can be anticipated to continue to occur as long as the Navy suffers from its chronic manpower shortages.

This project resulted in the development of revised training syllabi tailored to the specific needs and capabilities of VF-124 and VF-101. The training syllabi are now objective based and provide maximum utility and efficiency in the use of available resources. Organizational changes which provided increased emphasis on aircrew training have been implemented within the Operations Departments at the FRS's. This reorganization also allows the performance of the quality control processes which are essential in maintaining the quality and efficiency of the training syllabi. As of the date of this report, the revised training system is in operation at both FRS's and contractor support has been terminated.

PREFACE

The Naval Training Equipment Center has a continuing interest in the use and evaluation of state-of-the-art procedures and methodologies in the design and development of training programs. Recent interest has centered on the systems approach to training now referred to as Instructional Systems Development (ISD). The effort discussed in this report concerns the application of the ISD process to the development, implementation, evaluation and revision of F-14A fighter (MAS) and reconnaissance (TARPS) aircrew training programs. The project, begun in AUG 1977, was conducted by the Naval Training Equipment Center for the Naval Air Systems Command; the work was performed by Veda, Inc. under contract N61339-78-C-0004.

The operational objectives of the project were to design an aircrew training program that would permit update as weapons system hardware is modified, and to develop and evaluate the program using the ISD process. The research and development objectives were to gain experience in the use of MIL-T-29053 and associated DID's and to acquire resource utilization data for future ISD planning and acquisition.

Special appreciation is expressed to those personnel of VF-124, VF-101, COMNAVAIRPAC, COMNAVAIRLANT, COMFITAEWWINGPAC and COMFITWING ONE who made significant contributions to this project.

Robert G. Bird

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Acquisition Director

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SECTION I

INTRODUCTION

PURPOSE

The goal of the F-14 Instructional System Development (ISD) project was to improve the existing aircrew training syllabus in use at the F-14 Fleet Readiness Squadrons (FRS). As stated in the Program Master Plan (PMP), the objective of the F-14 ISD project was to develop, produce and implement a new aircrew training program which:

a. is instructionally effective as measured by criterion reference measures of student performance,

b. is efficient in terms of resource consumption,

c. can be adequately supported over its life cycle, and

d. continuously meets training objectives.

The F-14 training program redesign was to be accomplished through the application of the ISD methodologies specified in MIL-T-29053, "Training Requirements for Aviation Weapon Systems". MIL-T-29053, dated October, 1977 and henceforth referred to as the military specification, represented the most current document designed to standardize the processes and products of aircrew training ISD for the Navy. This project was the first full scale training development project governed entirely by this specification. A second purpose of this project was therefore practical validation of the new military specification.

Specifically, this project was intended to make the F-14 syllabus a more efficient and effective instrument. The F-14 is one of the most complex and sophisticated fighters ever procured. The two man crew, the Pilot and the Naval Flight Officer (NFO), are responsible for the operation of an aircraft with more air-to-air and air-to-ground capability than has ever been available before in one single airplane. For the first time a true division of responsibility and labor existed between the two cockpits.

This division of responsibility led to the need for partially separate training syllabi for the pilot and the NFO. The number and variety of operational tasks to be mastered by the aircrew and the high and constant aircrew replacement demands required syllabi capable of transmitting an immense amount of knowledge in a fairly limited amount of time. To accomplish this demanding training task a carefully and systematically designed training system was needed; a training system capable of training each crew member individually and a crew jointly with an optimum of efficiency.

The characteristics of the F-14 also demanded a training system that could be easily updated. The AWG-9 weapon system, incorporated in the F-14, can be changed merely by modifying the computer program.

This computer program can be loaded into the aircraft in a matter of hours. This capability, while yielding immense benefits in terms of cost and tactical adaptability, creates a significant problem in the training system. A syllabus and a management system which can effectively integrate new information in a very short time was required.

SCOPE

The F-14 ISD project involved the analysis and revision of the entire F-14 training syllabus. There were no sections of the syllabus which were a priori defined as unchangeable. While this approach undoubtedly increased the total effort, it certainly contributed to the homogeneity of the end product. Integration of existing materials with new materials is always problematic due to disparities in quality and methodology between the existing and new portions of the syllabus.

The scope of revising the existing F-14 syllabus can best be characterized by some numerical values. Overall length of the syllabus prior to this project was 26 weeks. The syllabus consisted of approximately 250 events for the pilot and 240 events for the NFO. When expressed in terms of hours of instruction, the syllabus contained approximately 417 hours for Category I pilots and 390 hours for Category I NFOs if briefings and debriefings are included as instructional time. The precise tabulation is found in Table 1.

Table 1: Syllabus Length (Old Syllabus)

	VF-124		VF-101	
	Pilot	NFO	Pilot	NFO
Number of Syllabus Events	247	239	250	243
Hours of Instruction (including briefings and debriefings)	417	386	417	394
Hours of Instruction (excluding briefings and debriefings)	304	293	299	292

This syllabus was subdivided into six phases which were commonly taught in the following sequence:

1. Transition
2. Basic Fleet Air Superiority
3. Weapons
4. Advanced Tactics
5. Advanced Fleet Superiority
6. Field Carrier Landing Practice and Carrier Qualification

Student throughput was 200 - 210 students per year, approximately equally divided between pilots and NFOs. This student load was divided between the two FRS squadrons such that VF-124 carried approximately 60% of the training load and VF-101 40%.

The two FRS's have slightly different syllabi with 80-90% similarity. In this project standardization of the syllabi between squadrons was desired but not absolutely required. Priority was given to satisfying the needs of either squadron, i.e., the scope of the project included the possibility of training program portions unique to each squadron.

Finally, the scope of this project increased over time. In 1978, additional ISD needs were generated by introduction of the RF-14 with its Tactical Air Reconnaissance Pod System (TARPS). The training requirements for the system were extensive and eventually resulted in a syllabus addition of 46 events.

While the numerical values above give some indication of the scope of the project, the depth of the work can perhaps best be described by the starting and end point. The redesign of the F-14 course started at the very basis, i.e., it began with a task analysis. This task analysis however, was part of preceding efforts sponsored by COMNAVAIRSYSCOM. The present project built on this task analysis and began with the development of an objectives hierarchy. The end point of the project was implementation of the course at both squadrons. Implementation consisted essentially of one course administration to one regular class at either squadron and of support in executing the revisions indicated by these two full scale tryouts. Between objectives hierarchy and implementation, all processes specified in the military specification were executed and all products described by the corresponding data item descriptions were delivered.

SECTION II

BACKGROUND

REQUIREMENTS

The F-14 ISD program was the second phase of a continuing revision of the F-14 FRS aircrew training program. This revision process began in 1974 with the analytic portions of the ISD process. The initial contract required completion of task listings, learning objectives hierarchies, student syllabi, and lesson specification documents. All work on this contract was completed by January 1977.

In January 1977, the Naval Training Equipment Center (NAVTRAEQUIPCEN) was designated COMNAVAIRSYSCOM agent to execute the development of the F-14 Aircrew ISD program. In a review of the previously delivered documents, NAVTRAEQUIPCEN identified several areas which required additional effort to bring them into conformance with the newly-developed Fleet Aviation ISD Model for Existing Weapons Systems at the lesson specification level of development. Additionally, NAVTRAEQUIPCEN was to conduct a problem analysis to determine program goals, assets and constraints.

The problem analysis was conducted and served as a basis for preparation of the continuation program. It also acted as the basis for the development of the F-14 ISD Program Master Plan (PMP) which was published in August, 1977, and revised in MAR, 1979. The purpose of the PMP was to coordinate continuation of the F-14 ISD program, ensuring that all technical, logistical, and managerial requirements for the program had been addressed in proper sequence and that roles and responsibilities had been defined.

Work on the project described in this report began in August, 1977. As mentioned previously, this contract was governed by the MIL-T-29053 which was published in October, 1977. The work performed between the start of the contract and the receipt of the Military Specification was based on preliminary copies of this document and on continuous assistance and guidance by NAVTRAEQUIPCEN.

ASSUMPTIONS

INSTRUCTIONAL.

The instructor workload could be reduced if a greater proportion of the syllabus was self instructional. One of the anticipated outcomes of this ISD project was that the excessive workload of the FRS instructors could be reduced. Prior to this project, the primary mode of instruction was the interactive lecture. Instructor workload was further increased by the lack of accuracy or currentness of the existing audio/visual media. Most of the self-instructional events required a debriefing, which amounted to another lecture.

The effectiveness of instruction in flight could be increased by increasing the proportion of training in the training devices. The ratio of instruction in the trainers to that in the aircraft was between 1:2.5-3 prior to this project. It was assumed that the instruction received in the aircraft could be greatly improved by increased preparation in the training devices.

More relevant training could be obtained by deemphasizing procedural drills and by adding explicit instruction in the area of decision making skills. Prior to this project, the training syllabus required a great deal of rote memorization of facts and procedures. This was especially evident in the BOLDFACE emergency procedures. One of the goals of this project was to add to the instruction the rationale behind these procedures. It was assumed that the correct performance of procedures could be improved if the student understood why the procedures were performed.

The pilots and NFO's had very similar but not identical training needs. In the existing training system the pilots and NFO's progressed together through one syllabus. One of the primary goals of this project was the development of a truly efficient training system which was also effective. This required that the essential areas of training be emphasized and the non-essential deemphasized. In that the essential information differed for the pilot and NFO, separate but similar syllabi were developed for the pilot and NFO.

Front-end-loading could be reduced. The first phase, transition, showed a very high preponderance of academic instruction and relatively little trainer and flight instruction. This is commonly referred to as "front-end-loading a syllabus". A certain amount of this front-end-loading cannot be avoided when dealing with single stick airplanes such as the F-14. Safety considerations dictate that the pilot acquire a great deal of knowledge on the ground before he can safely operate the aircraft. The same is not true for the NFO, therefore, it appeared that the pilot and NFO did not require the same degree of front-end-loading in the syllabus.

Subject matter could be restricted to what the crew can either perceive or control, or both. The existing training syllabus spent a considerable amount of time teaching theories of operation and detailed functioning of mechanical systems. In a program involving a system as complex as the F-14, efficiency cannot be achieved unless the focus of training is oriented to crew, i.e., how do I operate it?, vice how does it function?

The instructional resources which existed within VF-124 and VF-101 were to be utilized as much as possible during the development of the revised syllabi. It was hoped that many of the instructional events, particularly the more expensive slide/tape presentations, could be used in the new syllabi. However, it was clearly delineated that no event or phase of the syllabus was considered "sacred". The ISD methodology was to be prosecuted and existing resources were not to be a hindrance in this effort.

The need for a continuous output of graduates from the FRS's would continue throughout this contract including the period of implementation. It was not deemed feasible to shut off the input of students or the output of graduates. The needs of the operational squadrons could not be altered due to the syllabus revision effort. An implementation plan was, therefore, required to ensure that the new syllabus could be placed in operation without disrupting the flow of graduates.

The training goals could be achieved with a syllabus not exceeding 26 weeks in length. Based on experience with the old syllabus the FRS training goals could be reached within 26 weeks given good resource availability and fair weather. This 26 week limit was not to be exceeded by the new syllabus. If application of the ISD process could lead to a syllabus of less than 26 weeks in length, no objections would be raised. However, due to numerous factors such as the availability of students and the need for regular replacements in the fleet, a limit of 26 weeks was set. This was the length of the syllabus which existed prior to this revision effort.

TECHNOLOGICAL.

The ISD technology described in the military specification and associated DID's was sufficient, but in need of validation. It was assumed at the time that the military specification and the DID's were sufficient in detail to perform all the tasks requested. The content of the military specification was well known to the instructional designers working on this project. The ISD technology was up to date in every way. Still, this set of DID's and specification had not been validated in the actual performance of a full scale ISD project. The F-14 ISD project was one of several to provide that validation.

The existing task analysis was useable without rework. This task analysis had been done as part of a previous effort. An appraisal of this analysis was made and it was determined that it could be used without modification. The development of the learning objectives hierarchies was therefore the first task in this project.

The physical resources for performing training at the FRS's were sufficient. During the early stages of development of VF-124, decisions were made and implemented which resulted in the creation of a modern academic center. Classrooms and study carrels with modern audio visual equipment were procured and located in the building housing the F-14 training devices. This building was air-conditioned and away from the noise of the flight line. It provided a quiet, comfortable atmosphere conducive to study and learning. As a result of the success of the academic facility at VF-124, similar equipment was procured for VF-101.

The existing syllabus was supported by separate front and back seat simulators which could be linked for joint operation. These simulators were considered adequate for the new syllabus.

The Air Combat Maneuvering Range (ACMR) debriefing facility could provide valuable pretraining if used in a pro-active mode. The ACMR is a facility in which aircraft participating in simulated air combat are tracked via telemetry. This allows the simulated combat to be viewed from a ground facility on computerized display screens. The telemetry is also stored on tape for later viewing by the aircrews who engaged in the simulated combat. It was assumed that these tapes could provide training if used in a pro-active mode. In this scheme, students would observe selected tapes of previous engagements. At certain points the tape could be stopped and the students would be questioned as to the probable results of the various options available to the aircrews at that point. The tape could be restarted and the results of one possible decision could be examined. This would allow the crews to improve their decision making abilities in an inexpensive and efficient manner, not involving flight time expense.

MANAGEMENT.

The contractor was responsible for the design of the product. The DID's and military specification were to be used as guidance in the performance of all tasks. However, it was expected that some innovation would result from the performance of the project. Besides validating the DID's and military specification, it was hoped that the state-of-the-art in aircrew training would be advanced.

Navy SME's from VF-124 and VF-101, would support the project. The development of the training program was to be supported by Navy SME's with 80 hours per week as stated in the Program Master Plan. This support was to be coordinated by a full time SME team leader, the ISD officer. The tasks to be performed by the Navy SME's consisted of lesson specification development, review of lesson specifications developed by contractor SME's, and in formative evaluation of the training materials produced from those lesson specifications.

The overall coordination of the project was to be accomplished by a series of Fleet Steering Committee. The Fleet Steering Committee, chaired by VF-124, consisted of representatives from the type and wing commanders, and from VF-124 and VF-101 ISD departments. Personnel from NAVTRAEQUIPCEN and the two contractors involved in this project also attended the meetings.

The Automated Training Support System (ATSS), a computer assisted managment tool, would be available during this project. The primary functions anticipated to be performed by ATSS were scheduling and record keeping. The design of ATSS was to allow the input of the syllabus and the available resources, and provide an output of the daily academic,trainer and flight schedules. These schedules would be derived from the accomplishments of the previous schedules. Record keeping of individual student progress and achievement was a clerical function necessary to derive the new schedule.

CONSTRAINTS

Separate training syllabi, training philosophies and management organizations existed at VF-124 and VF-101. The syllabi which were developed differed for the two squadrons. Likewise, the management organizations and therefore the procedures for management differed slightly. The needs of both organizations had to be satisfied by the ISD effort.

Further, both the development and implementation of the revised syllabi had to be done on a non-interfering basis. The operations of the squadrons could not be suspended. The need for graduates on a regular basis would remain constant throughout the project.

There would be a maximum time limit of a 26 weeks for the syllabus. This time limit was established by CNO based upon pragmatic and historical factors. These included the need to input and graduate students based on their availability from the training command and the demands of the fleet. Historically, other fighter training syllabi (F-4 in particular) were accomplished in that same time period.

Major modifications to the training devices were not to be proposed as a part of this ISD effort. The result of this situation was that the syllabi had to be designed around the capabilities and limitations of these devices.

Student progress through the syllabus was to be in groups (classes) vice individually. Navy management desired to maintain the class structure which has historically existed in the FRS's. The contractor had proposed that the syllabus be designed for individual progress. However, the Navy preferred the retention of the class system because of the ease of management of small groups vice individuals, and the benefits of cooperation and competition among the class and between classes.

SECTION III

IMPLEMENTATION

ORGANIZATION

Figure 1 describes the commands and organizations involved with this project. The ultimate authority and responsibility for this project rested with the Chief of Naval Operations (CNO). The Fighter Training Branch (4132) of the Naval Air Systems Command (COMNAVAIRSYSCOM) acted as the procuring agency, i.e., the source of the funds. NAVTRAEQUIPCEN was designated as COMNAVAIRSYSCOM's agent to contract for and administer the project. On the military side, the chain of command extends from CNO to the type commanders (COMNAVAIRPAC and COMNAVAIRLANT), to the cognizant wing commanders (COMFITAEWWINGPAC and COMFITWINGONE) to the Fleet Readiness Squadrons (VF-124 and VF-101). The primary, or most frequently used, channel of communication was between NAVTRAEQUIPCEN and the two ISD officers at the FRS's.

In the implementation of this project, two separate contractors performed separate but related tasks. Veda, Inc. was contracted to perform the ISD project described herein, and Perspective Instructional Communications, Inc., a media production firm, was contracted to produce the audio-visual and printed materials based on lesson specifications developed by Veda. Some initial problems were encountered in this arrangement due to the lack of a contractual agreement specifying the responsibilities of the two contractors to each other. This problem was solved with a letter of agreement between the two contractors.

Figure 2 describes the relationship which existed during the performance of this contract. The contractor's General Manager and Technical Director were responsible to NAVTRAEQUIPCEN for the performance of all tasks. Their jobs included the direction and supervisions of the project manager and the generation of all reports and documentation required.

The project manager interfaced primarily with the ISD officers at VF-124 and VF-101. The project manager was responsible for the coordination of the contractors staff. In conjunction with the ISD officer, the project manager coordinated the efforts of his staff and the SME's supplied by the ISD officer. All work performed by the contractor was originated or performed by the project manager under the guidance and direction of his technical director and general manager.

This organizational relationship was found to be very effective. The working level personnel, the contractors staff and the Navy SME's interfaced with each other in generating the revised syllabus. The administrative and contractual interfaces were separated from

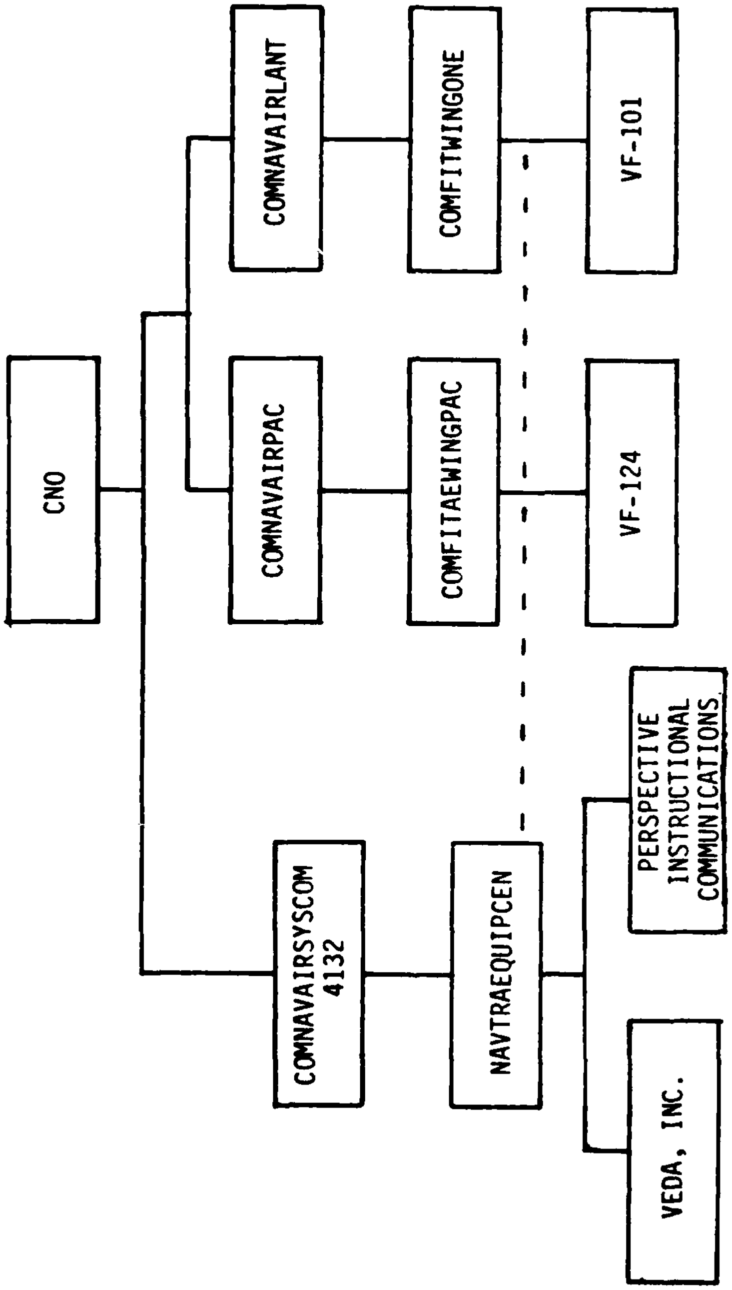


Figure 1. Project Organizations and Commands

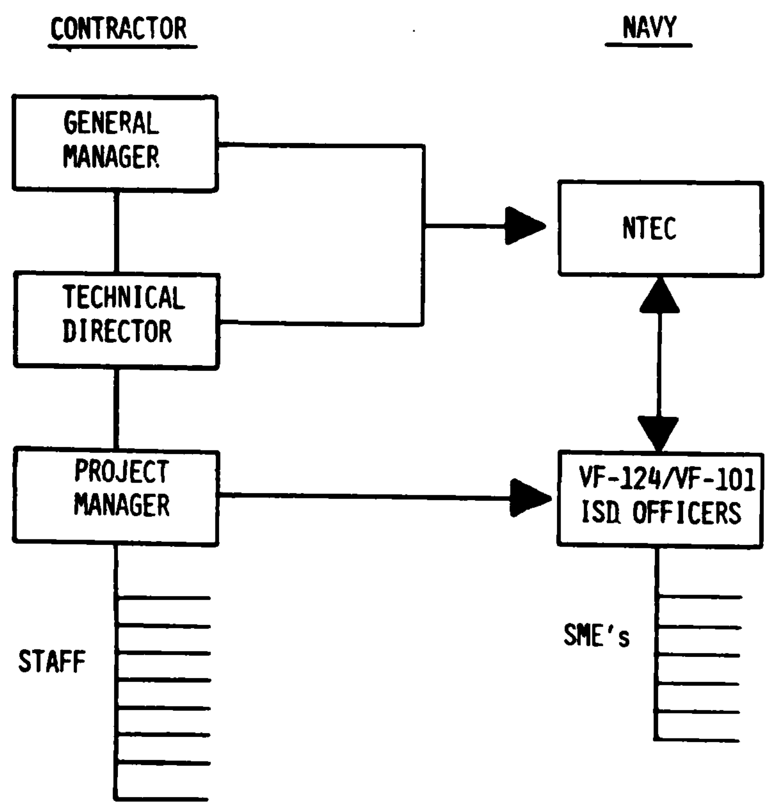


Figure 2. Management Relationships

this working environment and performed by the appropriate managers and contracting officers. It should be noted that at the beginning of this project the Technical Director and the Project Manager were, in fact, the same person. As the scope of the project, and thus the staff, increased a separate project manager was appointed.

The final organizational structure which should be discussed is that of the FRS's. This discussion will trace the changes which occurred in the organization of VF-124, the points of the discussion also pertain to VF-101.

At the beginning of this project the organization of VF-124 was almost identical to that of an operational fighter squadron. An operations officer, as a department head, was responsible for all flight operations and for all training. The maintenance officer, however, was responsible only for the maintenance of the squadron's aircraft. Training for fleet replacement maintenance personnel was performed by the Fleet Replacement Aviations Maintenance Personnel (FRAMP) department. The FRAMP officer was a department head with status equal to the Operations and Maintenance officers.

The contractor recommended that an organizational structure similar to the FRAMP structure be considered for aircrew training. Most significantly, the reorganization was to include an Aircrew Training Department on the same level as the Operations Department.

During the course of this project, a division of responsibility between the Training Department and the Operations Department was realized. The jobs of operating the squadrons aircraft and the overall management of the aircrews were separated from the jobs of developing and performing aircrew training. The organizational structure now in use at VF-124 is shown in Figure 3. It was decided by VF-124 that an Operations Officer would retain control over aircrew training, however, two sub-departments called TRAINING MANAGEMENT and TRAINING DEVELOPMENT/MODEL MANAGER, would functionally effect the operation of the department. The emphasis on the development and performance of training was achieved by this organizational structure.

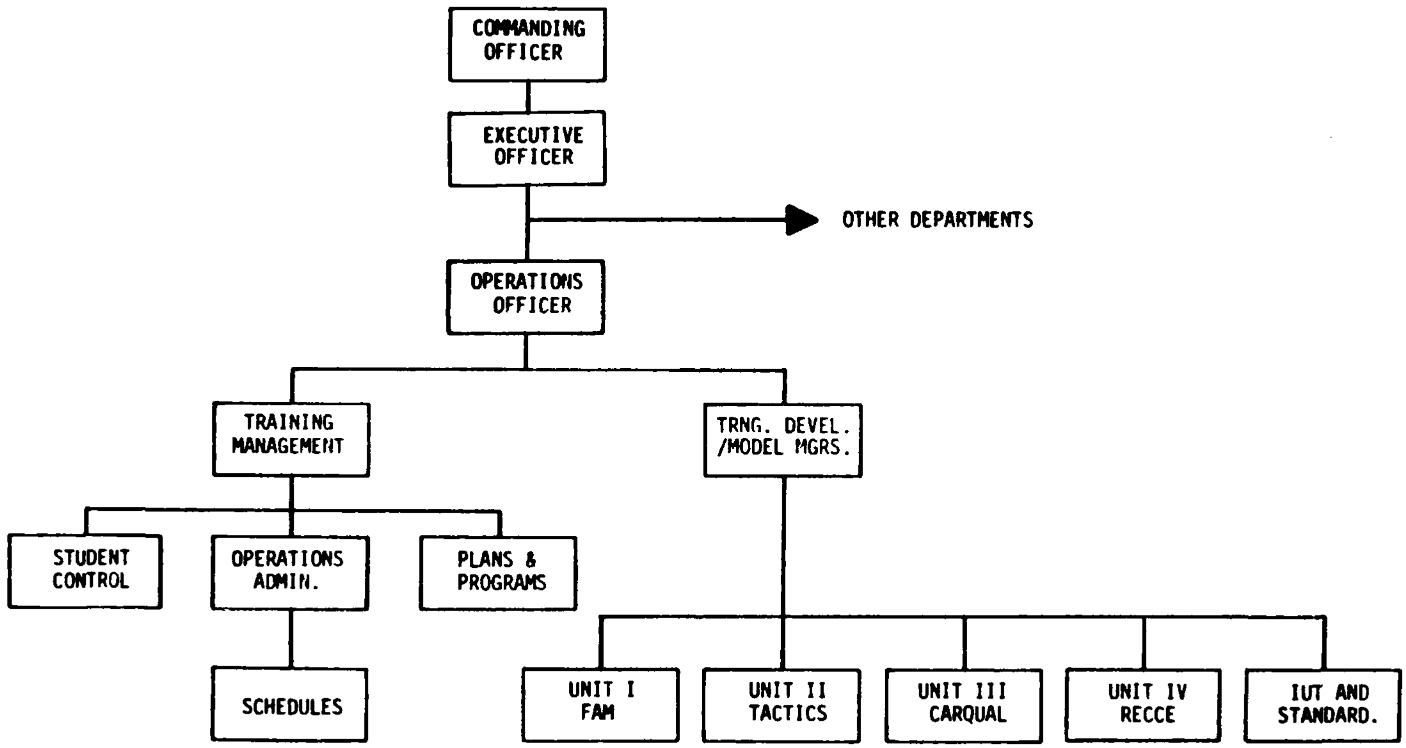


Figure 3. VF-124 Organization for Aircrew Training

STAFFING

The Veda staff was composed of an average of 9 persons during the course of this project. The staff included two PHD's who acted as instructional psychologists and provided the primary design and management of the instructional products. Assisting were 4 instructional designers with completed masters degrees in educational technology or psychology. The remainder of the staff acted as SME's. The staff expertise and experience varied. Most were former instructors from the F-14 FRS's. Their educational backgrounds ranged from bachelor to master degrees.

The combination of instructional design expertise with contractor SME's proved to be an ideal staffing method. The SME's, working full time with the instructional designers, gained valuable expertise in the field of ISD. The instructional designers were likewise able to gain knowledge in the fields of aviation and Navy aircrew training.

PROJECT TASKS

SUBJECT MATTER EXPERT (SME) TRAINING MATERIALS.

Duration of Task: November, 1977 - March, 1978
Mandays Expended:

Program Manager	8
Instructional Psychologist I	11
Instructional Psychologist II	59
Instructional Technologist I	0
Subject Matter Expert	5
Clerical	23
TOTAL.	106

Subject Matter Expert (SME) is a term which is generally accepted in the instructional design field as pertaining to those individuals who have extensive, first-hand knowledge of technical content. In the specific context of the F-14 training program, the subject matter experts were Navy instructor F-14 pilots and naval flight officers (NFO) from VF-124 and VF-101 who had current and intimate knowledge of the weapon system.

Navy SMEs were utilized during the F-14 training program design phase to provide information to the contractor's instructional designers and to ensure technical accuracy of the lesson materials. SME involvement was necessary in providing input to the lesson specification portion of the design phase and to the formative evaluation of lesson materials during development. Contractual arrangements were made for 80 hours of SME participation per week. Course materials were developed to provide the SMEs with a general, overall understanding of the training program design process, and, more specifically, the lesson specification and formative evaluation requirements. It was not desired that these subject matter experts become experienced instructional designers, but that they be capable of understanding the instructional systems development (ISD) process and their role in developing lesson specifications and in formative evaluation.

The process of developing the SME training materials consisted of six steps: (See Figure 4)

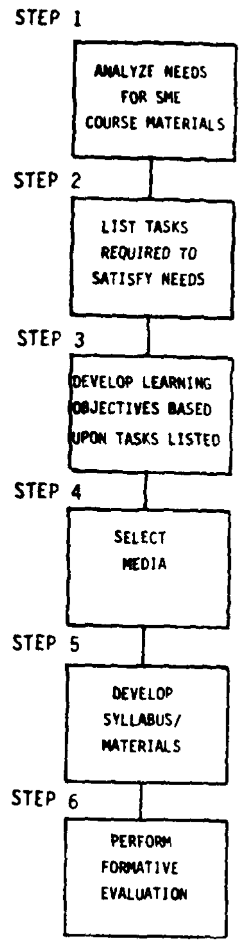


Figure 4. SME Training Materials Development Process

STEP 1. Analyze needs for SME course materials. The needs for the SME course materials were based upon the three requirements specified in the DID. Those requirements were that the SME's (1) have a overall understanding of the ISD process, (2) provide generality support, instance specifications and practice and test items, and (3) evaluate the course materials, aid in conducting small group tryouts and aid in data collection.

STEP 2. List the tasks required to satisfy the needs determined in Step 1. Contractor instructional technologists, surveyed the processes involved in accomplishing the requirements stated in Step 1. The end products or processes to be produced or performed were listed and analyzed to determine individual tasks. The tasks were then listed and associated with their corresponding requirements or goal.

Of the three requirements determined in Step 1, only two of the three had tasks associated with them. The tasks corresponding to the three goals are listed below.

Goal 1: Understand the meaning of the ISD process and its use for the F-14 training program.

Tasks corresponding to Goal 1:

No tasks.

Goal 2: Give appropriate subject matter input to the contractor provided lesson specifications.

Tasks corresponding to Goal 2:

1. Review contractor-supplied generalities.

2. Write support generalities for the generalities provided in the lesson specifications.

3. Write examples and non-examples for concept and rule-using generalities.

4. Provide common error analysis for concept and rule-using generalities.

5. Help contractor instructional designers in writing test items for each objective within each lesson.

Goal 3: Understand the meaning of formative evaluation and be able to give appropriate feedback in the one-to-one and small group tryouts.

Tasks corresponding to Goal 3:

1. Review lessons for content and technical accuracy.

2. Aid in the conduct of small group tryouts.

3. Serve as a subject in individual tryouts.

4. Administer tests.

5. Score tests.

STEP 3. Develop learning objectives based upon the tasks listed in Step 2. The SME objectives were derived from the task listing by asking the question, "What must the SME know in order to perform this task?". In the case of Goal 1, where there are no tasks, the procedure for defining the objectives directly from the goal is termed "operationalizing". This procedure is essentially the same as when deriving the objectives from tasks and asks the question, "What must the SME know in order to achieve this goal?". The following are examples of objectives which were determined in this manner:

A. The ISD Process

(1) Objectives

The SME will be able to list four major advantages of the ISD process of instructional design.

Given a list of ISD components and a list of possible definitions, the SME will be able to match all the components with their appropriate definition.

B. Lesson Specifications

(1) Objectives (examples)

Given an objective and corresponding generality, the SME will be able to recognize the appropriate generality support.

Given a concept or rule-using objective and generality, the SME will be able to identify the types of examples and non-examples.

C. Formative Evaluation

(1) Objectives (examples)

Given various alternatives, the SME will be able to recognize the types of information desired from an individual tryout.

Presented with lesson materials, the SME will be able to evaluate the materials for technical accuracy and completeness.

STEP 4: Select media. The selection of media for the SME course materials was based upon the following considerations: Who are the learners? What type of information is to be delivered? What method of delivery is most cost effective?

The learners were Navy instructors from VF-124 and VF-101 who worked long and varying hours. Since there was little time and few opportunities to conduct group training, and since there was a continuous turnover in the instructor corps, it was deemed necessary that the instruction be readily available at any time. Also, some of the SME's were located at VF-101 where there was little availability for interface with the contractor. The materials, therefore, had to be easily transferrable.

The types of information presented in the SME course materials were for the most part, facts, concepts and rules. This type of learning can be done without an instructor and with little or no visual display requirements.

With this in mind, the most cost effective method of mediation for SME course materials was clearly a print instrument, modularized, and packaged for individual use. The lessons for the SME course materials were identified and sequenced especially to be presented by print materials in an individualized package where the SME can work through as many or as few of the lessons or modules as he desires or has time for in a single sitting.

STEP 5: Develop the syllabus/materials. Syllabus development was accomplished by first grouping objectives into lessons. The rationale for grouping objectives was essentially one of conceptual relationships. In addition, certain learning principles were applied to the conceptual relationships of objectives in order to ensure their instructional compatibility. During this process the following questions were asked:

a. Does the set of objectives for this lesson represent a coherent unit?
b. Are all prerequisite objectives to the lesson noted?
c. Are there too many or too few objectives in the lesson?
d. Is the lesson too long or too short?

When the lessons were identified, they were then sequenced into the optimal order for instruction. This ordering was based on prerequisite information and logical relationships. More precisely, in the case of ordering the lessons for subject matter experts, the order in which each of the components occurs in the lesson specification provides some logic for sequencing. Even though the learner does not necessarily have to learn how to write a generality support before he learns how to develop an instance specifications, it seemed logical to have him learn the material in this sequence because one occurs before the other in the lesson specification.

STEP 6: Conduct formative evaluation of the SME training course materials. A formative review of SME course materials was conducted prior to final development. Completed lesson specifications were given to Navy SMEs for evaluation. Based on their understanding and feedback from these materials, the SME course was revised and produced.

The Subject Matter Expert training materials development task was one of the first performed as a part of this project. This was required because of the need for trained SME's during the lesson specification development phase. The SME's would later aid in the formative evaluation of the training materials. Timeliness was not an issue here.

The early development of SME training materials was essential for another reason unrelated to the performance of the various tasks. The first portion of the SME training materials that deals with the ISD process proved to be instrumental in "selling" the ISD philosophy to the instructor corps. If the enhancement of the existing training system was to be successful, it was essential that the support of the entire instructor corps be gained. A clear presentation of the goals and processes involved in the project proved to be successful in gaining that support.

An example of the SME training materials produced during this task can be found in Appendix A.

OBJECTIVES HIERARCHIES.

Duration of Task: August, 1977 - May, 1980
Mandays Expended:

Program Manager	76
Instructional Psychologist I	76
Instructional Psychologist II	137
Instructional Technologist I	46
Subject Matter Expert	59
Clerical	8
TOTAL	402

This section details two major processes concerning the learning objectives hierarchies. The first process, which occurred at the start of the project, converted the existing learning objectives hierarchies into the form and format specified by the new DID. The second process, which occurred following lesson specification development, created syllabus oriented learning objectives hierarchies.

The data base used for development of the learning objective hierarchies was the F-14 aircrew task inventory and the set of learning objectives which were in existence at the start of this project. This data base was developed using an interactive review procedure with Navy F-14 subject matter experts. Individual and group interviews were conducted to control the level of detail and ensure the technical accuracy of the product. Sixteen instructor aircrews from VF-124, VF-1, VF-2 and VX-4, as well as several VF-124 ISD personnel were consulted, incorporating an average subject matter expert experience level of 10 years military service and 2,000 flight hours.

Figure 5 outlines the methodology used for revision of the existing learning objective hierarchy behaviors, conditions and standards. This procedure ensured a high degree of quality control and is outlined in the following paragraphs. Special care was exercised not to omit any of the data previously documented during the revision of the original data.

<u>STEP 1. Select a first level objective from the existing hierarchy</u>. This analysis began at the top of the hierarchy, i.e., with the terminal or upper level objectives. It was essential that these objectives be the first to be verified since the remainder of the objectives were prerequisite to them.

<u>STEP 2. Is there a parallel NFO objective</u>? Two separate hierarchies were developed, one for the pilot and one for the NFO. These hierarchies, while different, contained many sections which were identical for the pilot and NFO. By looking for a parallel NFO, or PILOT, objective, the work of revising the objectives hierarchies could be substantially decreased by avoiding duplication.

<u>STEP 3. Work on both objectives together</u>. If a parallel objective existed, time was saved by working on both simultaneously.

<u>STEP 4. Check overall hierarchy rationale</u>. This procedure involved the analysis of a portion of the existing pilot and corresponding NFO hierarchies for validity of the overall rationale by asking the the following questions:

a. Are all necessary and sufficient prerequities objectives listed?

b. Can any nice-to-know prerequisities be eliminated?

c. Are all superordinate and subordinate, dependent and independent relationships correctly indicated?

This step ensured that all subtasks, skills and knowledge required to perform the first order tasks were included in the hierarchy. The aircrew task inventory was used for the identification of subordinate behaviors by providing an in-depth job description from which these requisite tasks, skills and knowledge were derived.

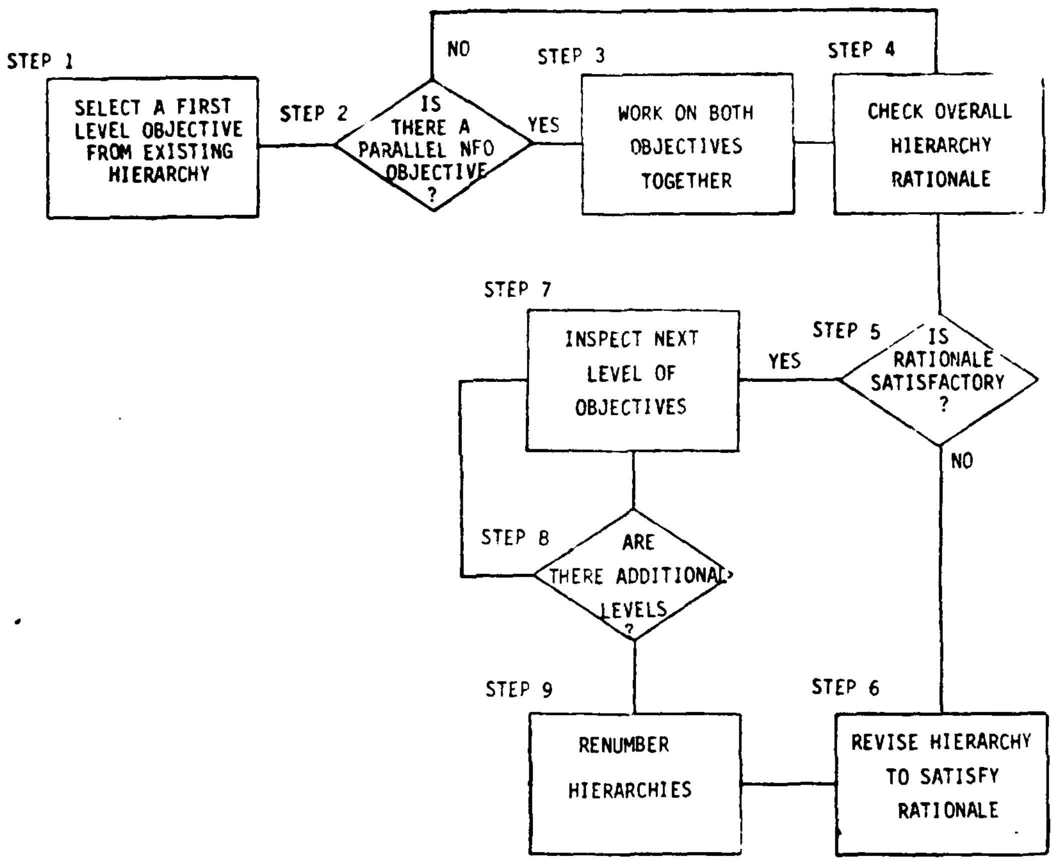


Figure 5. Objectives Hierarchies Revision Process

STEP 5. Is the rationale satisfactory? In making this decision, the continuously increasing knowledge base being gathered by the contractor was used. Each new SME who worked with the contractor provided valuable inputs thus updating the base of information.

STEP 6. Revise hierarchy to satisfy rationale. If the decision in Step 5 was that the rationale was not satisfactory, revisions were made to the hierarchies and/or the objectives making up those hierarchies. In most cases the hierarchies proved to be valid, i.e., the prerequisite relationships were valid. The majority of revisions were made to the objectives themselves. Once the overall structure of the hierarchy was validated, attention was centered on improving the objectives. They were examined in terms of their three parts: behavior statement, conditions and standards.

The behavior statement is a description of the observable student behavior which identifies that the anticipated learning has occured. The behavioral statements were examined according to the questions:

a. Is the behavior directly observable?

b. Will the stated behavior reflect the required learning?

c. Is the behavior stated simply and clearly?

d. Is there a subject, verb, object?

e. Are unnecessary clauses avoided?

The conditions spell out the essential features of the situation under which the behavior is to occur. This statement is analyzed for for clarity and content, since it determines to a large extent what occurs in subsequent stages of the design process. Three essential features found in the conditions statement are the stimuli to which the learner must react, the environment in which the behavior should occur and the tools he may use.

The stimuli are the objects or materials to which the student responds. For instance, in order to visually identify a target the student may be given black and white line drawings of target aircraft, or color photographs, or even an actual target. The specification of stimuli alone does not unambiguously determine conditions. It is frequently necessary to state, in addition to the stimuli, the general environment in which these stimuli are to be presented. The three primary types of environment for the purposes of this program are the classroom, simulator and aircraft. In addition to the specification of the stimuli and environment, the conditions should, where necessary, indicate what tools or aids the learner may or may not employ. For example, the checklist for the execution of procedures may be allowed or disallowed. In the case of a fire during during engine start it would be well advised to disallow it, as the student should have this committed to memory. In the case of an internal cockpit check it would be advisable to allow it.

The quality of the conditions statement was examined against the following checklist:

a. Is the stimulus specified?

b. Are the tools and constraints specified or implied?

c. Does the testing environment correspond to the task?

d. Has safety been considered?

e. Are security constraints considered?

f. Has the meaning of the behavior been kept consistent with the conditions?

The <u>standards</u> specify quality of performance expected of the student when he has mastered the objective. Standards are defined by factors affecting time, quality, quantity, or a combination of these. When establishing standards for an objective the following checklist was used:

a. Is the standard realistic and attainable?

b. Is speed and/or accuracy a factor?

c. Are there regulations which call for specific standards of performance?

d. Is sequence important?

e. Is safety important?

The above process resulted in a technically accurate hierarchy of learning objectives for the aircrew members. However, it could not be assumed that these objectives were totally complete. As lesson content was formulated and lesson tryouts commenced, new information influenced the past work. Standards particularly were influenced, because without tested instructional materials it was impossible to pre-determine them within given constraints. The necessity for updates during later stages of the design process was anticipated by the Data Item Description UDI-H-25717, which required update reports on objectives and hierarchies.

<u>STEP 7. Inspect next level of objectives</u>. This is the process resulting from a YES answer to the previous decision (Step 5). If the rationale was found to be satisfactory on the level examined, then the next level down on the hierarchy was examined.

STEP 8. Are there additional levels? This decision block simply ensured that the process of determining the satisfactory versus unsatisfactory rationale of the hierarchies would continue until the whole hierarchy was validated or revised.

STEP 9. Renumber Hierarchies. The final process to be performed was was to verify the continuity of the objective numbering system. The revised hierarachies were examined to ensure that additions, deletions or revisions had been properly accounted for, thus ensuring that the coding scheme used in identifying each objective would continue to be useful.

The process presented above was used continuously during the development of the lesson specifications. As each of the lesson specifications was developed, the level of content became greater. This increase frequently resulted in the need for revisions to the objectives contained in that lesson specification. The quality and standardization of the objectives hierarchies was maintained by the use use of this process.

The second major process involved the development of a syllabus oriented learning objectives hierarchy. This type of hierarchy resulted from the processes of sorting and grouping the original objectives into the events of the syllabus. The mission phase approach to the objectives hierarchy was the foundation for the structure of the aircrew task listing and original learning objectives hierarchy. There were ten mission phases, consisting of 1) mission planning, 2) pre-launch, 3) takeoff, 4) navigation, 5) reconnaissance, 6) surveillance, 7) combat, 8) in-flight fundamentals, 9) approach/landing and 10) post mission phase. These ten phases allowed tracking an aircrew task (eventually a learning objective) throughout all possible tactical situations.

The first step which occurred in syllabus development was the sorting of the learning objectives according to an aircraft system or aircrew function within an area of training in the syllabus. These sorted objectives were then grouped into a set of training events or lessons. These lessons were hierarchically sequenced (ordered simple to complex) for training. Within each lesson existed a hierarchy of the specific objectives which were sorted into that lesson from the original mission phase objective hierarchy.

Lesson specification development for every syllabus event, each event designed in the manner just described, generated the requirement for transforming the original hierarchy of objectives to a syllabus oriented objective hierarchy. Within each syllabus event was a mini-hierarchy of the specific lesson objectives. The syllabus events were hierarchically related themselves based on student entry skill level. The events were ordered simple to complex to accomplish the terminal training objectives. The syllabus oriented hierarchies represented the original learning objective hierarchies, only now transformed into a format for training.

The new syllabus oriented objective hierarchy was designed to be used by the training squadron personnel in locating a specific learning objective if the process of internal quality control or the results of criterion tests generated the need for modifying or adding learning objectives.

Each objective within a training event was coded in a manner that reflected not only the order of the objective in the training event, but also was coded to the individual training event in the syllabus. For example, if a criterion test showed a specific objective consistently failing criterion, the training personnel would generate a requirement to examine that specific objective. Once the objective was located in the syllabus oriented learning objective hierarchy, any required modification could be made by the appropriate personnel or educational specialist.

MEDIA SELECTION.

Duration of Task: September, 1977 - April, 1978
Mandays Expended:

Program Manager	0
Instructional Psychologist I	9
Instructional Psychologist II	11
Instructional Technologist I	0
Subject Matter Expert	13
Clerical	8
TOTAL	41

The media selection model used during the F-14 program development consisted of the model specified in MIL-T-29053 with the addition of a new branch dealing with perceptual motor skills. See Figures 6, 7 & 8.

Each objective was classified and given one primary and two alternate media choices. This process was performed prior to the grouping of objectives or the development of syllabus events. However, economic and other pragmatic issues were not considered by this or any of the other media selection procedures available because instructional concerns are invariant across training settings, while economic constraints are not.

These economic constraints are particularly dominant in a project which is concerned with revising an existing system for which considerable media resources already exist. These resources should obviously be used where possible, therefore, the selection of media will be affected or biased by the existing resources.

In the case of the F-14 program, the academic facilities and equipment were designed to accommodate lectures with visual support, individualized audio-visual programs and individualized written materials. Regardless of the fact that CAI was the logical media selection for many of the objectives, CAI was not an economically valid choice. In such cases, the second or third media choice was used.

The existence of the major training devices also affected the selection of media. Again, the economics of adjusting the objectives to fit the existing resources far outweighed the economics of modifying multi-million dollar devices.

The actual process of media selection using a given procedure or "algorithm" is tedious at best. Each individual objective is treated separately and mentally processed through an algorithm which determines a primary and secondary media selection.

There are several reasons to doubt the efficiency of this entire step, because of what happens downstream with the media selected for any given objective. First, following the assignment of media types, the objectives must be grouped into lessons. This process often results in lessons which contain a variety of different media choices. A second media selection, or reorganization, is then necessary to reduce the number of different media within a lesson to a number which is instructionally sound.

Secondly, as the syllabus develops, more and more changes to the basic objectives and to the objective groupings take place. Because of the increased knowledge base gained by interaction with SME's, changes in the tactical employment of the aircraft from the time of the original task analysis, etc. This in turn requires a continuous reassessment of objectives and media selections. This suggests that media selection should occur in conjunction with the definition of resources and training support requirements, rather than earlier in the ISD process. This was done, although neither the MIL SPEC or the DID required that this relationship be considered.

TRAINER MODIFICATION AND UTILIZATION REPORT

Duration of Task: February, 1978 - May, 1978
Mandays Expended

Program Manager	7
Instructional Psychologist I	11
Instructional Psychologist II	0
Instructional Technologist I	5
Subject Matter Expert	36
Clerical	5
TOTAL	64

The trainer modification and utilization task consisted of five steps aimed at defining needs for modifications to the trainers based upon changes to the training syllabus. This determination of the

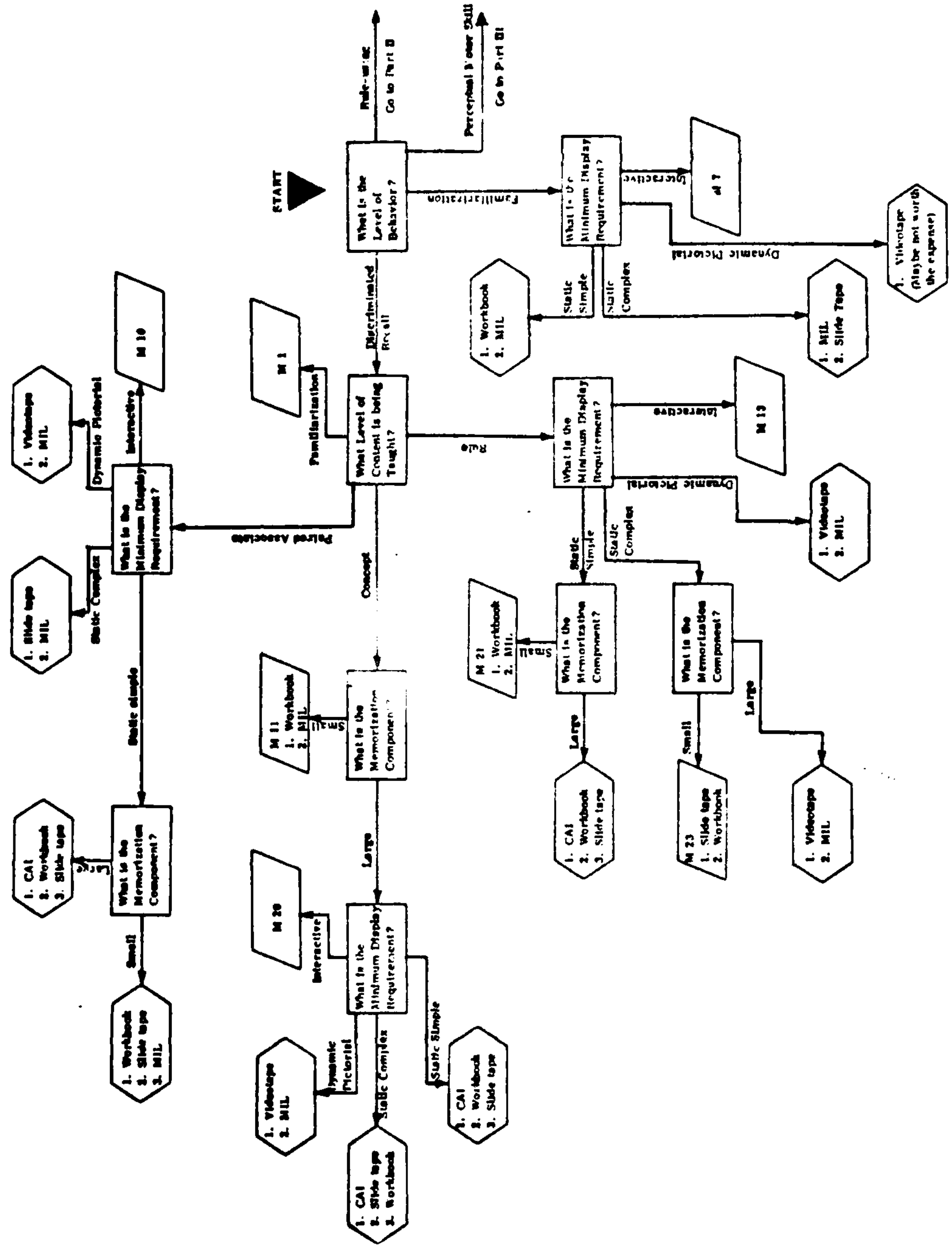


Figure 6. Media Selection Algorithm, Part I

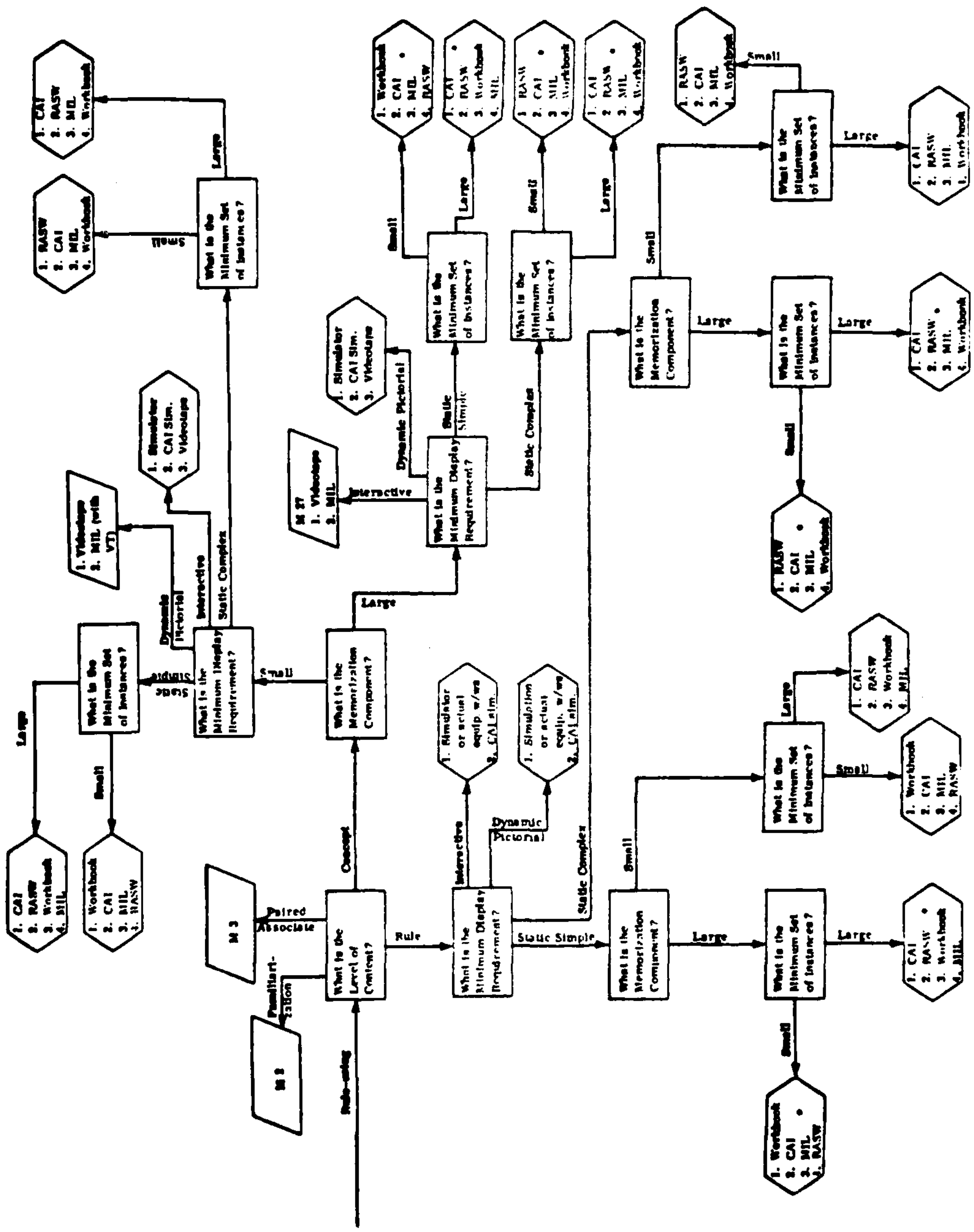
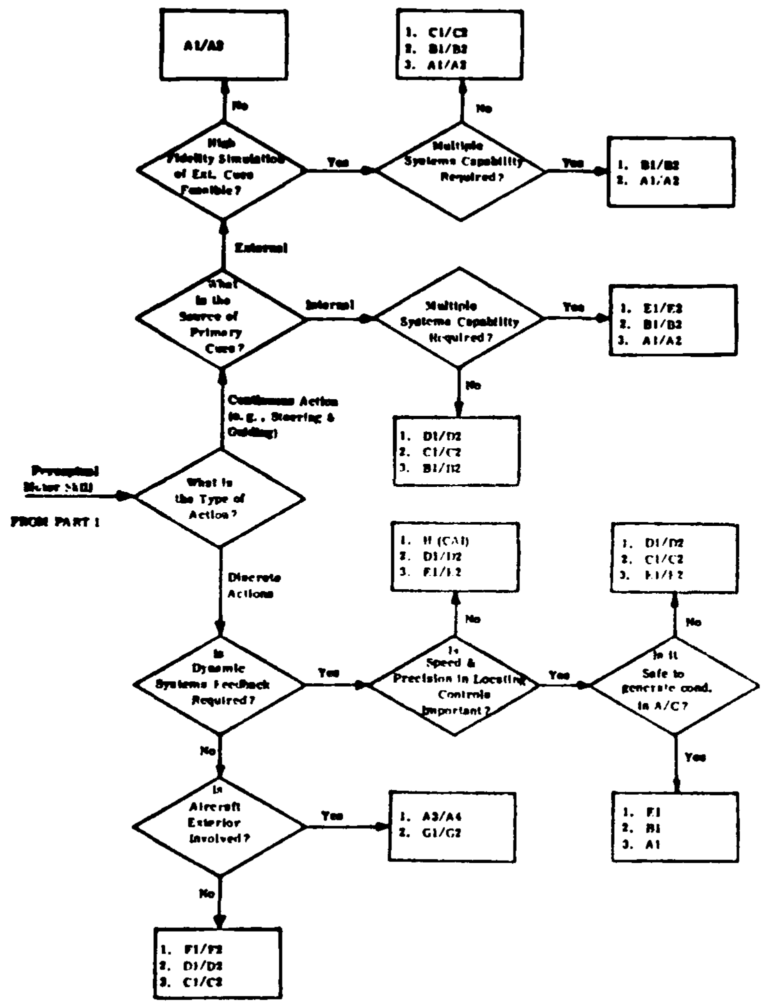


Figure 7. Media Selection Algorithm, Part II



MEDIA OPTIONS

A1: A/C (operational), real environment, instructor, briefing guide
A2: A/C (operational), real environment
A3: A/C (static), checklist, instructor, instructor guide
A4: A/C (static), checklist
B1: Full Simulator (external cues cap.), instructor, briefing & lesson guide
B2: Full Simulator (external cues cap.), student guide
C1: Part Task Trainer (external cues cap.), instructor, briefing & lesson guide
C2: Part Task Trainer (external cues cap.), student guide
D1: Part Task Trainer (no ext. cues cap.), instructor, briefing & lesson guide
D2: Part Task Trainer (no ext. cues cap.), student guide
E1: Full Simulator (no ext. cues cap.), instructor, briefing & lesson guide
E2: Full Simulator (no ext. cues cap.), student guide
F1: Operable mockup, instructor, lesson guide
F2: Operable mockup, student guide
G1: Photos, instructor, lesson guide (MTL)
G2: Photos, selfstudy material (workbook, slidetape, video)
H: Computer Aided Instruction

Figure 8. Media Selection Algorithm, Part III

need for modifications was limited in one respect. Major modifications to the devices were not to be recommended. If the trainers were to be modified to meet the requirements of the syllabus, the modifications would have to be minor in nature.

The process of determining the need for trainer modifications consisted of five steps as listed below and shown in Figure 9:

STEP 1. Compare syllabus needs with trainer capabilities. This process of comparison was not performed exclusively as a part of this task. During the process of media selection, the capabilities and limitations of the training devices were allowed to bias the selection of the media and as stated previously, major modifications to the training devices were not to be recommended as a part of this effort. Therefore, in many cases where trainer capabilities did not fit requirements for training a given objective, modifications were made to the terminal objective or its enabling objectives.

STEP 2. Do the trainers meet the needs of the syllabus? A determination was made of the adequacy of the trainers to support the syllabus being designed. As is shown, a positive determination caused an end to this process, a negative determination led to Step 3.

STEP 3. Determine modifications needed to satisfy syllabus requirements. In performing this process, the objectives or event requirements were used in determing how the training device would need to be modified. The stimulus, display requirements, response requirements, performance monitoring and measurement capabilities as well as economic considerations were the major determining factors.

STEP 4. Can the needs be satisfied with minor modifications? The outcome of Step 3 was a list of needed modifications. This list was evaluated to determine the specific trainer changes desired and the possibility of combining these changes into a single modification. Based upon the constraint that no major modifications would be made, a NO answer caused an exit from this process, a YES answer led to Step 5.

STEP 5. Submit Trainer Equiment Change Request (TECR). If the determination was made that the syllabus requirements could be satisfied with minor modifications, a request (the TECR) was submitted to NAVTRAEQUIPCEN to accomplish that modification.

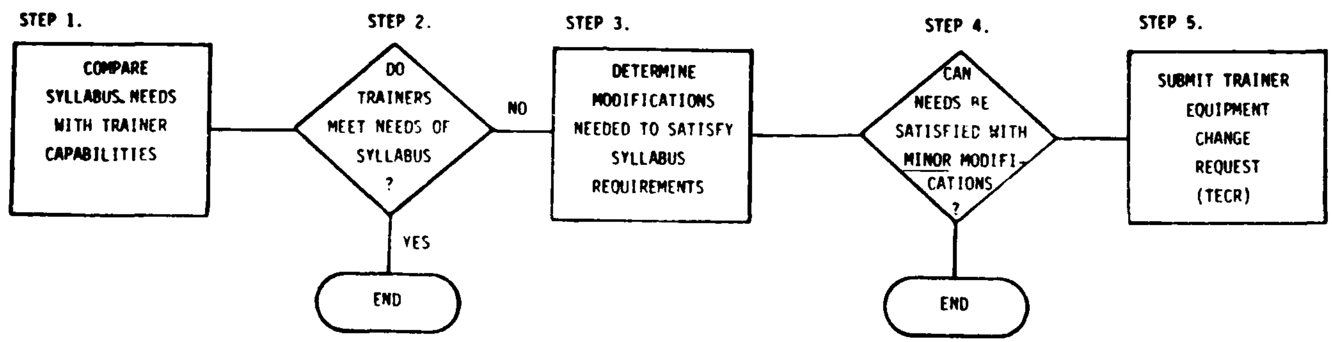


Figure 9. Determining the Need for Trainer Modifications

STUDENT SYLLABI (MAS/TARPS).

Duration of Task: October, 1977 - May, 1980
Mandays Expended:

Program Manager	31
Instructional Psychologist I	95
Instructional Psychologist II	47
Instructional Technologist I	68
Subject Matter Expert	116
Clerical	79
TOTAL	436

The development of the student syllabus proved to be one of the most demanding and complex tasks performed during the project. It involved assembling the more than 3500 learning objectives which had been developed from the previously performed task analysis and then, through a series of steps, converting these learning objectives into a hierarchy of lessons. This hierarchy of lessons comprised the student syllabus.

When the task analysis was performed, a method was devised to ensure that each operator task would be accounted for. This method involved the analysis of eight separate mission phases from Pre-Flight to Post-Mission to determine what tasks were required in each one of those eight mission phases. This method proved effective for the task analysis and the generation of the objectives hierarchy but did not prove applicable to the development of the student syllabus. An example of this lack of applicability can be seen if one looks at the seventh mission phase, which is Approach and Landing. Landing the airplane is one of the requirements the pilot must learn prior to his very first flight. If the syllabus were organized along eight mission phases, landing would be the next to the last thing that he would learn. For this reason, the mission phase oriented objectives hierarchy had to be restructured into a training oriented syllabus.

It should be pointed out that the retention of the mission phase structure in the development of the objective hierarchy leads to a high degree of redundancy. As the tasks for each phase in the task hierarchy are transformed into behavioral objectives and as the prerequisites for these objectives are defined down to student entry level, one encounters more and more prerequisites that are common across phases the lower one descends on the hierarchical tree. A good example is the objectives associated with aircraft systems. As one might logically expect, these objectives turn up as prerequisites to any mission phase.

In developing the syllabus from the objective hierarchies, the first step was a process of sorting and grouping the learning objective into the rough categories of Systems Operation, Aircrew Procedures, Weapons System Employment and Mission Support. Based on these four topic areas, a matrix was developed which contained subjects associated with each of the respective areas (See Figure 10). Each topic area was separated into 3 phases representing increasingly more difficult subject areas. The learning objectives were then systematically sorted into these subject areas rather than into the mission phase. The simple to complex relationship was maintained during this sorting process.

The next step performed was the process of lesson development. The objectives which had been grouped into the subject/topic area matrix were examined, one category at a time. Each objective was studied for subject matter content as well as inter-relationships with other learning objectives in the same area. The objectives were roughly organized by subject matter and learning types and ordered from simple to complex behavior. Lesson size was determined by organizing similar groups of objectives into what were estimated to be manageable time frames. Finally, the lessons were grouped into either academic, trainer or flight events. This process was repeated until all of the objectives within the subject/topic area matrix had been sorted and grouped into lessons.

At this point in the syllabus development process, it was necessary to identify instructional areas which would serve as the basic elements for the new curriculum. Examples of these broad instructional areas are: aircraft systems, basic flight maneuvers, advanced combat maneuvering and carrier qualification as shown in Figure 11. Entry level and exit skills were identified for each of these broad instructional areas. Based upon these entry and exit skills, the lessons within these broad areas were then defined. These included lessons for the academic, trainer and flight phases. When the entry level skills for each of the phases were prepared, it was evident that the phases with the lowest entry skills would be the first instructional areas to be presented to the student. This provided for the students entry into the syllabus hierarchy. In performing this function, it was determined that there were multiple entry points into the syllabus and multiple paths through this syllabus hierarchy along which the student could progress. This hierarchical format allows for maximum ease in scheduling in that a schedules officer, by looking at the syllabus hierarchy, can determine alternative events in which the students can validly participate, if the resources for performing the preferred event are not available.

A separate syllabus was developed for both the pilot and the NFO since it was determined that the skills needed for the Pilot's first flight, and for some of his subsequent flights, differed from the skills required for the NFO's first flight and subsequent flights (See Figure 12). This proved to be an area of concern to the Navy in that it deviated from the traditional method of parallel training of pilot and NFO; however, this dual track type syllabus has resulted in the elimination of high front end loading and a subsequent higher level of preparedness for the first flight for both the pilot and the NFO.

TOPIC AREAS	F-14 SYSTEMS OPERATION I	F-14 SYSTEMS OPERATION II	F-14 SYSTEMS OPERATION III
	a) Aircraft Systems Fam b) Aircraft Systems Operation c) WCS Operation (Basic) d) NAV Fam e) NAV Operation	a) Missile Fam b) Missile Operation c) Gun System Operation d) WCS Operation (Intermediate) e) Armament Control System Operation	a) DECM Theory (Basic) b) WCS Operation (Advanced) c) Weapons Configuration
TOPIC AREAS	F-14 AIRCREW PROCEDURES I	F-14 AIRCREW PROCEDURES II	F-14 AIRCREW PROCEDURES III
	a) Aircraft Inspection c) Communications d) Ground Operations e) System Checks f) Takeoff g) Landing h) Navigation i) Emergencies j) Approach	c) Weapon Inspection d) WCS/Missile Evaluation e) Combat Communications f) Weapon Safety	a) WCS Evaluation (Advanced) b) Combat Engagement Procedures
TOPIC AREAS	F-14 WEAPON SYSTEM EMPLOYMENT I	F-14 WEAPON SYSTEM EMPLOYMENT II	F-14 WEAPON SYSTEM EMPLOYMENT III
	a) Aircraft Maneuvers (Basic) b) Aircraft Performance c) Aircraft Formations d) Search Configuration	a) Mission Orientation b) WCS employment c) Intercept Geometry d) Combat Maneuvering (Basic) e) Missile Employment (Basic) f) Gun Employment g) Tactical Planning (Basic) h) Combat Formations	a) Combat Maneuvering (Advanced) b) Missile Employment (Advanced) c) Enemy Threats d) Multiple Threat Engagements e) Tactical Planning (Advanced)
TOPIC AREAS	F-14 MISSION SUPPORT I	F-14 MISSION SUPPORT II	F-14 MISSION SUPPORT III
	a) Aircraft Servicing	a) Data Link Operation (Basic) b) Air Refueling	a) Data Link Operation (Advanced) b) DECM Operation c) Mission Support Forces d) Carrier Operations

Figure 10. Subject/Topic Area Matrix

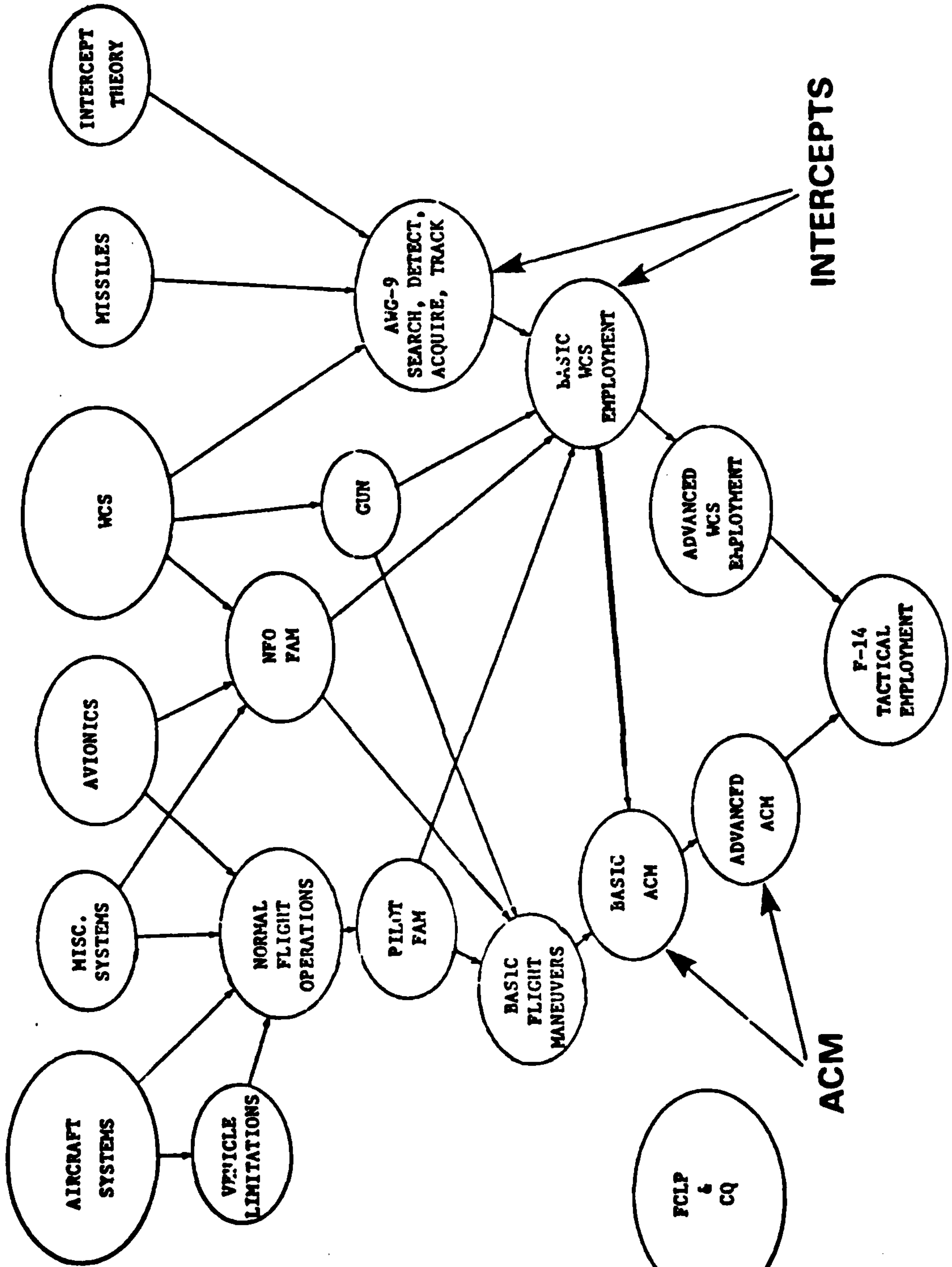


Figure 11. General Layout of Proposed Syllabus

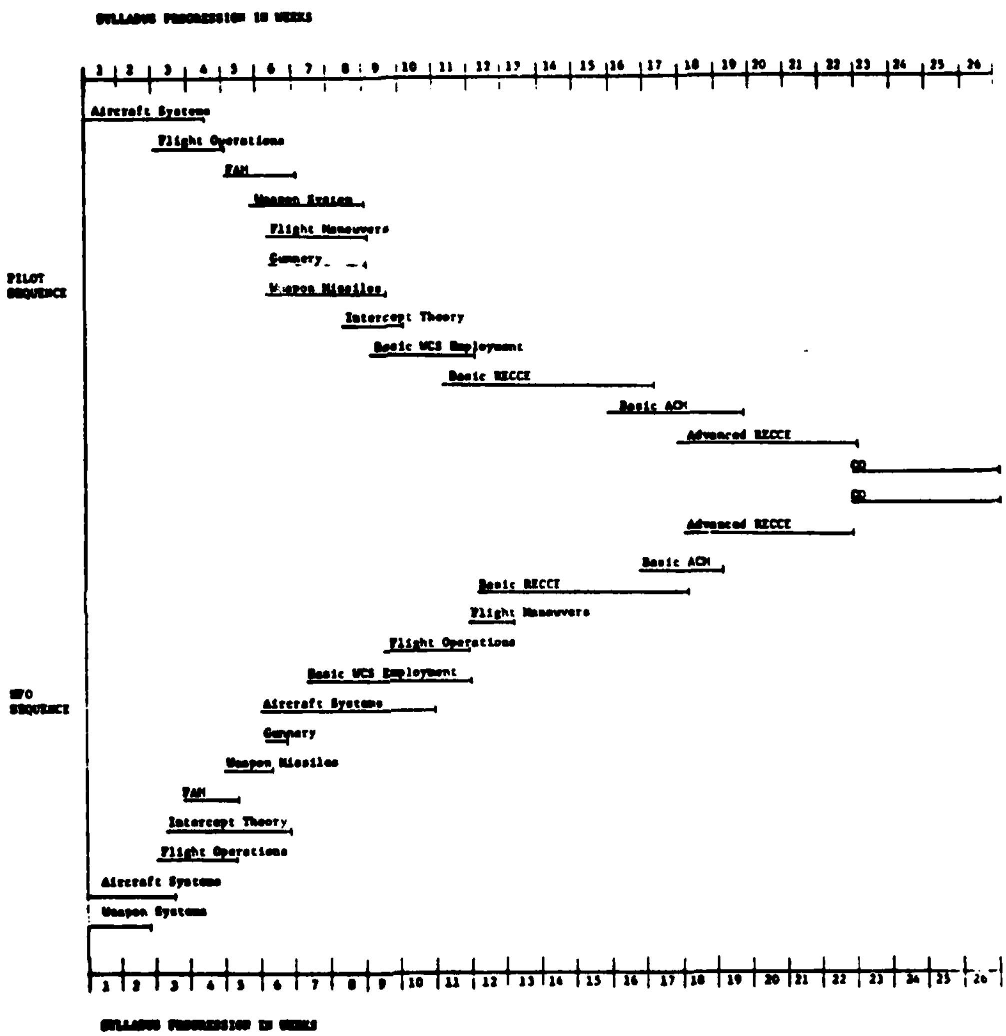


Figure 12. Comparison of Typical Pilot and NFO Syllabi

TRAINING SUPPORT REQUIREMENTS ANALYSIS (MAS/TARPS).

Duration of Task: September, 1977 - October, 1979
Mandays Expended:

Program Manager	32
Instructional Psychologist I	86
Instructional Psychologist II	14
Instructional Technologist I	67
Subject Matter Expert Expert	0
Clerical	53
TOTAL	252

The training support requirements analysis (TSRA) was initiated immediately after the generation of the syllabus and preceded the development of lesson formatting and segment specifications. It was prepared in accordance with the Military Specification and the Data Item Description UDI-H-25722. These documents were interpreted in the light of the present task which is concerned with the redesign of an existing training program.

An existing training program, in contrast to a new or emerging program commonly already owns or has access to a significant amount of assets which, especially in the case of aircrew training programs, represent a considerable investment. A TSRA for the redesign of an existing program is, therefore, less concerned with the generation or procurement of new resources than with the utilization and modification of the existing training assets. It is obvious, therefore, that a TSRA for the redesign of an existing program must begin with a clear description of the training task and an inventory of the existing training assets. The training task is described in terms of the overall mission for F-14 aircrew training and in terms of the general conditions under which this training must take place. The two factors with the greatest influence on the type and amount of training assets required, the student population and the syllabus, were described and analyzed in detail. The assessment and inventory of the current training assets provided the baseline for the development of the resource requirements of the proposed syllabus.

The process employed is depicted in Figure 13. It consists essentially of an analysis phase and a definition phase. During the analysis phase, three major training system components were assessed:

a. the existing physical resources at both squadrons,
b. the personnel, i.e. students and instructors,
c. the syllabi, i.e. the existing CNO syllabi versus the proposed syllabi for pilots and NFO's.

During the definition phase, required resources were determined for each syllabus event under two different media mixes. The resource requirements were then assessed over events and daily, monthly and yearly requirements of each major resource were determined. In addition, and in variance from the DID, a plan for a training management organization was developed in rudimentary form. It was felt that it is vital to include a simple and effective training management system in any training development procurement and that the military specification and the data item descriptions should be amended accordingly.

The analysis process was relatively simple and straightforward, albeit labor intensive. The various steps in the process can be traced in Figure 13. Standard data collection methods using observation, interviews, questionnaires and document collection were used.

The definition process was equally labor intensive and somewhat more complex. The military specification did not contain specific methods or procedures to accomplish this phase. The contractor was therefore required to develop appropriate forms and procedures. These newly designed tools proved to be very useful and effective and it is for this reason that some of them were incorporated in the revised DID's. Because the resource definition process was breaking new ground it is described in more detail below.

Procedures For Resource Definition. Resource definition was initiated after the analysis phase and after the proposed syllabus hierarchy had been developed. At this point, syllabus events for each of the three instructional environments were defined. For each event there was a set of behavioral objectives and a lesson cover sheet with the lesson reference number, the lesson title and a brief prose description of the purpose of the lesson. The lesson reference number clearly identified each event by major syllabus area, specified whether it was to be administered to Pilots or NFO's or both, and stated whether it was to take place in an academic, trainer, or flight environment. The goal was to determine for each syllabus event the specific media and all other resources required to support this event, including personnel and facilities. In accordance with the Military Specification and the Data Item Description, an attempt was made to define wherever possible at least two different resource configurations for each event. The guidelines for the definition of the primary and secondary resource configurations were three essentially independent variables which were given different priorities as shown in Table 2.

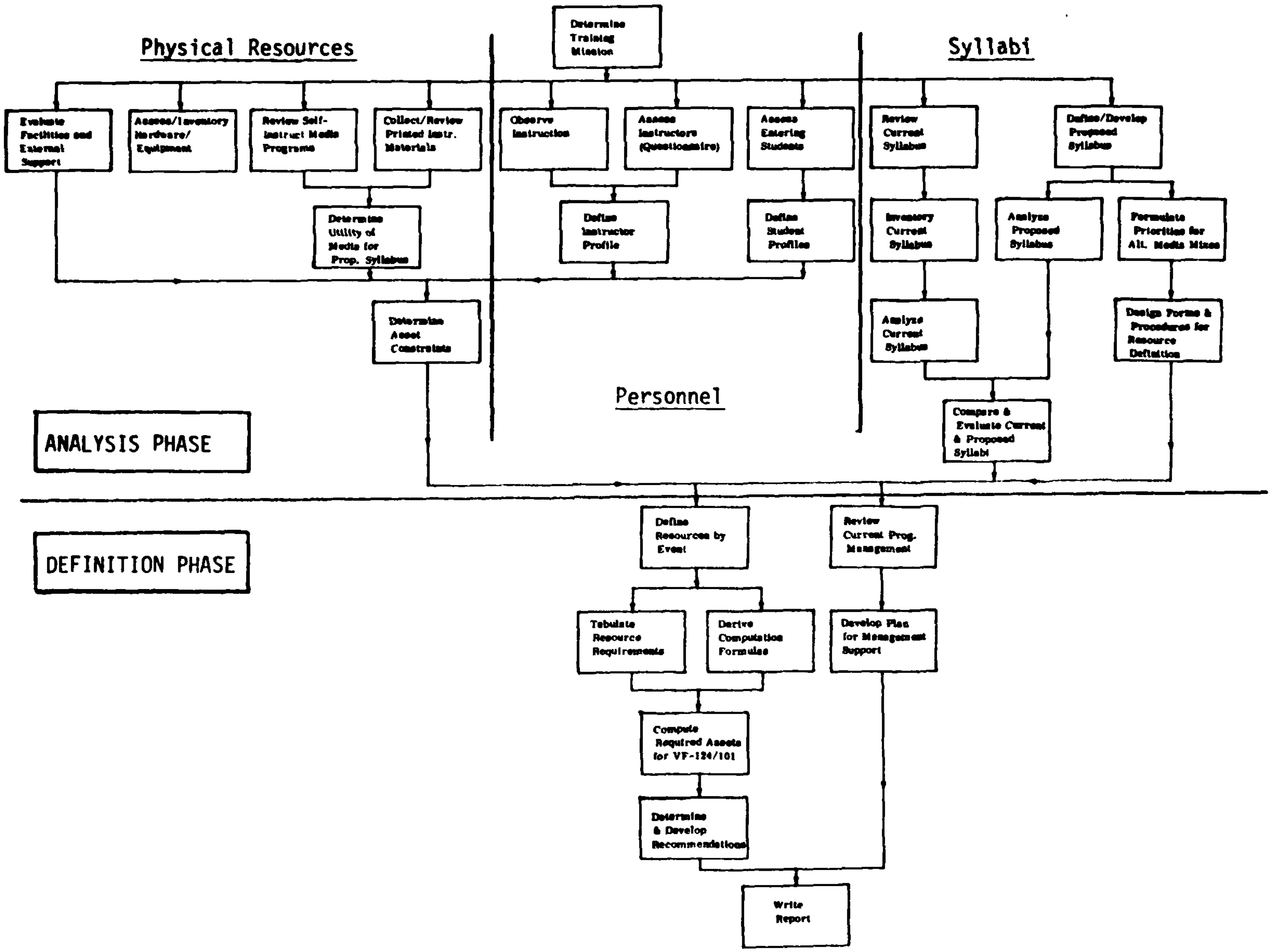


Figure 13. TSRA Development Procedure

Table 2: Guidelines for Resource Definition

Priority	Candidate Media Mix	
	No. 1	No. 2
1	Instructional Effectiveness	Cost
2	Practicality	Practicality
3	Cost	Instructional Efficiency

These variables represent the three major concerns which must be addressed during resource definition. All other considerations such as editability, required stimulus properties, existing media, user acceptance or preference, etc. are related but subordinate and must be dealt with in the context of the sets of priorities above.

In order to systematize the practical process of *resource definition*, a lesson media and resource worksheet and a set of procedures for its completion, were developed. The lesson media and resource worksheet, hereinafter referred to as the ATF sheet, contains a matrix for all possible resource combinations for academic, trainer and flight events (See Figure 14). The area for academic instruction was subdivided into four major classes: lecture events, self-instructional events, briefings, and exams. For each of these classes, personnel, media, facilities and evaluation support can be specified. Care was taken to include as media those that could be accomodated by the instructional hardware currently onboard at both squadrons, as well as media that might be feasible and desirable alternatives. The trainer area is subdivided into the different types of trainers that are currently installed at both squadrons and the trainers that are scheduled to be ready for training during or after program implementation. For each of the trainers or simulators the required personnel and media support for the training event can be specified. For flight events, the ATF sheet permits a specification of crew as well as configuration for up to four F-14 aircraft. Additional space is provided to allow the specification of facilities, external support, weather minima and student flight hour minima. Provisions were made in each of the three areas to enable the inclusion of resources and/or media which were not explicitly listed in the matrix. Those entries can be made under the columns labeled "other" and particulars are explained under "remarks" in the middle section of the ATF sheet. The labelling of the rows by letters and the columns by numbers permits coding of the required resource support

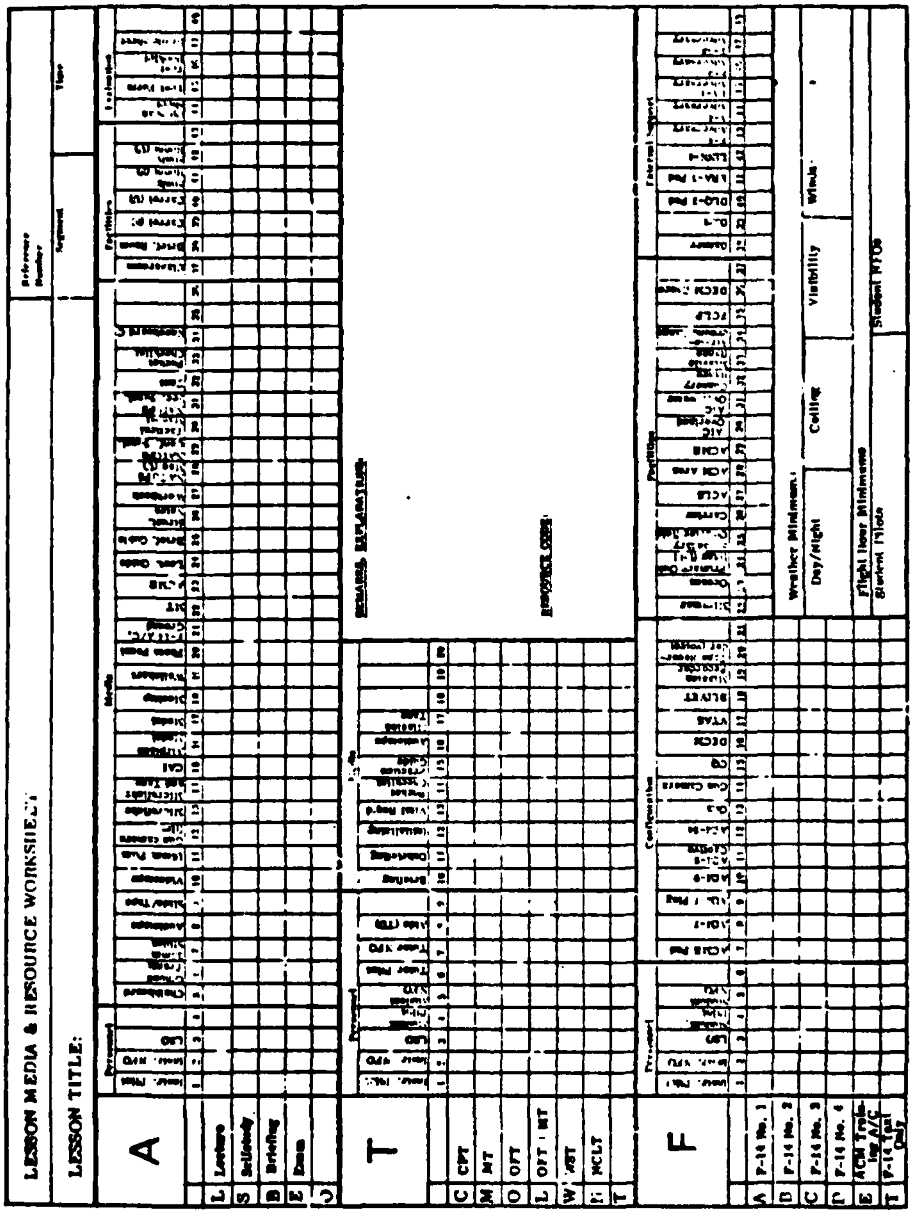


Figure 14. Lesson Media and Resource Worksheet

configuration and lends itself, together with the lesson reference number, very easily to computer storage and manipulation. A separate ATF sheet was prepared for each segment of each event. Trainer and flight events commonly contained three separate segments, consisting of briefing, hands-on portion or flight and debriefing. Several academic events were mediated by two different types of media. In this case a different ATF sheet was prepared for each segment.

A set of procedures for the completion of the ATF sheets (see Figures 15 through 20) was designed to ensure a systematic decision making process by all staff members involved in this particular evolution. The point should be made that neither these procedures, nor any other procedures for media selection that may be found in the recent literature in this area, can rightfully be called algorithms. Algorithms are strictly deterministic procedures which always lead to the same result given a certain input. Media selection procedures, even though they are non-algorithmic, are nevertheless systematic, since they prescribe the type and order of decisions to be made for the media selection process.

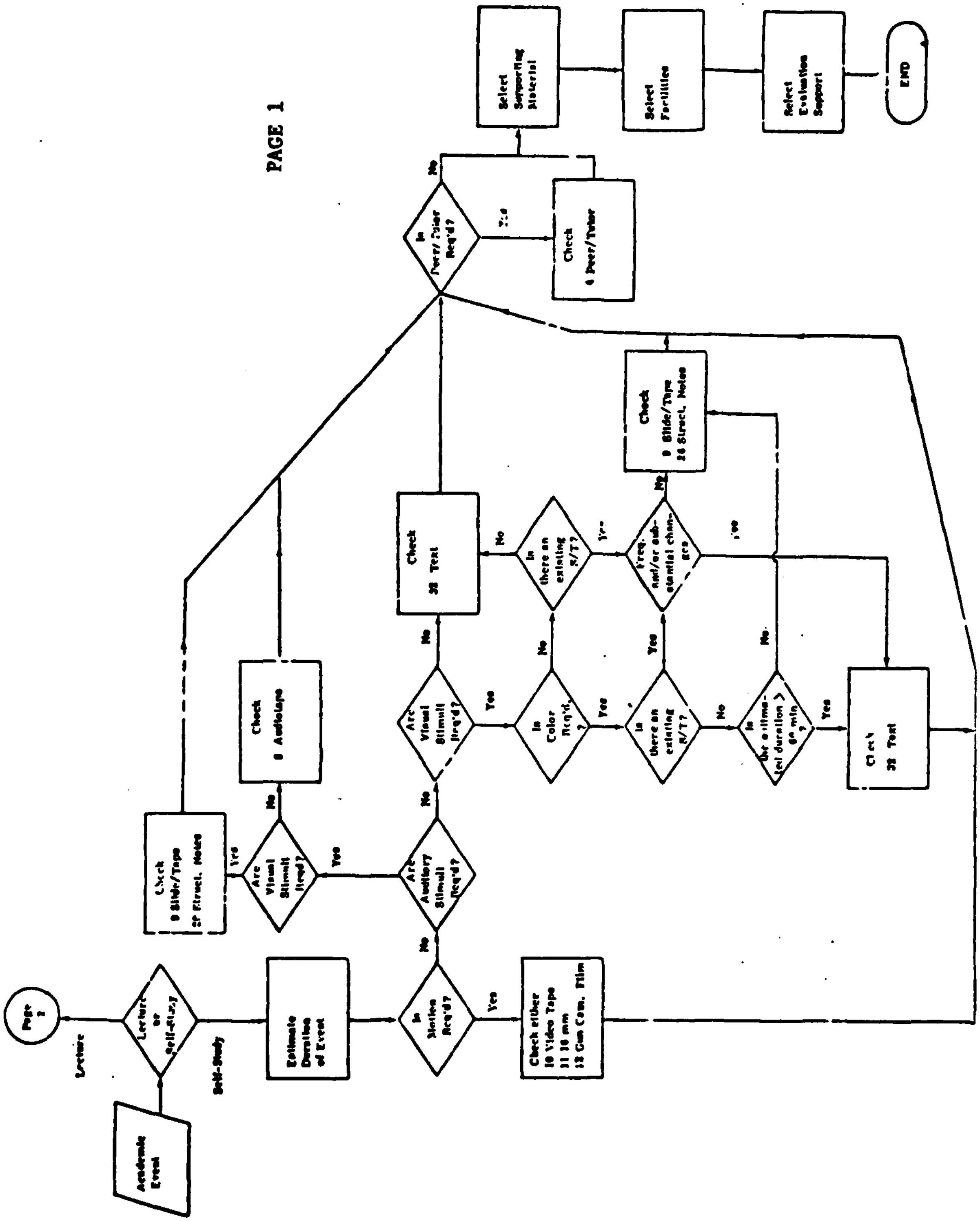


Figure 15. ATF Procedures: Academic Self-Study Events

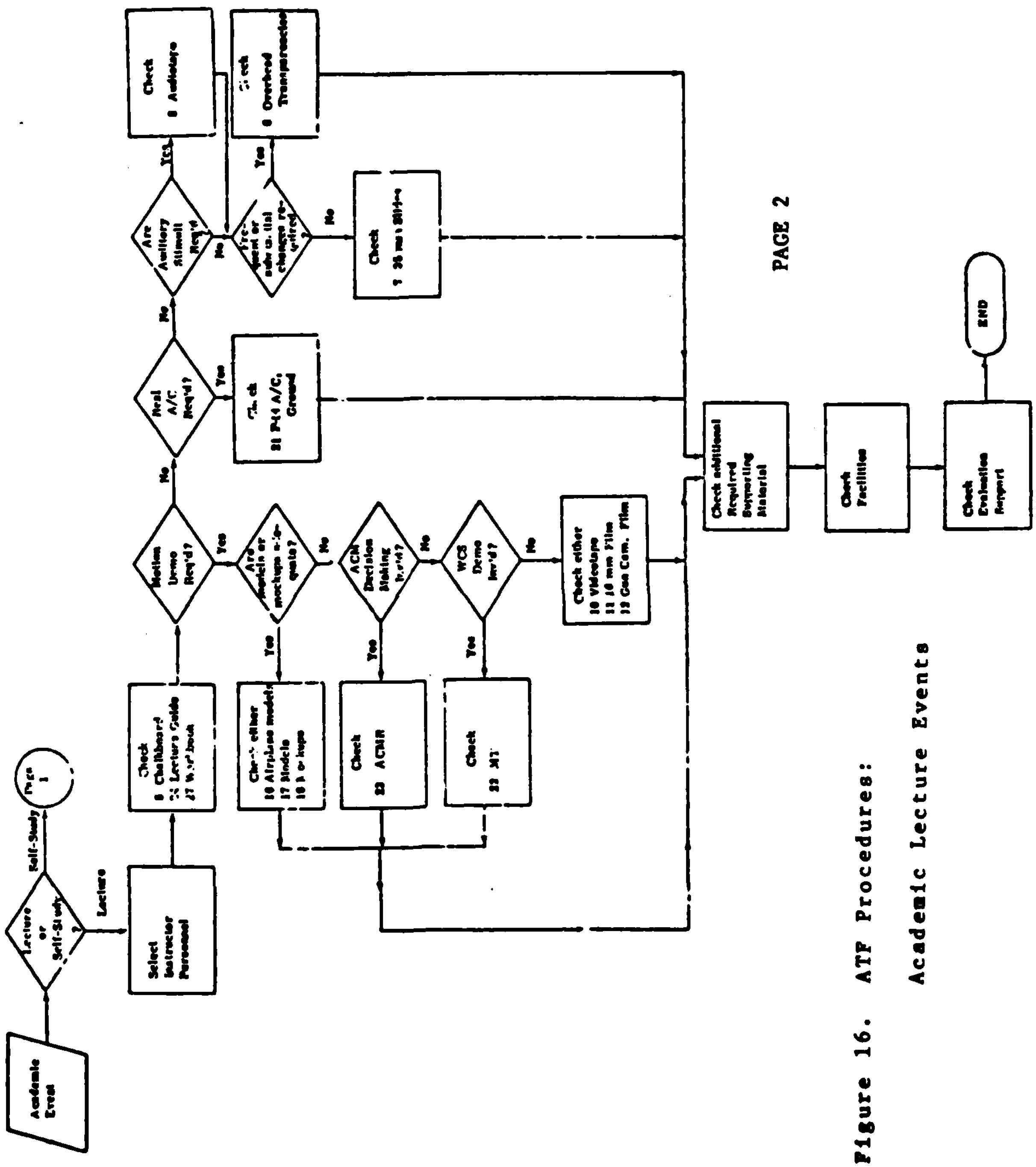


Figure 16. ATF Procedures:
Academic Lecture Events

PAGE 3

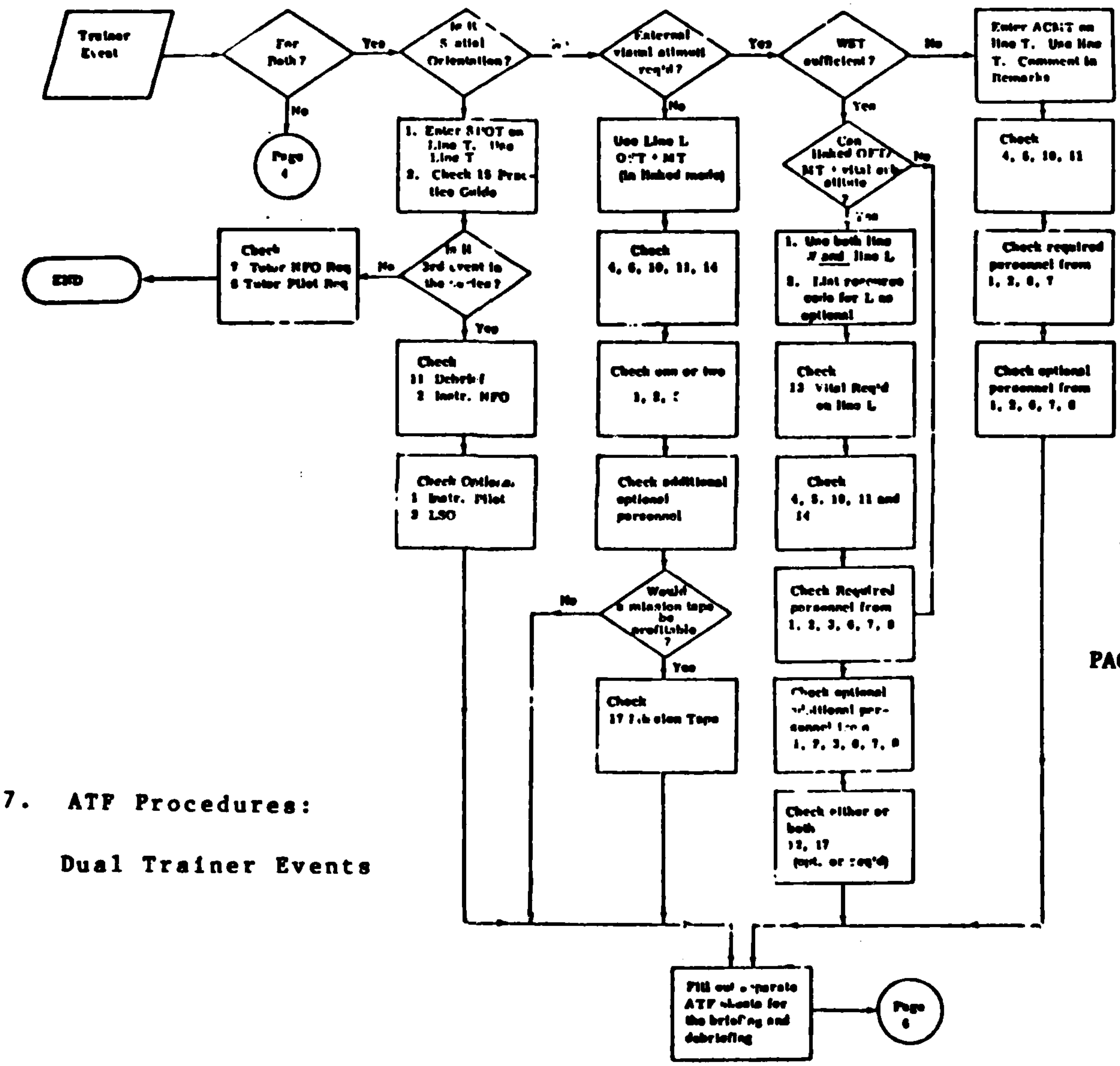


Figure 17. ATF Procedures:

Dual Trainer Events

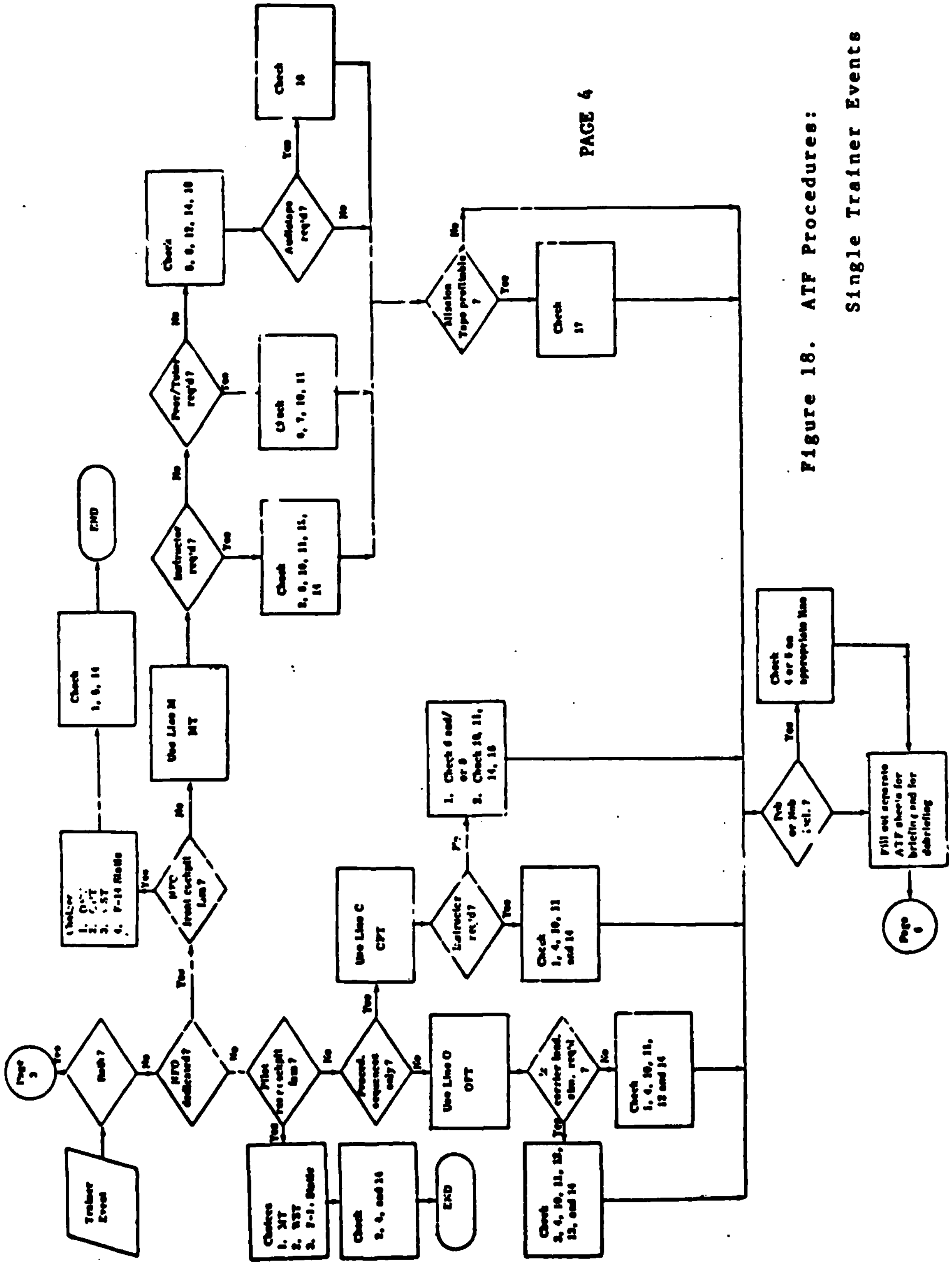


Figure 18. ATP Procedures: Single Trainer Events

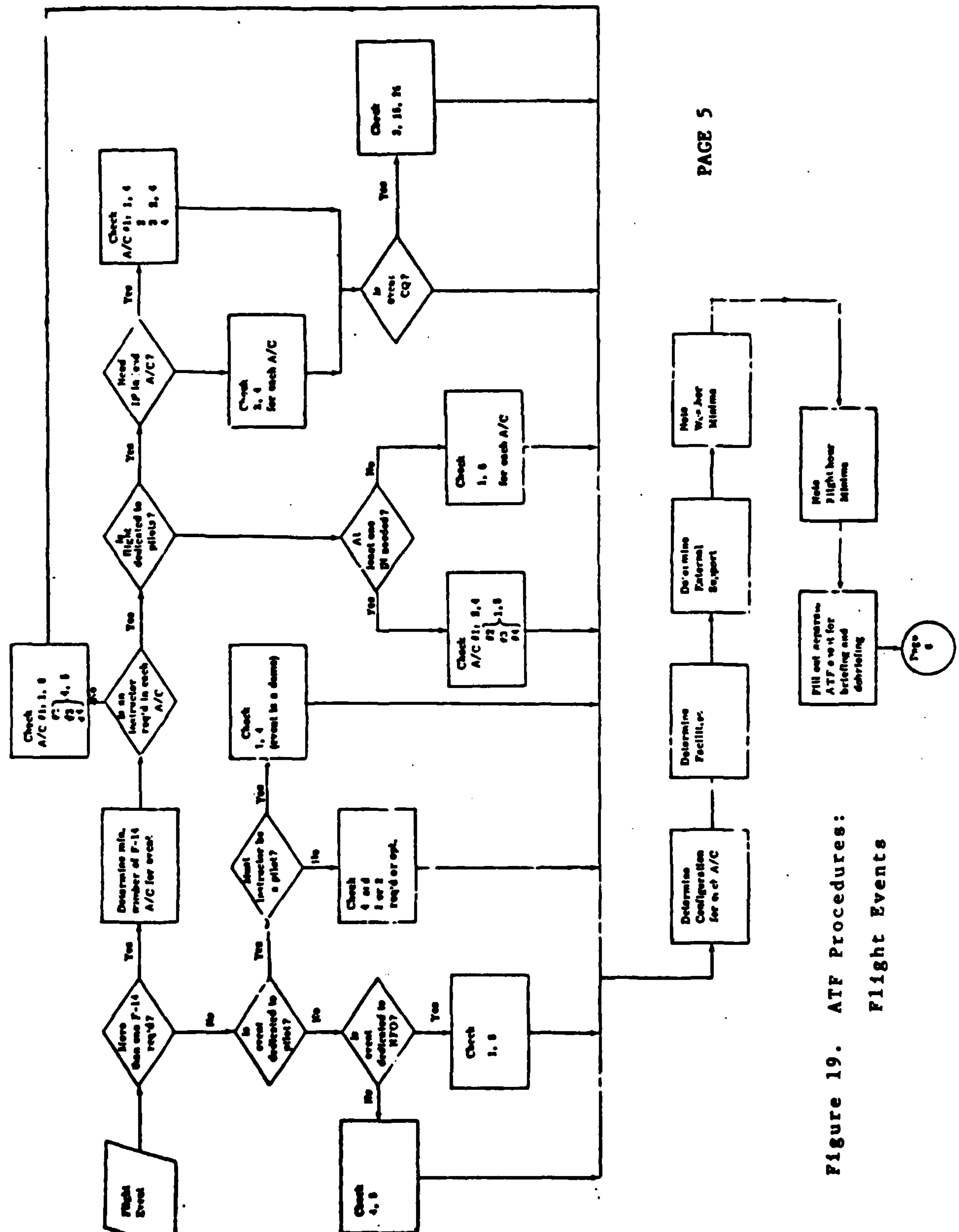


Figure 19. ATF Procedures: Flight Events

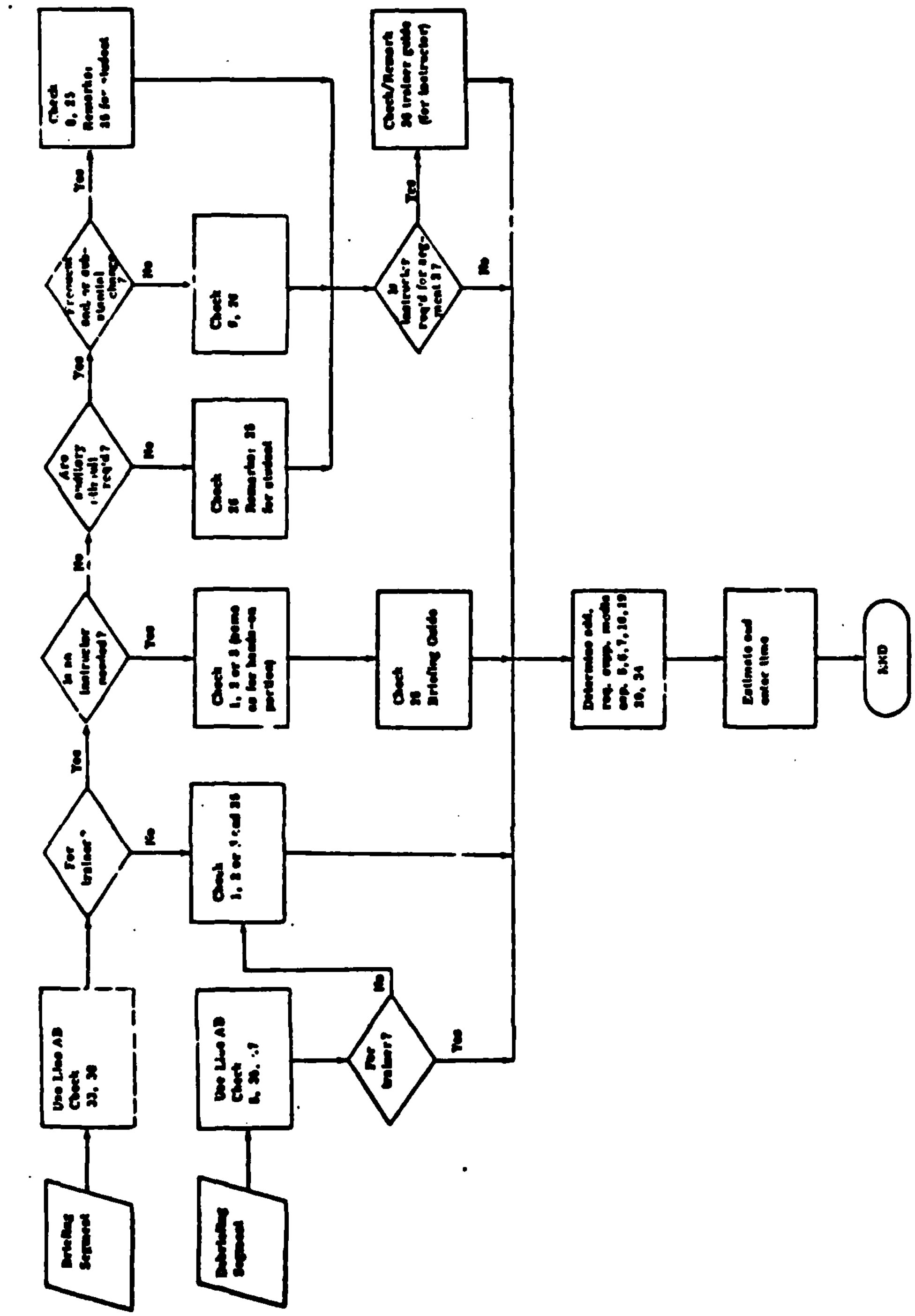


Figure 20. ATF Procedures: Briefings and Debriefings

<u>Computation of Resource Requirements</u>. The completed ATF sheets formed the raw data for the computation of the resource requirements. These computations were based on the following three assumptions:

a. Annual student throughput will remain at FY-78 levels or increase very slightly. In FY-78 207 student inputs were scheduled. For purposes of this computation, an annual student load of 220 was assumed, allowing for a slight margin of growth.

b. The distribution of students over types and categories will remain the same as in FY-78. The following distribution was assumed:

Category I	- 60%	Equal parts of Pilots and NFO's
Category II	- 27%	
Category III	- 8%	
Category IV	- 4%	
Category V	- 1%	

c. Based on a consideration of the backgrounds of the various student categories as well as of figures obtained from the syllabus summaries of the current syllabus, it was assumed that each student category would receive the following proportions of the full syllabus:

Category I	receives	100%
Category II	receives	80%
Category III	receives	50%
Category IV	receives	10%
Category V	receives	30%

Based on these assumptions, the annual requirements for any given resource can be computed as follows:

If

r_{p_i} = amount of resource R required to train one student pilot of category i

S_p = number of Category I student pilots to be trained per year = category i student pilot load

R_{p_i} = annual amount of resource R required to train all student pilots of category i

then, for any given category of student pilots:

$$R_{p_i} = r_{p_i} S_{p_i}$$

and therefore the total annual requirement for resource R for all categories of students together

$$[1] \quad R_{p_{total}} = \sum_{i=1}^{i=5} R_{p_i}$$

or

$$[2] \quad R_{p_{total}} = r_{p_1} S_{p_1} + r_{p_2} S_{p_2} + r_{p_3} S_{p_3} + r_{p_4} S_{p_4} + r_{p_5} S_{p_5}$$

The same equation can be written for NFO's by substituting the subscript n for the subscript p.

Given Assumptions 1 and 2 above, the student load in each category can be expressed as a fraction of the total annual student load of pilots or NFO's, S_p or S_n.

$$S_{p_1} = .60\ S_p \qquad S_{p_4} = .04\ S_p$$

$$S_{p_2} = .27\ S_p \qquad S_{p_5} = .01\ S_p$$

$$S_{p_3} = .08\ S_p$$

If $S = 220$

and $S_p = .5S$

then $S_p = 110$

and therefore

$S_{p_1} = 66.0$; $S_{p_2} = 29.7$; $S_{p_3} = 8.8$; $S_{p_4} = 4.4$; $S_{p_5} = 1.1$

then equation [2] becomes

[3] $R_{p_{total}} = 66.r_{p_1} + 29.7.r_{p_2} + 8.8.r_{p_3} + 4.4.r_{p_4} + 1.1.r_{p_5}$

Given Assumption 3, the resource requirements for training students of categories 2 through 5 can be expressed as fractions of the resource requirements for category 1 students.

$r_{p_2} = .8\ r_{p_1}$; $r_{p_3} = .5\ r_{p_1}$; $r_{p_4} = .1\ r_{p_1}$; $r_{p_5} = .3\ r_{p_1}$

Substituting these values in equation [3] results in

[4] $R_{p_{total}} = 66r_{p_1} + 29.7 \cdot .8r_{p_1} + 8.8 \cdot 5r_{p_1} + 4.4 \cdot .1r_{p_1} + 1.1 \cdot 3r_{p_1}$

$R_{p_{total}} = 95r_{p_1}$

and by the same reasoning

$R_{n_{total}} = 95r_{n_1}$

The annual requirement for resource R for the total student load of pilots and NFO's together is then

$R = R_{p_{total}} + R_{n_{total}}$

or

[5] $$R = 95\,(r_{p_1} + r_{n_1})$$ Annual requirement for resource R for VF-101 and VF-124 combined

The computation of the average daily requirement R_D for resoure R is based on the average number of working days per year, w.

$$w = 50 \text{ work weeks} \times 5 - \text{holidays} - \text{average stand down days}$$

$$w = 50 \cdot 5 - 9 - 2$$

$$w = 239$$

therefore

$$R_D = \frac{R}{w} = \frac{95}{239}\,(r_{p_1} + r_{n_1})$$

or: $$R_D = .397\,(r_{p_1} + r_{n_1})$$

rounded up:

[6] $$R_D = .40\,(r_{p_1} + r_{n_1})$$ Average daily requirement for resource R for VF-124 and VF-101 combined.

By the same chain of reasoning, formulas can be derived which allow the computation of monthly resource requirements at either squadron. These formulas are based on the assumption that 60% of the student load S will be carried by VF-124 and 40% by VF-101.

[7] $$R_{124_m} = 4.83\,(r_{p_1} + r_{n_1})$$ Monthly requirement for resource R at VF-124

[8] $$R_{101_m} = 3.22\,(r_{p_1} + r_{n_1})$$ Monthly requirement for resource R at VF-101

Results. The TSRA definition phase resulted in projections for out-year support requirements which were based on the proposed syllabus as it was defined at that point in time. It should be noted that these these projections changed as the syllabus underwent further refinement as a result of the development process and user squadron inputs. These changed projections were documented in update reports and the final TSRA report. The updating was accomplished with the same methods that led to the initial projections, i.e., by means of a fairly manpower-intensive manual process. This experience showed clearly that significang cost savings could be obtained, if the TSRA process could be supported by computer software, which would enable the development team to not only maintain a resource data base keyed to syllabus events but also to investigate quickly the results of any syllabus manipulations or resource changes. A data base of this nature could furthermore be used for managmement purposes over the life cycle of the training program.

The TSRA resulted in specific recommendations for changes in the available facilities and the on-board training equipment at both squadrons as well as in specific figures for daily, weekly monthly or yearly requirements of all major resources. These resource requirements are shown below by squadron in Table 3 and Table 4.

Table 3.

VF-124 Resource Requirements Summary

A. PERSONNEL

Function	Total/Type Required	Due In/ On Hand	Needed
1. Management	ISD Model Manager	Staffed	None
	Media Manager	Staffed	None
2. Instructors	14-20 Instructor Pilots	23 Instructor Pilots	
	22-31 Instructor RIO's	30 Instructor RIO's	2 Instructor RIO's (minimum)
3. Support	2 Non-rated Sailors	Staffed	None
	3 Rated YN or DM Sailors	Staffed	None
	1 Compugraphics Operator	Contractor Support	Support past FY81
	1 Educational Specialist	Position Vacant	1 Ed. Spec.

B. MATERIAL/SERVICES

Category	Total/Type Required	Due In/ On Hand	Needed
1. Student Material Reproduction	2500 pages/student 440,000 pgs/yr	None	440,000 pgs/ yr
	4 notebook binders/ student 600 binder/yr	None	600 Notebook binders/yr
	5 comb binders/ student 750 binder/yr	None	750 comb binders/yr
2. Student Material Revision	180 printed pgs/yr 1.2 rolls of compugraphic film per year	Provided by FASOTRAGRUPAC	1.2 rolls of film/yr
3. Media Revision Services	up to 450 slide changes/yr. up to 5 sound/ slide script changes/ yr.	Contractor support through FY81	Support past FY81

C. **EQUIPMENT**

Resource	Total/Type Required	Due In/ On Hand	Needed
1. Aircraft	39 sorties/day	25 sorties/ day	14 sorties/day
	1050 flt. hrs/mo.	775 flt. hrs/ mo.	275 flt hrs./ mo.
2. Trainers			
MT	11.3 hrs/day	15.2 hrs/day	None
3. Study Carrels	24 carrels (shared w/VAW 110)	24 carrels equipped	None
	2.62 hrs/day/ carrel	8 hrs/day/ carrel	None
4. 16mm Gun-sight Camera	8 KB26B	2	6
5. Gunsight Camera Film Projector	1 Photo Optical Data Analyzer (PODA)	1	0
6. HUD Camera	15 CTVS Fairchild camera	1	14
7. Video Recorder for HUD Camera	15 TEAC V-1000	2	13
8. Video Playback for above film	1 TEAC V-4200	0	1
9. Mission Cas-sette Recorder	20 Sony M-201	20	0
10. Overhead Projector	3	0	0
11. Videotape Camera and Recorder	1 AVC-3400	1	0
12. Caramate	6 Kodak	2	4
13. Random Access Slide Projector	3 Kodak RA-960	3	0
14. 16mm Movie Projector	3 Kodak AV12E6	3	0
15. Study Carrel	25	25	0
16. 35mm Slide Projector	25 Kodak AF-2	25	0
17. Audio Cassette Player	25 VM-752	25	0
18. Video Cassette Player	20 Sony VP-1000	20	0
19. Color Monitor	20 Sony CVM 1200UA	20	0
20. Word Processor	1 Compugraphic	1	0
21. Copier	1 Xerox 9400	1	0
22. ATSS Terminals	3	3	0

D. FACILITIES

Resource	Total/Type Required	Due In/ On Hand	Needed
1. Classrooms	5 Mediated Classrooms	5	0
2. Briefing rooms	6	6	0
3. Study areas	400 sq. ft.	225 sq. ft.	175 sq. ft.
4. Ready room	1400 sq. ft.	1400 sq. ft.	0

Table 4.

VF-101 Resource Requirements Summary

A. PERSONNEL

Function	Total/Type Required	Due In/ On Hand	Needed
1. Management	Media Manager	Staffed	None
2. Instructors	13-19 Instructor Pilots	19 Instructor Pilots	3 Instructor Pilots (minimum)
	21-29 Instructor RIO's	17 Instructor RIO's	12 Instructor RIO's (minimum)
3. Support	2 Non-rated Sailors	Staffed	None

B. MATERIAL/SERVICES

Category	Total/Type Required	Due In/ On Hand	Needed
1. Student Material Reproduction	2500 pages/student 385,000 pgs/yr	None	385,000 pgs/ yr
	4 notebook binders/ student 600 binder/yr	None	600 Notebook binders/yr
	5 comb binders/ student 750 binder/yr	None	750 comb binders/yr

C. EQUIPMENT

Resource	Total/Type Required	Due In/ On Hand	Needed
1. Aircraft	39 sorties/day	25 sorties/ day	14 sorties/day
	1050 flt. hrs/mo.	775 flt. hrs/ mo.	275 flt hrs./ mo.
2. Trainers			
MT	11.3 hrs/day	15.2 hrs/day	None
3. Study Carrels	24 carrels (shared w/VAW 110)	24 carrels equipped	None
	2.62 hrs/day/ carrel	8 hrs/day/ carrel	None
4. 16mm Gun-sight Camera	8 KB26B	2	6
5. Gunsight Camera Film Projector	1 Photo Optical Data Analyzer (PODA)	1	0
6. HUD Camera	15 CTVS Fairchild camera	1	14
7. Video Recorder for HUD Camera	15 TEAC V-1000	2	13
8. Video Playback for above film	1 TEAC V-4200	0	1
9. Mission Cassette Recorder	20 Sony M-201	20	0
10. Overhead Projector	3	0	0
11. Videotape Camera and Recorder	1 AVC-3400	1	0
12. Caramate	6 Kodak	2	4
13. Random Access Slide Projector	3 Kodak RA-960	3	0
14. 16mm Movie Projector	3 Kodak AV12E6	3	0
15. Study Carrel	25	25	0
16. 35mm Slide Projector	25 Kodak AF-2	25	0
17. Audio Cassette Player	25 VM-752	25	0
18. Video Cassette Player	20 Sony VP-1000	20	0
19. Color Monitor	20 Sony CVM 1200UA	20	0
20. Word Processor	1 Compugraphic	1	0
21. Copier	1 Xerox 9400	1	0
22. ATSS Terminals	3	3	0

D. FACILITIES

Resource	Total/Type Required	Due In/ On Hand	Needed
1. Classrooms	3 Mediated Classrooms	3	0
2. Briefing rooms	4	4	0
3. Study areas	300 sq. ft.	300 sq. ft.	0
4. Ready room	1200 sq. ft.	1200 sq. ft.	0

STUDENT TRAINING COURSES: LESSON FORMATTING AND SEGMENT SPECIFICATION.

Duration of Task: November, 1977 - December, 1979
Mandays Expended:

Program Manager	99
Instructional Psychologist I	414
Instructional Psychologist II	205
Instructional Technologist I	297
Subject Matter Expert	809
Clerical	576
TOTAL.	2500

The original procedure followed in the development of lesson specifications (see Figure 21) included fifteen steps and had very heavy emphasis on early SME input to ensure technical accuracy and completeness from the start. This procedure was later revised when it became apparent that the necessary SME manhours were not available. The revised procedure required less SME time and more early design review, and resulted in equal or higher output quality than the original procedure.

The original lesson specification development procedure began with the contractor instructional designer researching the subject matter area. Following this, a Navy SME was scheduled to review the planned objectives for the lesson and to identify critical lesson content. After meeting with the SME, the lesson content was organized by the instructional designer and reviewed with a contractor instructional psychologist to establish a lesson plan. At the completion of this review, the instructional designer wrote generalities and generality support. After the generalities and support were written, the lesson specification was again delivered to the SME for review and discussion, after which the first draft was assembled. Instructional psychologists reviewed the draft lesson specification for content and instructional effectiveness. The draft was revised and typed, and again submitted to the Navy for SME review. Based on the Navy's comments, the draft was again revised and a final copy delivered to the Navy for SME and Navy ISD approval.

This procedure was found to be unsatisfactory from two standpoints. First, Navy SME's were hard pressed for time, and could not meet the obligation required by this development procedure. Secondly, it was found that the instructional design inputs (primarily the organization of the instructional material) occurred too late, which frequently led to major revisions at a point where only minor revisions should occur. For these reasons, the original development procedure was revised as shown in Figure 22.

The revised procedure allowed more appropriate utilization of existing staff talents throughout the specification production process. The major change in the process was the addition of the development of an outline which forced the lesson specification authors

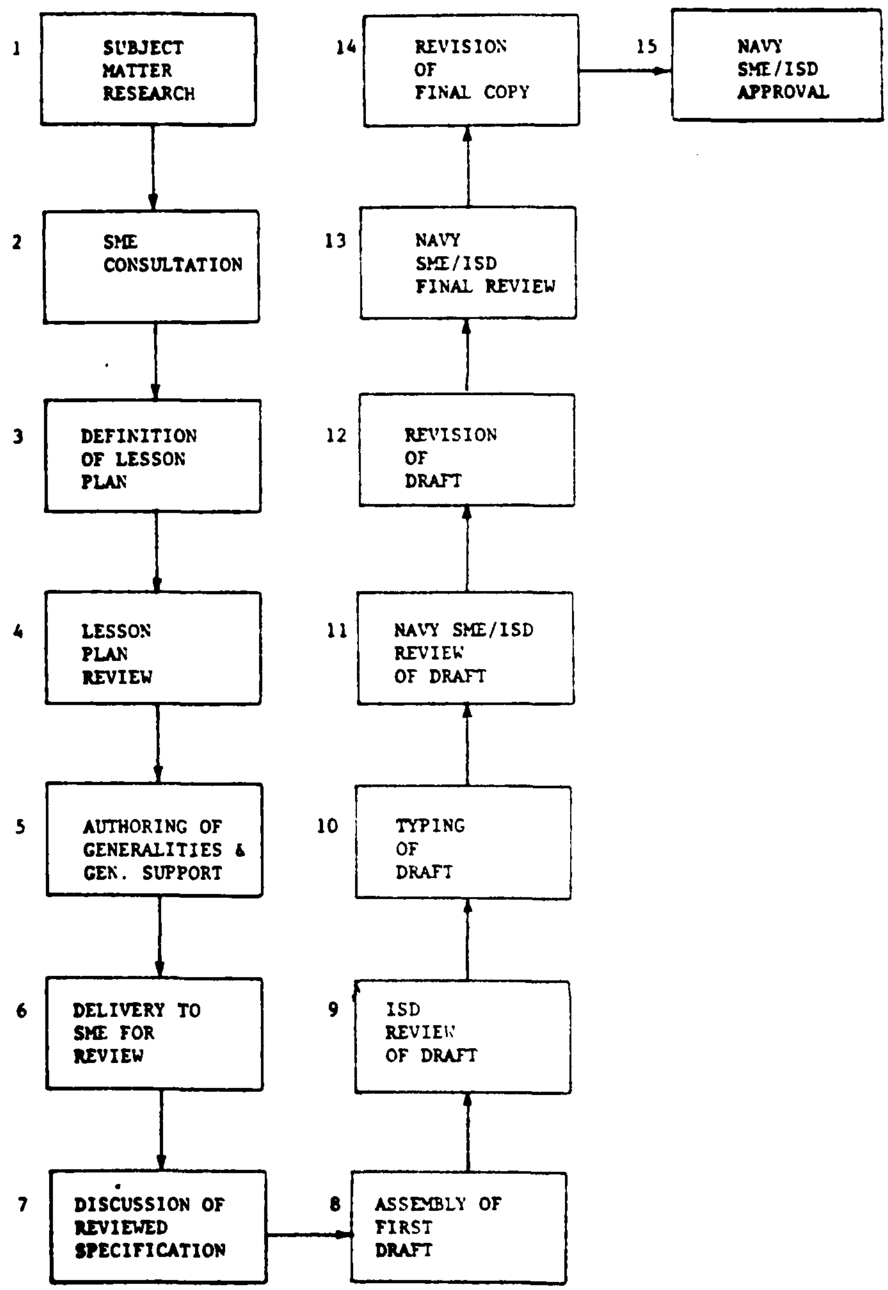


Figure 21. Original Lesson Specification Development Process

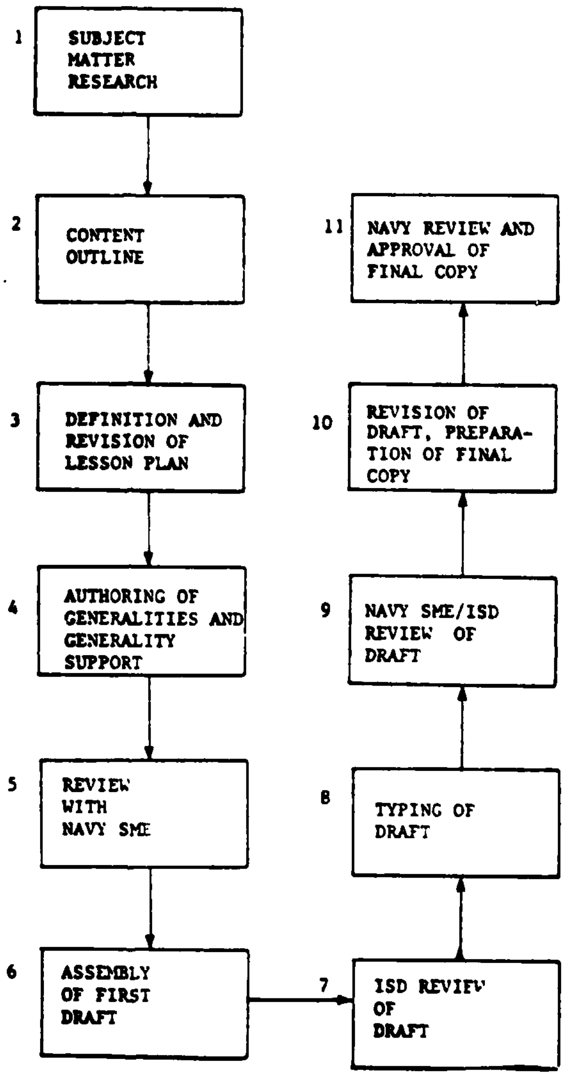


Figure 22. Revised Lesson Specification Development Process

to concentrate on the structure of the lesson material and permited precise and early design decisions by the instructional psychologists. Again, the process started out with subject matter research. The instructional designer obtained, read and studied appropriate existing material in the NATOPS manuals, pocket checklist, briefing guide, lecture guides, etc. He also viewed existing slide tapes or video tape lessons. If possible, he attended appropriate lectures or trainer events and consulted with the NATOPS officer for the latest subject matter changes. He also consulted, at this time, with the Navy SME concerning points of ambiguity of material. Then, after he grouped and ordered his research material on the instructional topic, the author developed a detailed and well structured outline of the lesson or group of lessons assigned to him. Based on this outline, a lesson plan was developed which subdivided the lesson into segments, each addressing one objective. The lesson plan development included finalizing the lesson objectives, structuring of the generalities and determining number and form of practice and testing items. Following development of the lesson plan, generalities and generality support were written and then reviewed by Navy SME's. Following this review, a complete lesson specification was assembled in draft form and reviewed by an instructional psychologist. The draft was revised, typed, reviewed again with Navy SME's, revised as necessary, and then finally delivered to the Navy. This procedure required fewer Navy SME manhours, reduced contractor in-house revisions and allowed for a more efficient utilization of in-house SME capabilities.

With this general process overview as a background, the following paragraphs provide a more detailed discussion of the specific procedures and problems associated with exercising quality control over technical content, instructional design and formal standardization.

<u>Ensuring Technical Accuracy and Completeness</u>. Ideally, the quest for technical accuracy should begin with a review of the lesson objectives between the Navy SME and the lesson specification author. This review <u>should</u> yield finalized terminal and enabling objectives for a given lesson. This did not work for two reasons. First, Navy SME's were in very short supply, and an attempt to schedule them separately for this process was found to be inefficient. Second, subject matter experts don't have the requisite instructional technology training to provide meaningful assistance at this point, therefore, the initial SME review of technical input was moved to a point where the SME had an opportunity to review not only objectives but also generalities and generality support in written form at the same time. The SME then had a second opportunity for input in step nine, where the entire leson specification was available, including practice and testing.

The SME reviews were accomplished in one of two ways. One was to sit down face-to-face with the SME and to discuss the entire material point by point; the other was to leave the lesson specification with the SME and to obtain written comments. It was found that the best choice was to hard-schedule SME's for a face-to-face lesson review. This not only provided immediate technical feedback but it also eliminated a considerable amount of wasted time spent in tracking down SME's who were typically engaged in the more urgent tasks of trying to accomplish the current syllabus.

The teamwork between the instructional designer or lesson author and the SME was generally a very effective, if not always efficient, mechanism for producing technically correct lesson material. In a situation where the subject matter existed only in the heads of the SME's, and where frequent changes of procedures and hardware occured, it was the only available method of generating materials that were technically acceptable to the user. The fact that the instructional designer and the SME had slightly different orientations to the problem of designing new materials occasionally created obstacles which detracted from the efficiency of the process. Typical problems were:

a. Focusing the SME's critique on the technical information: In most cases, the SME for a given topic was the officer who had taught this topic for some time. In the course of his teaching the SME had usually developed an instructional strategy which differed from the strategy suggested by the instructional designer, especially where the topic was taught in lecture form by the SME, and was taught by a slide/tape presentation in the new program. The issues of strategy then tended to become the primary focus of the discussion and quality control of the technical material could only be assumed after a clarification of the purpose of the review.

b. Restricting content to "need-to-know" material: The SME for a given topic was, by choice and by definition, a specialist in that topic and knew much more than a student either needed to know or should have known at this stage of training. This problem, i.e., the expert's difficulty in putting himself into the role of the novice and non-expert, tended to result in attempts to "stuff" too much and/or unnecessary material into a given instructional event. It was therefore important that the instructional designer elicited information from the SME as to why a given piece of content material was needed by the student and why it was needed at that stage of training, and for that objective or behavioral outcome.

c. Obtaining the most experienced SME: Ideally, the SME for any area should have been the officer who was most experienced (in spite of the drawbacks this entails, as discussed above). The operational experience of seasoned pilots and NFO's represented one of the most valuable sources of information available to this project and it was that experience which needed to be passed on to the students.

Unfortunately, the user squadron was continually plagued with manpower problems and the most experienced aircrew members were the the ones which were most burdened with collateral duties and thus least available.

d. Switching SME's: Another consequence of the user's manpower shortage was that in some cases it became necessary for one SME to take over a lesson from another SME in midstream. This was valuable on the one hand because it provided a second opinion. On the other hand, such switches led to some duplication of effort, repeated revisions and thus to decreased efficiency of the process.

In most projects of this type, these problems are probably unavoidable and are intrinsic features of the process. It can be assumed that some of them could be at lease partially solved by SME training. However, for that solution to be efficient, the SME training would have to be restricted to a cadre of experienced aircrew members who for the duration of the program, would have no other collateral duties except acting as technical advisors to the contractor. In reality however, it is easier to train an SME to speak the language of the instructional designer than to turn the latter into an SME, but this training is still time consuming. Ideally, the contractor or instructional design agency, should have its own staff SME's. Such a contractor thus has the benefit of a rather smooth and efficient interaction with squadron SME's. Under different circumstances however, an ISD-trained SME cadre would seem to be the only *really* viable model for ensuring quality control of the technical material.

Ensuring Soundness of Instructional Design. There are four basic criteria for determining the soundness of instructional design:

a. The objectives must be worthwhile and technically correct.

b. There must be an exact congruency between the objective, the generality and support, and the practice and testing.

c. There must be a sound prerequisite relationship between objectives within the lesson and between lessons in the curriculum.

d. The components of the lesson specification, that is the generality, generality support, practice and testing and instance specification, must contain all required elements and must be in technically correct form.

Extensive measures were taken to ensure that the first criterion, adequacy of the objective, was met. The lesson specification author researched his assigned subject matter area using the original objectives as guidelines. Following this research he produced a detailed content outline. At this point, the author and the instructional psychologist finalized the objectives to ensure that they are both technically correct as well as worthwhile to the instructional program. Experience has shown that the objectives created on the basis of the task analysis are good preliminary or "working" objectives and that they define the domain of behaviors to be acquired very well. However, only detailed subject matter research and a good outline will permit the developer to focus precisely on the desired behavior, conditions and standards. During this intensive and very detailed involvement with the subject matter, it frequently becomes apparent that objectives must be changed in some way, i.e., either the action statement, the conditions or the standard must be reformulated, enabling objectives must be added or deleted, and compound objectives split up into simpler objectives.

During this time of finalizing the objectives with the outline in hand, the structure of the generalities was established and practice and testing was determined in terms of type, method and number of items. The instructional psychologist also ensured that there was an exact congruency between the objectives, the generality and support and the practice and testing. Finally, lesson objective hierarchies were developed and hierarchical relationships between lessons were reexamined. The definition of the lesson plan was thus the step where all significant instructional design inputs were made and were an initial quality check of the first three criteria (a through c above) took place.

Next, after Navy SME review the lesson specification author wrote generalities and supports and assembled a complete draft. This draft was then reviewed by the instructional psychologist to provide a final check on criteria a through c and to check criterion d. Quality control at this point was extensive. The contractor developed a detailed checklist for this step. This checklist utilized a series of questions to test each component of any given lesson specification. In order to pass, all questions had to be answered positively.

These lesson specification review procedures worked extremely well and resulted in a high and consistent output quality. The checklist was not only useful to the instructional psychologist in the quality control process, but also to the authors who wrote lesson specifications. Furthermore, positive comments were received from the media developer following the introduction of this document to the development process. The media developers found the specifications to be more clear, concise, and easy to follow when writing scripts and slide/tape presentations.

Ensuring Formal Correctness and Standardization. There were four criteria for determining the formal correctness of the lesson specifications.

a. All the components are present and in order.

b. Each component is correctly identified.

c. Standard terminology is used.

d. There are no typographical errors, spelling errors, etc.

The method for controlling formal correctness and standardization consisted of four substeps. First, the checklist discussed previously was used to determine that all the parts were in order and that everything was correctly identified. The typist, after typing the lesson specification, proofread it for typographical and spelling errors. It was then given to the author who proofread it again for technical accuracy and standard terminology. Finally, the instructional psychologist spotchecked it and verified the quality of the final product.

<u>Time Requirements</u>. The time required to insure the quality of the lesson specifications was consistently higher than expected for two reasons: the requirement of the instructional design process and the SME availability. First, the design model, Military Specification MIL-T-29053, which was used in this contract, required lesson specifications which represent essentially a new design device. Therefore, there were very few examples and even less experience to draw upon. Nearly all contractor personnel working on this project had to go through an intensive learning process which included both formal training sessions and on-the-job training.

The other problem was Navy SME availability. From the beginning, VF-124 was overtasked with the requirement for providing technical inputs to the lesson specification process. The contractor found over and again that, in spite of sincere squadron efforts, the SME's were just not available and could not be scheduled for the number of manhours needed. SME participation, therefore, was consistently below the level requested. This delayed the work output, not only by making it more time consuming to collect the necessary technical data but also because each hour given by an SME required an hour of contractor time. If the SME's time had been dedicated more exclusively to this project, SME's could have worked more indepentently, and thus increased the output considerably without impact on contractor instructional developer time.

<u>Summary</u>. Overall, the procedures and methods for quality control of lesson specification authoring resulted in high quality lesson specifications. Initially, some refinements to the procedures were necessary and extensive in-house training had to be developed. It was found that the procedures used were workable both with in-house lesson specification authors and with Navy SME's. Time requirements for quality control were initially excessive, but were reduced over time.

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Summary. Overall, the procedures and methods for quality control of lesson specification authoring resulted in high quality lesson specifications. Initially, some refinements to the procedures were necessary and extensive in-house training had to be developed. It was found that the procedures used were workable both with in-house lesson specification authors and with Navy SME's. Time requirements for quality control were initially excessive, but were reduced over time.

In addition, some quality control input was received from the media producer who used the lesson specification. In general, such input was desirable, since the lesson specification designer and the media producer are normally different people, with different requirements for utilizing the lesson specification. These requirements cannot always be perfectly anticipated by the lesson specification developer.

STUDENT TRAINING COURSE MATERIALS.

Duration of Task: May, 1978 - May, 1980
Mandays Expended:

Program Manager	35
Instructional Psychologist I	157
Instructional Psychologist II	234
Instructional Technologist I	166
Subject Matter Expert	838
Clerical	483
TOTAL	1913

Prototype Production of Lesson Materials and Tests. Prior to large-scale development of the student training materials, the formats for each type of course material were developed and finalized. This process (see Figure 23), began with the selection of one prototype lesson specification for each media type. While there were no hard and fast criteria for the selection of the topic of each of these prototype lessons, there were some considerations. One consideration was the location of the lesson within the syllabus, and another, to what degree this lesson was representative of the lessons to be produced in that type of medium.

The second step in the process was to develop a single format based on the type of medium developed. There were several questions that drove the design of each of the media formats. These questions were:

a. How can the generality best be highlighted in this type of medium?

b. How can practice and feedback be most effectively integrated through this type of medium?

c. What is the clearest, most straightforward way to organize material within this medium for optimal instructional effectiveness?

d. How can the format lend itself to easy access of information on the part of the student at a later date?

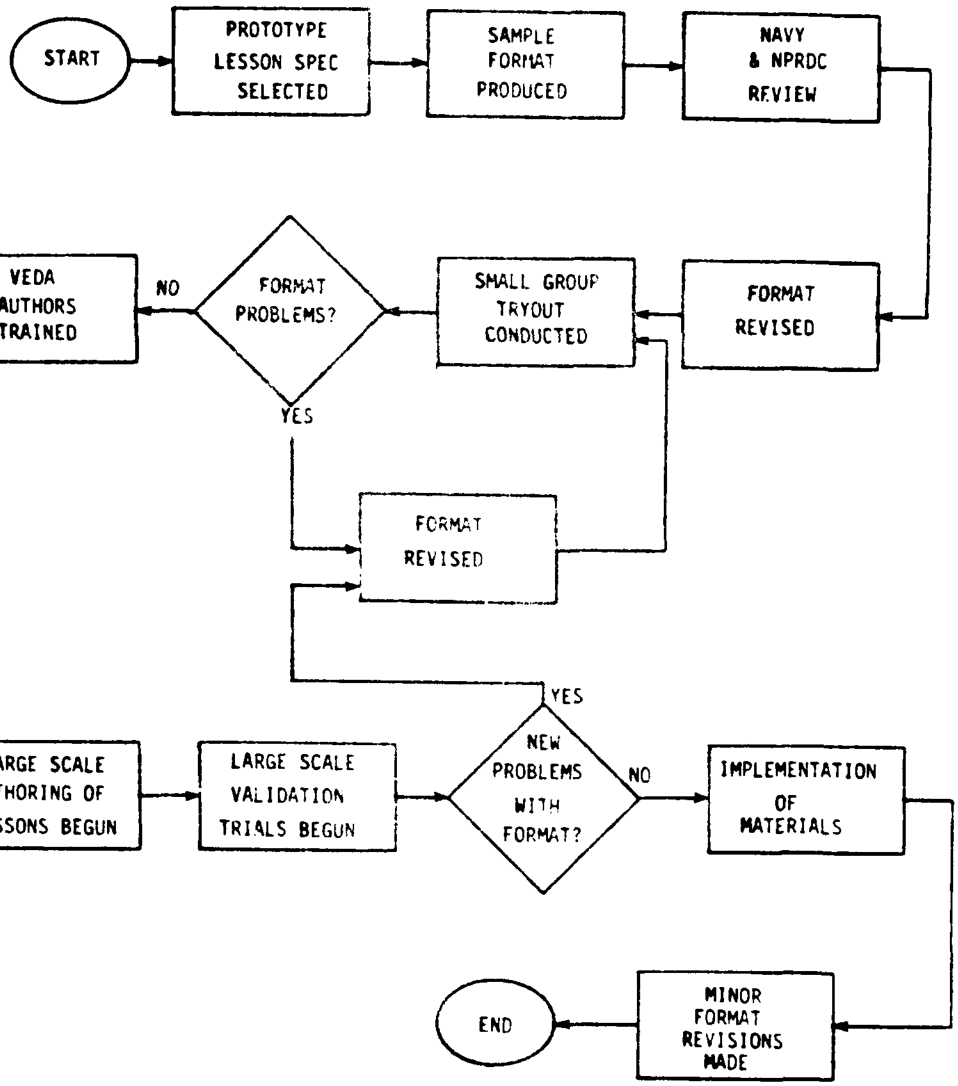

Figure 23. Prototype Lesson Format Development Process

c. How should the lesson parts be sequenced for optimal effectiveness?

Once each of the formats was developed, it was presented to the Navy for approval. The formats were generally reviewed by a small group, in a conference setting. The group usually included four or five Navy personnel, including the ISD officers, SME's and consultants from NPRDC. Once the format was agreed upon, it was tried out on a small group of students. In most cases, it was difficult for the student to give much input about the usefulness of the formats since they had no basis for comparison. Conversely, the instructors always had input which, understandably, was usually concerned with the ease of use of the format. Usually any given prototype event went through several revisions before it was considered ready for large scale production. As the flow chart shows, provisions were made to permit format changes even after the start of large scale production.

Training Contractor Authors. Once the formats were finalized, contractor authors were trained as to what would be contained under each of the major headings in each format. For example, in the case of trainer briefing guides, there were headings such as: training exercises, training objectives, reference material, etc. There was also a heading called "reference material" contained in flights. All authors needed job aids as well as training sessions to be able able to produce high quality, standardized course material components under each heading. Each author spent approximately one day reading the reference materials and producing practice components. He received feedback from in-house experts and then proceeded with an OJT phase over the next two weeks. During the OJT phase, his output was continuously checked and feedback was provided as frequently as possible. After the OJT phase, normal quality control procedures were employed.

Large Scale Production. One general overall procedure was used for the development of all lesson materals (see Figure 24). The first step in this procedure began with a Navy approved lesson specification, that contained all the component parts necessary for authoring the lessons, such as objectives, generalities, generality support, instances and practices, testing and examples.

Once the author had the approved lesson specification, he gathered all pertinent reference material that might be helpful in authoring the lesson material. This step was required primarily when the lesson specification (LSP) author was not also the training materials author. Even though the LSP should have satisfied all informational needs, it did not and could not answer all the technical questions that an author might have when translating the LSP information into smooth discourse.

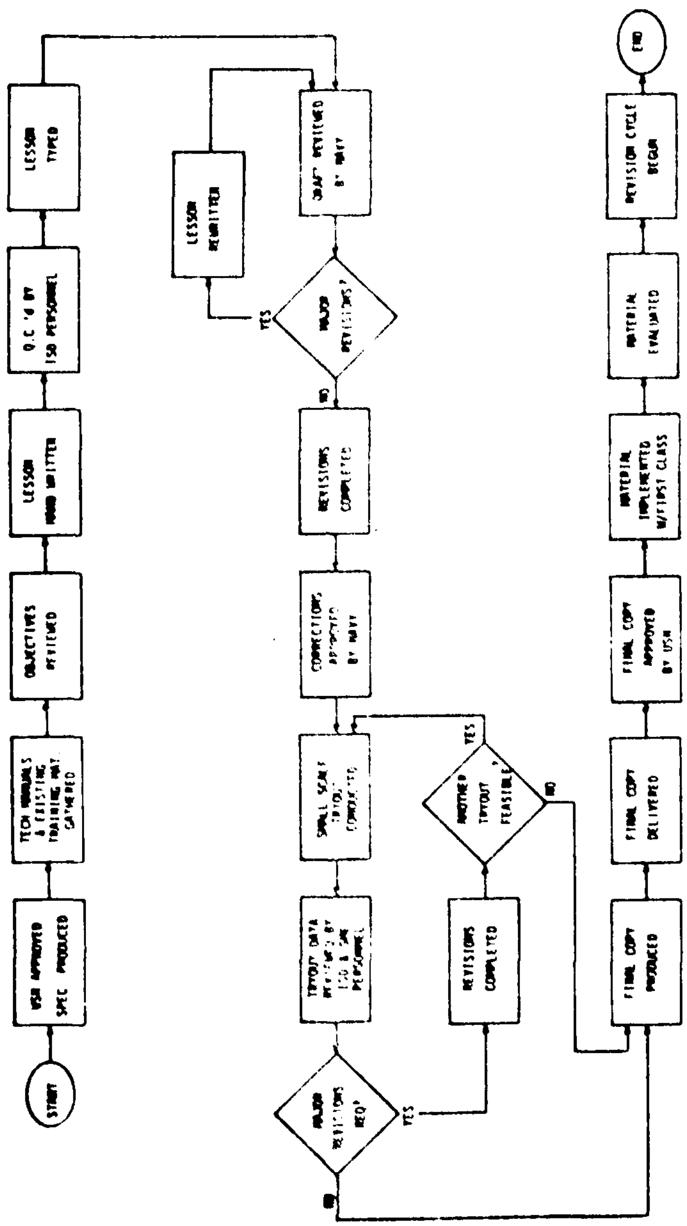

Figure 24. STC Materials Development Procedure

Next, the objectives were reviewed again. In some cases, changes in action verbs, criteria and standards were suggested by the subject matter on the one hand and by practical considerations on the other hand.

Next, the lesson was written out by hand. This was the most lengthy portion of the authoring process, and it frequently required additional interface among contractor and Navy SME's.

Once the first draft was written by hand, contractor ISD specialists reviewed the lesson for internal consistency, format and instructional effectiveness. At this point, the lesson was typed in the first rough draft.

It should be mentioned at this point, that often, toward the end of the project, the lesson materials were reviewed by Navy SME's in the handwritten form. This is particularly true of lecture guides. This intermediate step was taken to prevent major revisions of typed materials.

Once the lesson was typed, it was sent to the Navy and reviewed by both the ISD officer and the Navy SME for that particular subject matter area. If major revisions were required, there was usually a meeting between the SME and the contractor author, during which the revisions were defined. The lesson was then rewritten and sent back to the Navy for review.

At this point, after the Navy approved the corrections, the material would go through a small group tryout of a form dependant upon the medium.

Once the event had been tried out, Navy & contractor SME's and instructional designers made decisions about how the lessons might be altered to improve them and make them more effective. Depending upon the kinds of revisions that were required, the materials either went through another authoring process, or were revised on a small scale, and then put into final production.

The final production process was also a fairly labor-intensive procedure. It involved a great deal of editing and review of final copy for typos, format, type sizes, etc. It required at least three people to proof the final copy: an editor, an SME, and the production supervisor.

Once the final copy was complete, it was delivered to the Navy and subsequently approved by Navy ISD personnel. This completed the first full cycle of production of materials, after which time the material was implemented and used by the first class. Once the first class was through using sections of the instructional materials, the revision process, which entailed an entirely new cycle of revisions and corrections, began.

QUALITY CONTROL PLAN & REPORT.

Duration of Task: November, 1977 - October, 1979
Mandays Expended:

Program Manager	8
Instructional Psychologist I	10
Instructional Psychologist II	36
Instructional Technologist I	30
Subject Matter Expert	3
Clerical	8
TOTAL	95

This section outlines the procedures used for quality control during the accomplishment of the project. Figure 25 depicts the entire quality control process including formative evaluation, internal quality control, and external quality control. Outyear quality control will not be a subject of this section.

The quality control procedures, while very complex, were not unlike the general procedures followed in most traditional ISD projects. For purposes of simplification and summarization, the process has been reduced to eleven steps.

STEP 1: Input. In the development of the lesson materials for the F-14 Aircrew Training Program, the quality control procedure began with the following inputs: lesson specifications, draft of learning materials and, blank data collection forms. During the lesson specification stage, there were several quality control reviews undertaken, both instructionally and technically. That is, instructional designers and subject matter experts reviewed lesson specifications before authoring of the materials for instructional soundness and technical accuracy.

STEP 2: Instructional Review. Once the instructional materials were drafted, the first person to review and make suggestions for revision was the senior instructional psychologist who provided input on the first several drafts of each individual media. Once formats had been established, the process was then turned over to an instructional technologist who ensured that lesson materials adhered closely to lesson specifications, were instructionally sound, and were readable, clear, and concise.

STEP 3: Technical Review. Once the lesson author received suggestions for revision from the instructional psychologist, he revised materials and submitted them to a Navy subject matter expert. The Navy SME in that phase area reviewed the instructional materials draft prior to tryout. Revisions to the instructional materials at this point were coordinated through the contractor lesson author.

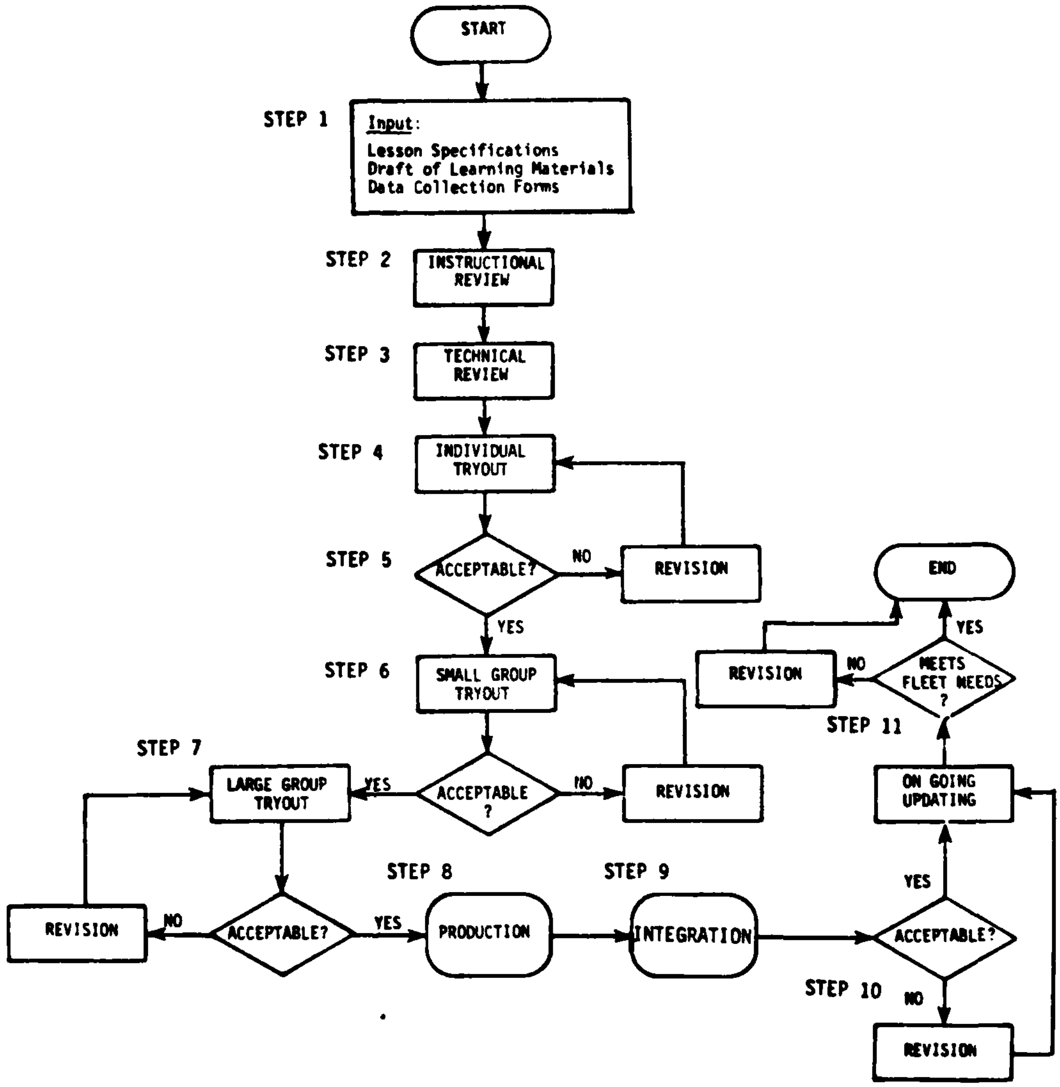

Figure 25. Quality Control Process

STEP 4: Individual Tryouts. When time permitted, individual tryouts were conducted with all lesson materials. More often than not, however, individual tryouts were only conducted with texts and tests due to severe time limitations. The individual tryouts were conducted relatively informally by in-house contractor SME's who assumed the role of students.

STEP 5: Acceptable? After the individual tryouts, the most apparent or obvious problems were identified, and materials were then revised accordingly.

STEP 6: Small Group Tryout. Small group tryouts were conducted for all replicable events. Slide tapes were the largest single medium evaluated by this method. The groups varied in number from four to six current FRS students. Pre and post testing was also conducted and student attitude questionnaires were completed on each lesson tried out.

The final test scores of the small group together with the information obtained from the student attitude inventory resulted in another revision to the instructional material. Once this revision was completed, the materials were then considered ready for implementation.

STEP 7: Large Group Tryout. The large group tryouts occured during implementation since time and student availability made these tryouts infeasible prior to implementation. Again, test data was analyzed, and student and instructor attitude questionnaires were used as the basis for revisions. Most slide tapes were of pre-production quality during these tryouts and did not go into final production until after implementation.

STEP 8: Production. During this step of the quality control procedure, the final materials were reviewed by an instructional designer for instructional quality, a contractor SME for technical accuracy, a technical editor for clarity, conciseness and typing accuracy, and finally by the Navy.

STEP 9: Integration. Once materials were completed in final form, they were integrated into the syllabus.

STEP 10: Revision. Materials were monitored very closely through student test results and printed questionnaires. Both instructional psychologists and technologists and SME's regularly reviewed questionnaires and made updates and/or revisions to the instructional materials as required.

STEP 11: Meet Fleet Needs? Detailed plans have been described in earlier reports for collecting data from the fleet regarding graduate performance and adequacy of the course in meeting fleet needs. Most of this data will be collected continuously by questionnaires and interviews after the graduates have been in an operating squadron long enough to demonstrate performance.

To summarize, the quality control procedure in the development of lesson materials can best be described as an iterative process. At several points during the development of the materials, they were reviewed by SME's, instructional designers, and by typical students. Before implementation, the students interacted with the materials as though the materials were part of the current syllabus. As a result, data on practice and feedback items and test scores were used to revise the materials. This was accomplished so that as the material became a permanent part of the syllabus, they would be in the best form possible. Plans have been made for lesson materials to be continuously subject to review and reassessment throughout the life cycle of the training program.

IMPLEMENTATION PLAN.

Duration of Task: September, 1977 - October, 1979
Mandays Expended:

Program Manager	28
Instructional Psychologist I	39
Instructional Psychologist II	63
Instructional Technologist I	34
Subject Matter Expert	8
Clerical	12
TOTAL	184

The F-14 ISD project involved replacing one training system with another training system. Since this replacement had to be accomplished without stopping the constant flow of graduates, the implementation of the revised training system required very careful planning. This section discusses the development of the implementation plan. The steps are represented in a detailed flow diagram in Figure 26.

STEP 1: Compare the Proposed and the Existing Training Systems. In this step, the principle features (the length, type of sequencing, degree of individualization, degree of self-pacing, media mix and predominant instructional strategies) of the existing and new training systems were compared with each other. Most of the data required for this comparison was contained in the Training Support Requirements

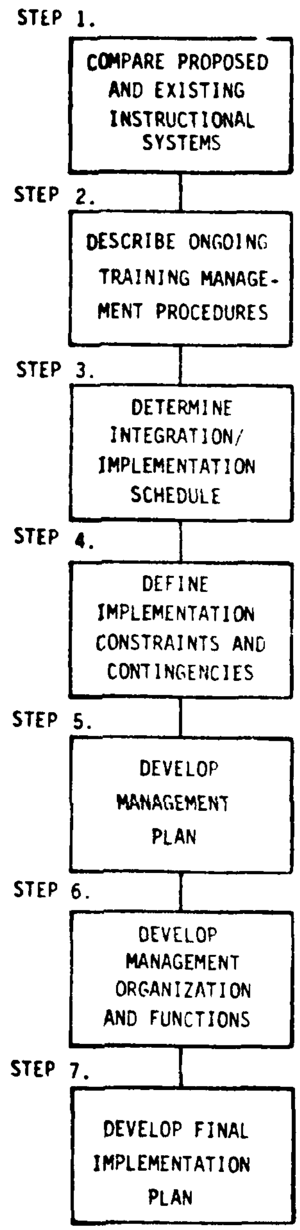

Figure 26. Implementation Plan Development

Analysis (TSRA). The result of this step was a syllabi identification of the factors which would affect implementation. These results provided inputs to the development of the plan for implementation of the new syllabus.

STEP 2: Describe Ongoing Training and Management Procedures. The task of implementation of the proposed F-14 program was facilitated by the existence of an ongoing training program. It was determined that the existing procedures for administration, student management, and facilities usage were acceptable for implementing the proposed system. This decision was reached through a series of interviews with Navy personnel in conjunction with in-house expertise. These results determined the areas of the existing system needing detailed plans and procedures for management.

STEP 3: Determine Integration/Implementation Schedule. This step established the major events to take place in setting the stage for implementation of the proposed system. All the required activities were shown on detailed time lines arranged to meet the implementation schedule. The major milestones were:

a. Course Material Development

b. Instructor Training

c. Management Procedures

d. Internal/External Quality Control

STEP 4: Define Implementation Constraints and Contingencies. The ideal implementation of a training program assumes that all components of the system are available for employment at the time of implementation. Unfortunately, it was determined in the preceding step that implementation would occur with less than the optimum conditions existing. Many components would not be ready for implementation, and, therefore, neither would the final phase of instructor training which required those components. As a result, the contractor and the Navy developed a contingency plan for implementation which would reduce the ramifications of these shortcomings.

STEP 5: Develop Management Plan. As a result of step 2, which defined existing training and management procedures, the various detailed plans for organization and management of the components of the proposed system were developed. These plans were reviewed in draft form by the Navy and then used to develop the final implementation plan. These sub-plans are described in the discussion that follows.

a. Equipment Storage, Maintenance and Facilities Utilization Plan.

This plan detailed the procedures, schedules, and personnel roles and responsibilities involved in equipment maintenance and storage, as well as facilities utilization. Both training squadrons were considered separately, and the data was documented in the TSRA and the subsequent updates to the TSRA. These procedures were essentially in operation at each respective squadron, and no changes were made to the existing mode of operation.

b. Student Management Plan.

This plan also used the existing procedures and schedules in operation within each training squadron. It was felt that there was no change needed to these procedures, especially since greater support from ATSS was becoming available to the squadrons. The only unknown was the student flow rate which was not controllable by the squadrons.

c. Training Materials Management Plan.

The management plan established the detailed procedures and responsibilities for storage, issue, reproduction and maintenance of all training materials. Included here were the procedures and the schedule for the Navy and the contractor to complete final production of all student materials four weeks prior to implementation. Also included were, the procedures for internal quality control of the training materials by Navy personnel. Based on this schedule, the plans for instructor training were then developed.

d. Instructor Management Plan.

This plan established the policies and procedures regarding the utilization of instructors within the instructional system. The plan specified instructor roles and responsibilities with respect to students, materials, syllabus requirements, testing, monitoring, counseling, and instruction. There were two types of instructor training to consider: first, training the instructors onboard prior to implementation, and second, training newly assigned instructors, including instructional management personnel, after the program was implemented. With Navy agreement on these plans, a detailed, time-lined schedule for instructor training was developed which required a start date four weeks before implementation.

e. Syllabus Scheduling and Resource Management Plan.

This plan detailed the procedures and techniques for use in scheduling all resources so that they interfaced properly with the syllabus sequence requirements. The contractor provided training in the use of manual scheduling aids, and also provided ADP compatible data for ATSS syllabus management. The squadrons were able to adapt the requirements of the proposed syllabi scheduling to the existing procedures for daily resource management. The contractor provided a master training course schedule for planning purposes, as well as a unique hierarchical syllabus layout to enable instructionally valid alternatives to a daily scheduling. This type of layout was developed to allow for contingency planning based on daily changes and constraints in resource availability. The existing procedures governing identification and counseling of students with problems, and recycling of students through test points were reviewed and remain unchanged for implementation.

f. Student Grading and Evaluation Plan.
This plan established the procedures for grading and qualification of students. It specified the academic test format and trainer/flight grade sheet format that was to be used to determine the pass/fail or numerical grade for each tested event. The instructor training materials detailed the procedures for training the instructors in the use of these materials. The plan also addressed the requirement for an instructor on duty in the learning center and his defined roles and responsibilities.

STEP 6: Develop the Management Organization and Functions. An analysis of management requirements was performed by the Navy with support from the contractor. This analysis resulted in recommendations for a change in the organization of the Operations department in order to increase the emphasis on training. These organizational changes were made prior to implementation so that the new organizational elements and the lines of communication existed at the time of implementation.

STEP 7: Develop Final Implementation Plan. Based upon the previous steps, the final implementation plan was developed. It consisted of schedules for the processes involved in implementation. These processes included the coordination of delivery and storage of training materials, schedules for the remainder of formative evaluation, internal quality control, and student scheduling.

INSTRUCTOR TRAINING COURSE MATERIALS.

Duration of Task: April, 1978 - December, 1979
Mandays Expended:

Program Manager	11
Instructional Psychologist I	21
Instructional Psychologist II	76
Instructional Technologist I	5
Subject Matter Expert	58
Clerical	9
TOTAL	180

Two deliverables, instructor training course materials and training device instructor/operator training materials, were combined into one in order to streamline the documentation since the training device instructors also taught academics and flights.

In both cases, these materials were developed through the use of the same ISD methodology used in the development of the student syllabi. The tasks to be performed by the instructors were analyzed, objectives were developed from those tasks, and a training syllabus was developed from the learning objectives. The purpose of these materials was to inform the squadron instructors of the ISD methodology that was used in developing their syllabus and to train them in the use of the student training materials that were produced as a result of this project.

The materials were developed primarily by the contractor, however, there was significant interaction with senior SME's at VF-124. In particular, the officer in charge of Instructors Under Training (IUT) and standardization was used as the primary source of information and as the primary reviewer of the materials produced.

There were significant interrelationships between this task and others performed during this project. The instructor training course materials described the revised syllabus, the use of the new training materials, the revised management organization and the role of the instructor in the process of internal quality control. Any changes which occurred in these four tasks would have had an effect on the instructor training materials. For this reason, the final production of these materials occurred late in the project.

The training device instructor/operator training materials were not subject to the effects mentioned in the previous paragraphs. These materials were designed to teach a new instructor to operate the training devices without the need for a tutor. In the past, instructors had been trained in a one on one environment with a qualified instructor, however, this was determined to be an area where self instruction could achieve a reduction in the instructor workload with no reduction in training effectiveness. The materials produced were designed to be partially pre-read after which, hands on exercises at the device console were to be performed.

TRAINING PROGRAM WORK REPORT.

Duration of Task: February, 1980 - June, 1980
Mandays Expended:

Program Manager	5
Instructional Psychologist I	11
Instructional Psychologist II	0
Instructional Technologist I	2
Subject Matter Expert	8
Clerical	4
TOTAL	30

This task was concerned solely with the writing of the Training Program Work Report.

TASK LISTINGS (TARPS).

Duration of Task: August, 1979 - June, 1979
Mandays Expended:

Program Manager	4
Instructional Psychologist I	27
Instructional Psychologist II	41
Instructional Technologist I	24
Subject Matter Expert	2
Clerical	55
TOTAL	153

While performing the task listings for the TARPS syllabus, a problem common to all emerging systems was encountered. The problem was that no Subject Matter Experts in the use of the RF-14 TARPS Reconnaissance system existed. The TARPS pod was undergoing development at the time the task listings were required, therefore, the method which was used to assemble the tasks was to interview reconnaissance pilots and NFO's who were experienced with other similar reconnaissance systems. The resulting task listings were somewhat generic, but following the accumulation of experience with the systems, the task listings proved extremely adequate.

There were several favorable conditions which existed in this effort despite the limitations of not having true SME's. One of these conditions was that the SME's which were available had diverse backgrounds. There were SME's from the Navy's RA-5 and RF-8 communities as well as from the USAF's RF-4 community. Additionally, there were SME's from the F-14 community available. This resulted in a broad base of knowledge and experience which was successfully exploited.

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F-14 INSTRUCTIONAL SYSTEM DEVELOPMENT PROGRAM.(U)
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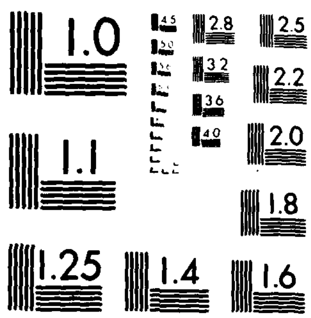

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Another favorable condition for this particular task listing was that there was no SME availability problem. There were reconnaissance pilots and NFO's on board in more than sufficient numbers to meet the requirements of this program. The ease with which the tasks were assembled and the resulting quality of the task listing is directly attributable to the ready availability of the SME's. There was far less of a problem in this effort than in the MAS effort during which SME availability was extremely limited. This advantage continued throughout the development of the learning objectives and the student syllabus and course materials for the TARPS addition.

In the process of assembling the TARPS tasks, the F-14 (MAS) task listings were used as the basis for determining the RF-14 tasks. The eight MAS mission phases were examined and TARPS peculiar tasks were added wherever needed. However, the interviews with the reconnaissance SME's yielded far more tasks than could be sorted into one of the eight MAS mission phases, the result being the creation of two additional mission phases peculiar to the RF-14. These mission phases were titled MISSION PLANNING and RECONNAISSANCE.

OBJECTIVES HIERARCHIES (TARPS).

Duration of Task: October, 1978 - December, 1978
Manhours Expended:

Program Manager	2
Instructional Psychologist I	4
Instructional Psychologist II	25
Instructional Technologist I	15
Subject Matter Expert	0
Clerical	30
TOTAL	76

The TARPS learning objective hierarchies were created through the same methodology used in creating the F-14 MAS learning objectives hierarchy. As in the TARPS task listing effort, no Subject Matter Experts experienced in the use of the TARPS system were available. The learning objectives were, therefore, based solely on the task listing and were somewhat biased by the use of the F-8, RF-4 and A-5 SME's. Learning objectives were added for the mission planning phase and for the reconnaissance phase. Due to the experience encountered in the initial F-14 learning objectives development process, the problem of redundant learning objectives which existed in the F-14 MAS objective hierarchy was eliminated. Again, as with the task listings development, the SME availability during the learning objectives hierarchy development phase was excellent and contributed greatly to the quality of the final product.

TRANSITION SYLLABUS (TARPS).

Duration of Task: September, 1978 - June, 1979
Manhours Expended:

Program Manager	8
Instructional Psychologist I	10
Instructional Psychologist II	66
Instructional Technologist I	19
Subject Matter Expert	0
Clerical	95
TOTAL	198

In the planning stages of the TARPS program, provisions were made for the arrival of students in accordance with expected availability of the TARPS equipped aircraft. At that time, aircraft were scheduled to be available prior to the completion of the RF-14 syllabus. For that reason a separate task was ordered to develop a transition syllabus which was to be used to train the aircrews who arrived prior to the completion of the fully developed syllabus.

Several assumptions and constraints were attached to this effort. The most obvious assumption was that the transition syllabus would be in use for a short time only and then be replaced by the fully developed syllabi. This effort was to be done at minimum expense with all training materials to be of a text or lecture medium with minimal artwork. The artwork which was needed was produced by the drafting department at VF-124. The contractor was to provide instructional design guidance, but the bulk of the work was to be done by the Navy SME's.

The development of the transition syllabus started with a review of existing reconnaissance training syllabi; in particular the Navy RA-5 and USAF RF-4 syllabi were studied. Using these syllabi and the knowledge of the available SME's, objectives for the transition syllabus were inferred. Again, it should be stressed that there were no SME's with experience in the RF-14 available.

After a suitable list of objectives had been developed, they were organized into a hierarchy based upon prerequisite relationships. They were then sorted and grouped into individual lessons. As stated previously, the media were to be texts or lectures only. Given that constraint, the process of media selections was eliminated. Objectives which would have been designated for other media were modified to be compatible with the text and lecture format. Lesson specifications were developed and the conversion to the training texts and lecture guides followed immediately.

Unfortunately, none of these training materials were ever used by students. Due to delays in the development and testing of the TARPS POD it became obvious that aircraft would not be available as originally scheduled, so the flow of reconnaissance students to VF-124 was stopped. The materials developed for this transition syllabus were, however, used as reference material during development of the actual student syllabus.

IMPLEMENTATION SUPPORT.

Duration of Task: November, 1979 - June, 1980
Manhours Expended:

Program Manager	44
Instructional Psychologist I	9
Instructional Psychologist II	58
Instructional Technologist I	28
Subject Matter Expert	34
Clerical	25
TOTAL	198

During the periods of syllabus implementation, support was provided by the contractor to both VF-124 and at VF-101. This support was required because there were many events in the syllabus which had not been properly validated during formative evaluation and because the number of instructors at both VF-124 and VF-101 was below that required for normal operations. The increased demands during implementation simply exceeded the capabilities of an already overworked instructor corps.

During syllabus development it was planned that each event would be formatively evaluated and revised as indicated, however, this goal was not achieved due to the lack of availability of qualified students. As a result, a great many events needed to be evaluated during the implementation of the syllabus. This necessitated the administration of pre- and post-tests, the interviewing of students and the compilation and analysis of the resulting data. These tasks were performed by the contractor.

SECTION IV

RESULTS

IMPLEMENTATION

The implementation of the revised F-14 syllabus began at VF-124 in November, 1979. Prior to this implementation, the contractor had provided a final implementation plan which was oriented specifically toward VF-124. The implementation of the revised syllabus at VF-101 took place in June, 1980. A separate final implementation plan was produced for VF-101. In both cases, these implementation plans detailed the requirements in terms of facilities, management, students and instructional resources. Further, the implementation plans provided contingency plans in the event that certain resources were not available at the required times.

PROGRAM MANAGEMENT

During the performance of this project, it was recognized by the Navy that the existing management system would not be adequate to meet the needs of the new training program. As a result, the Navy, in conjunction with the contractor, examined the problem of aircrew training management in detail and developed recommendations for a reorganization of the existing operations department which placed more emphasis on all aspects of training. This reorganization has been detailed earlier in this report.

It was also realized that the ongoing maintenance or quality control of the new aircrew training system was an absolute necessity. One of the tasks involved in this project was the development of specific quality control plans which would ensure the continued viability of the aircrew training program, once contractor support was no longer available. The Navy recognized that the optimum means for maintaining quality control would be through the use of an in-house educational specialist who could provide the FRS with instructional technology support through the outyears.

One of the tools which both the squadron and the educational specialist will use for the program maintenance is the Automated Training and Support System (ATSS). This computerized data base and management system provides management, bookkeeping and scheduling services to the squadron. It was envisioned that each objective in the training syllabus could be entered into this data base and quickly accessed if the need arose for revisions to an objective or to the training materials associated with an objective. The ATSS was also designed to maintain records of each student's progress and, based upon that progress, to develop and print the daily flight and training schedules. The method of coding each of the events in the syllabus was designed specifically to allow entry of the event codes into the ATSS.

STUDENT SCHEDULING

The events in the revised F-14 training syllabus were organized into a syllabus hierarchy which allowed the students to enter the training program at multiple points, all at a fairly low level, and to progress through the syllabus on varying paths. The reason for this hierarchical syllabus was to alleviate problems which had been discovered in the early phases of resource analysis. The previous F-14 syllabus was linear in nature in that the students would progress from one class to the next without deviation. If, however, the resources for the following class were not available, the students were forced to mark time in their training. With the hierarchical syllabus, the lack of resources for a following event does not necessarily cause a stoppage in training. There are many possibilities within the hierarchical syllabus for alternate training events to be given to the students if the resources for the primary training event are not available.

The performance of this function, as stated previously, was to be accomplished using the ATSS, however, at the time of implementation, the ATSS did not have the capability to perform this function. For this reason, contractor support in the area of student scheduling, was provided. An optimum sequence of events was developed and the first class of students was scheduled in conformance with that sequence. Contractor support personnel and the VF-124 schedules officer manually scheduled the hierarchical syllabus when it became apparent that the resources needed for the optimum flow of events would not be available. This occurred frequently throughout implementation, as had been expected, so despite the lack of ATSS capability, the function was performed manually with great success.

A final point concerning student scheduling concerns those students who were onboard VF-124 during the initial period of implementation. According to the old syllabus and to the new syllabus, a class of students would begin the training syllabus during the first week of each month. This created a situation in which the newest class was progressing through a different syllabus than the five previous classes. The result of this method of implementation, was that two separate syllabi, teaching similar material, existed for a period of five months following the initial implementation of the revised syllabus. By the end of the fifth month of implementation, the last students who were progressing through the old syllabus, had graduated and the entire aircrew training program was using the revised syllabus.

PROBLEMS AFFECTING IMPLEMENTATION

As with program development, there was also a problem of instructor availability during implementation. This was caused by the consistent undermanning of the squadron, as noted elsewhere, and by the fact that two months prior to implementation there were successive carrier qualification detachments which required the utilization of a great percentage of the instructors at VF-124.

The first of two major affects of this lack of availability was that the Instructor Under Training (IUT) program was not completely accomplished prior to the implementation of the syllabus. It had been planned that much of this training for the instructors would be done in groups, but as a result of the lack of availability, the training had to be performed by the contractor in a series of one on one encounters with the instructors. The second effect of this lack of availability was that many of the tasks which needed to be performed at the training squadron simply had to be postponed or overlooked. There was, for instance, a lack of capablity to staff the academic center with an instructor pilot or NFO on a full time basis as had been proposed.

Another problem resulted from the size of the first class to use the revised training syllabus. It had been expected that the class size would be approximately ten; those ten being five pilots and five NFOs. For the first class, however, the number of pilots increased to a total of twelve. The result of this excessive number of students was a tremendous demand on the resources which were available for training since the number of trainer sessions, the number of flights, and the number of self-instructed media had not been designed to meet a class of this size. This placed a tremendous burden on the scheduling mechanism in the squadron.

The final problem which affected implementation concerned the lack of availability of resources. The primary resource problem was that, due to maintenance or parts problems, the simulators were not operational to the extent required during the period of implementation. The result of this lack of simulator availability was that in many cases, an increased emphasis in the academic area was provided where the simulators would not be available for the hands-on training. This meant that, for the performance of some tasks, the student would receive extra academic instruction and proceed directly to the airplane. Those tasks which were deemed essential for safe flight, however, were performed in the simulators. This again added to the burden of scheduling which was being done manually by the schedules officer with contractor support.

The second major resource problem concerned the availability of the training materials necessary for the training syllabus. During the period of training materials development, there had been repeated delays in the production of these materials. Despite these delays, it had been decided that November of 1979 would be the date of implementation, so plans were developed for that implementation using, in some cases, preproduction materials. This was especially prevalent during the first two months of the new syllabus. During that two month period a maximum effort was put forward to complete all the remaining training materials for the other four months of the training syllabus.

EVALUATION

The formative evaluation process was used to evaluate and revise the lesson materials before implementation. To this end, the contractor conducted small group tryouts of a large number of replicable lesson materials using four to six FRS students. As mentioned earlier, it was not feasible to formatively evaluate all materials because of time and student availability constraints. There also were a few lessons that were tried out with review teams as opposed to students.

Prior to implementation, the total number of the events that were formatively evaluated was 265. The table below summarizes the revisions to the student training materials as a result of formative evaluation.

Table 5: Summary of Revisions During Formative Evaluation

TOTAL SEGMENTS 265	SEGMENTS REQUIRING REVISION 148		% REQUIRING REVISION 56%
Type of Revision by Medium	Content*	Technical	Format
Slide/tapes (66) (Perspective, Inc.)	9	38	0
Texts (33)	0	5	0
Lectures (37)	12	8	2
Trainers (38)	8	0	12
Flights (53)	0	0	0
Exams (38)	0	18	36

*Includes typographical errors, presentation, style, etc.

As mentioned earlier, much of the formative evaluation process was concentrated at the lesson specification stage. In this stage emphasis was placed on appropriate objectives, accurate generalities, and practice and criterion test items.

The most intense formative evaluations took place with slide tapes. There were 13.5 contractor man-hours spent for the average two-carousel program. This amount was at least doubled by the addition of Perspective and Navy personnel. Consultants from Naval Personnel Research and Development Center (NPRDC) also assisted in the formative evaluation process.

Internal quality control procedures concentrated on measuring the two most critical variables of the ISD program:

a. Student performance

b. Instructional materials effectiveness

The ability of the students to master the course objectives and to pass tests was the primary vehicle for the evaluation of the effectiveness of the training program. Consequently, student performance scores in academics, trainers and flight events were collected and analyzed. In addition, student attitudes were assessed through both informal interviews and questionnaires.

The instructional materials in the training program included all the printed and audio visual instructional materials used in direct support of the training effort. In evaluating the efficiency of the various media, instructional psychologists and technologists used the following internal quality control data:

a. criterion scores

b. student ratings

c. narrative comments

d. instructor ratings

e. narrative reports

The following table, Table 6 compares the test data collected from the first class using the new syllabus and the last class to use the old syllabus. In the area of academics, only tests that were normative (SOP course rules, etc.) as opposed to criterion scores, were included. These test scores can also be evaluated in terms of how close they came to the standard of 3.0 established by COMNAVAIRPAC.

Table 6. Student Grade Point Averages: Old and New Syllabi

June 1977 - August 1980

Phase of Instruction	Students GPA: Old Syllabus	Students GPA: New Syllabus
FAM		
Academics	3.75	3.84
Trainers	3.05	3.15
Flights	3.07	3.15
B WEAPONS		
Academics	-	3.74
Trainers	3.08	3.09
Flights	3.11	3.13
ADVANCED EMPLOYMENT		
Academics	3.57	3.84
Trainers	3.04	3.00
Flights	3.30	-
AIR TO AIR WEAPONS		
Academics	3.80	-
Trainers	3.10	3.16
Flights	3.09	3.13
GUNS		
Academics	-	-
Trainers	-	-
Flights	3.10	3.07
CARRIER QUAL		
Academics	-	-
Trainers	2.90	3.09
Flights	3.13	3.02

In summary, students did well on academic tests as well as in trainers and flights. These scores, together with inputs from instructor and student questionnaires, pinpointed the areas in need of revision within the syllabus. Most revision fell into two main categories as discussed earlier: technical accuracy and typographical errors. The third most common type of revision was to the instructional strategy. Table 7, summarizes the types of revisions occurring as a result of internal quality control.

Table 7. Summary of Revisions to Lesson Materials

Lesson/Event	Data Source for Revision	Purpose of Revision
ASBA 365 (addition) Cross Country Planning lecture 1.0	Student survey/ interview	To compliment ASBA 360 text and provide instructor interface and work NATOPS practice problem set.
ASBA 405 (addition) INS 3.0 lecture	Student test results/ interviews/SME review	Provides instructor interface for a technically complex subject matter; old sequence: text; test; trainer new sequence: text; lec; trainer; test
ASBA 330 (combination) Aerobatic Maneuvering Procedures/High AOA 1.5 lecture	SME review/IUT murder board	Compliment ASBA 330 & 340. Provide instructor classroom interface for technically difficult & safety of flight subject.
ASBE 010-170 (format revision) wording of test questions	SME review/student interviews	Simplify test format, and reduce length of test
ASBT 010-080 (combination)	SME review/student interviews	(combined a series of 12 trainer events conducting specialized task training into 8 trainer events) provided smoother sequence of events and met new trainer device availabilty constraints.
USRA 020 (addition) Missile Descriptions text 1.0	SME review/student surveys	Provide student with more detailed background on missile components/capabilities
USRA 090 (split) Range While Search USRA 095 Track While Scan	SME review/student test results/student survey	(USRA 090 split into USRA 090 and 095) to separate two complicated and hierarchically related subject areas, facilitating greater understanding & retention of subject matter.

In Table 8, the test data is summarized for the third class at VF-124. This data shows the test items most frequently missed, and the lessons in need of revision as a result of test failures. According to the data in this table, revisions need to be made to INS, Flight Controls, Pulse Modes, and Flight Characteristics.

There are no statistical data representing the summary of all student and instructor attitudes to date. There are however, some conclusions that can be drawn at this time. Student attitudes toward the syllabus are generally positive. Most of the instructional materials, at least 80%, were well received. Students liked frequent practice and feedback in the academic events, and were especially laudatory about the Aircraft System and FAM trainers. The flight syllabus was reputed to be well organized and logically supported by prerequisite events, however, the RIO's felt that INS was initially very difficult for them and the pilots said at times that they felt pressured by flying FAM hops while learning weapons system academics.

Instructors had both positive and negative responses to the new syllabus. The most encouraging comments centered around statements like "The best training available in the FRS to date". They also appreciated the standardization and logical flow of events. On the other hand, instructors felt that there was not enough instructor interface with the students and the instruction at times seemed to spoonfeed the students, and in addition, they were concerned about the fact NATOPS was not being read. Changes were made to the syllabus in order to ensure NATOPS reading occurred in future classes. Overall student performance on criterion referenced tests was excellent. Similarly, student performance in trainers and on flights was above COMNAVAIRPAC standards.

Table 8. Test Items Most Frequently Missed-Class 8005/VF-124

Test Coding	Test Title	Pilot/ RIO	Test Items Most Frequently Missed	Exam Passed By 90%+
ASBE 040-1	Fuel Systems	Both	none	yes
ASBE 040-2	Fuel System Emergencies	Both	D-3	yes
ASBE 050	Hydraulic Systems	Both	none	yes
ASBE 060	Landing Gear, Brakes, Hook	Both	23, 39	yes
ASBE 070	Electrical Systems	Both	5, 6, 7, 14	yes
ASBE 080	Aircraft Lighting; ECS/O^2	Both	Lighting: A-7, B-3b, B-4 ECS: B-9	yes
ASBE 090	Flight Controls	Both	6, 7, 9, 19-b,c, 30, 37, 45	no
ASBE 110	Master Test	Both	C-4, 6	yes
ASBE 120	Flight Characteristics	Both	A-3; I-1, 2; H-4, 7; P-3	no
ASBE 140	Course Rules	Both	24	yes
ASBE 141	SOP	Both	9-a, b, c, d	yes
ASBE 150	Avionics	Both	21, 41, 42, 44	yes
ASBE 160	INS	Both	3, 4, 9, 14, 15, 16, 20, 21, 24, 25, 26	no
FABE 170	Aircraft Sys Exam	Both	8-a	yes
WSBE 010	Radar Theory	Both	none	yes
WSBE 020	WCS Intro	Both	11, 29, 35, 38, 45, 46, 48	yes
WSBE 040	Pulse Modes	Both	21-6-3; 38-b; 39; 41-d; 50-a, e; 55, 61, 63, 64, 65	no
WSBE 060	TWS Modes	Both	3-a, 29, 31, 39, 45, 54	yes
WSRE 030	WCS OPS	RIO	4	yes
WSRE 050	Pulse Doppler Modes	RIO	33, 41, 43, 51	yes
WSRE 080	RIO WCS Final	RIO	none	yes
WSPE 070	Pilot WCS Final	Pilot	39, 71, 82, 100, 102	yes

STATISTICAL SUMMARY

The following tables provide statistical data resulting from this project. The first table compares the hourly requirements of the old versus the new syllabus. The second table refines this data into a ratio of self-instructed to instructor required events in the old versus new syllabus and the third table lists the total number of objectives resulting from this revision effort. The final table summarizes the events and hours required for the MAS and TARPS syllabi now in use.

Table 9. Comparison of Hours, Old Syllabus vs. New Syllabus

OLD SYLLABUS

	Academic		Trainer		Flight	
	P	N	P	N	P	N
Transition	84.0	90.0	25.0	12.0	13.6	5.4
Basic FAS	13.5	14.0	4.0	12.0	10.6	16.2
Weapons	21.5	21.5	0	0	11.6	5.6
Advanced Tactics	28.5	26.5	1.0	3.0	24.6	18.4
Advanced FAS	19.0	19.0	0	5	9.3	9.3
FCLP/CQ	17.0	17.0	0	0	20.7	17.7
	183.5	188.0	30.0	32.0	90.4	72.6

NEW SYLLABUS

	Academic		Trainer		Flight	
	P	N	P	N	P	N
Aircraft Systems	61.0	61.0	8.0	3.0	0	0
Familiarization	25.5	24.5	9.0	6.0	14.8	5.4
Weapons System	10.0	25.0	1.0	6.0	0	0
Weapons, Missiles	7.5	7.5	0	0	0	0
Intercept Theory	9.5	9.5	0	0	0	0
Basic Employment	13.5	13.5	11.0	12.0	13.7	17.1
Weapons, Guns	8.5	8.5	0	0	10.8	4.8
Basic ACM	14.5	13.5	0	0	9.0	5.5
Advanced ACM	8.0	8.0	3.0	3.0	9.0	10.1
Advanced Employment	23.5	23.5	11.0	11.0	7.2	7.2
Carrier Qualification	12.5	12.5	5.0	5.0	27.1	6.5
	194.0	207.0	47.0	46.0	91.6	56.6
Reconnaissance	39	39	0	0	31.8	31.8

Table 10. Ratio of Self-Instructed Events to Instructor Required Events — Comparison of Old Syllabus vs New Syllabus

	Old Syllabus		New Syllabus	
	P	N	P	N
Self-Instructed	20.4%	19.2%	52.5%	54.8%
Instructor Required	79.6%	80.8%	47.5%	45.2%

Table 11. Number of Objectives by Syllabus Phase

	Academic	Trainer	Flight
Aircraft Systems (AS)	205/186	31/12	—
Familiarization (FA)	47/49	17/13	101/24
Weapon System (WS)	47/97	1/30	—
Weapons (Missiles) (WM)	28/28	—	—
Intercept Theory (IT)	34/32	—	—
Basic Employment (BE)	35/35	65/72	50/65
Weapons (Guns) (WG)	26/20	—	36/9
Basic ACM (BA)	55/55	—	29/16
Advanced ACM (AA)	23/23	20/20	84/90
Advanced Employment (AE)	27/27	29/29	20/20
CQ/FCLP/IR (CQ)	18/18	20/20	18/18
RECCE (RC)	101/101	—	133/133
	646/671	183/196	471/375
Pilot: 1300 NFO: 1242			

Table 12. Summary of Events and Hours

	F-14		RF-14 TARPS	
	Pilot	NFO	Pilot	NFO
1. Events				
# Lesson Specifications	152	156	24	24
# Exams	35	39	3	3
# Trainers	43	43	0	0
# Flights	75	46	19	19
2. Hours				
Lectures	82.5	82.5	24.5	24.5
Slide/tape	55.5	65.5	2.5	2.5
Text	34.0	33.0	9.0	9.0
Video Tape	1.5	1.5	-	-
Total Academic	173.5	182.5	36.0	36.0
Exams	20.5	22.5	3.0	3.0
Trainers	47.0	46.0	0	0
Flights	91.6	56.6	31.8	31.8

SECTION V

CONCLUSIONS AND RECOMMENDATIONS

This section of the Training Program Work Report will examine each of the tasks involved in performing this aircrew training ISD project. The problems which were encountered in performing each of these tasks will be detailed and solutions or recommendations for improvements will be specified. Further, recommendations for changes and improvements to the military specification or data item description (DID's) will be given. It is hoped that these recommendations will provide guidance for future ISD contractors in the performance of similar projects.

OBJECTIVES HIERARCHIES

Two major topics will be discussed here. The first topic concerns the modification of the existing learning objectives hierarchies from the format specified in the data item description and specification to the format finally used in the development of the syllabus. This format is referred to as a syllabus oriented learning objective hierarchy. The second point to be discussed will be that of the formatting and numbering of the objectives hierarchy. It was felt by the contractor that improvements could be made in the display of the learning objectives hierarchy and in the methods of numbering the individual objectives. It is felt that these recommendations will lead to a more clearly defined relationship between subordinate and superordinate objectives.

In the early stages of this project, the learning objectives hierarchies were developed from a previously developed task listing. This task listing was developed by examining each task performed across eight separate mission phases. These mission phases encompassed the tasks which would be performed from before takeoff to after landing. When the objectives hierarchies were developed from this task listing, a redundancy of learning objectives occurred. This occurred because for each task in the task listing a corresponding objective was developed. As an example, consider the task "Perform Communication Using the UHF Radio". This task would be found in each of the mission phases as it occurs routinely from prior-to-flight through post-landing. As this task did occur in all eight mission phases, eight separate objectives, one for each mission phase, was developed in the learning objectives hierarchies. In fact, if the aircrew once performed UHF communications satisfactorily, there would not be a need to repeat this objective for each stage of the flight. The objective would be satisfied at its first occurrence.

As the syllabus events were being developed, objectives hierarchies were modified such that this redundancy was eliminated. Similar objectives were combined into single objectives and placed at an appropriate position in the syllabus. Also, as each lesson specification was developed, and the content of the training events became more evident, some new objectives were added and some objectives were eliminated. This process occurred continually during the development of the lesson specifications and resulted in a vastly different set of objectives from those originally developed from the task listings.

The point to be made here is that these changes to the learning objectives hierarchies should be anticipated. Unless all knowledge concerning the system is known beforehand, it is invalid to assume that the learning objectives hierachies developed from a task listing will be totally correct. The process of lesson specification development will consist of interactions with various SME's who will invariably improve or at least revise some of the objectives which have been developed.

The second major recommendation concerns the format and numbering of objectives in the objectives hierarchies which is specified in the data item description and military specification.

ALTERNATIVE OBJECTIVE CODING PROCEDURES

The contractor modified the objective coding procedure to clarify the relationships between subordinate objectives having two or more superordinate objectives. The two sample objective hierarchies shown on the following page illustrate this modification. Figure 27 shows objectives numbered according to conventions contained in the DID. Consider the objective "Conduct Mission Planning". While the number of this objective 3.2.3.1 shows that it is prerequisite to objective 3.2.3, it does not adequately indicate that it is also prerequisite to objective 3.2.4.

An improved procedure for indicating the hierarchial relationships of objectives with two or more superordinate objective is shown in Figure 28. The number 3-2-3,4-1 for the objective "Conduct Mission Planning" clearly indicates that it is prerequisite to both objectives 3-2-3 and 3-2-4. Note that this coding reference also includes a four character alpha prefix, originally used in the task inventory.

The coding procedure adopted by the contractor offers two advantages over that contained in the DID. First, the alpha prefix is the same as that originally used in the task listing so that any objective can easily be traced back to its related aircrew task. Second, the modified objective code facilitates development of computerized procedures to accurately trace through those branches of the hierarchy where a given objective is prerequisite to two or more superordinate objectives.

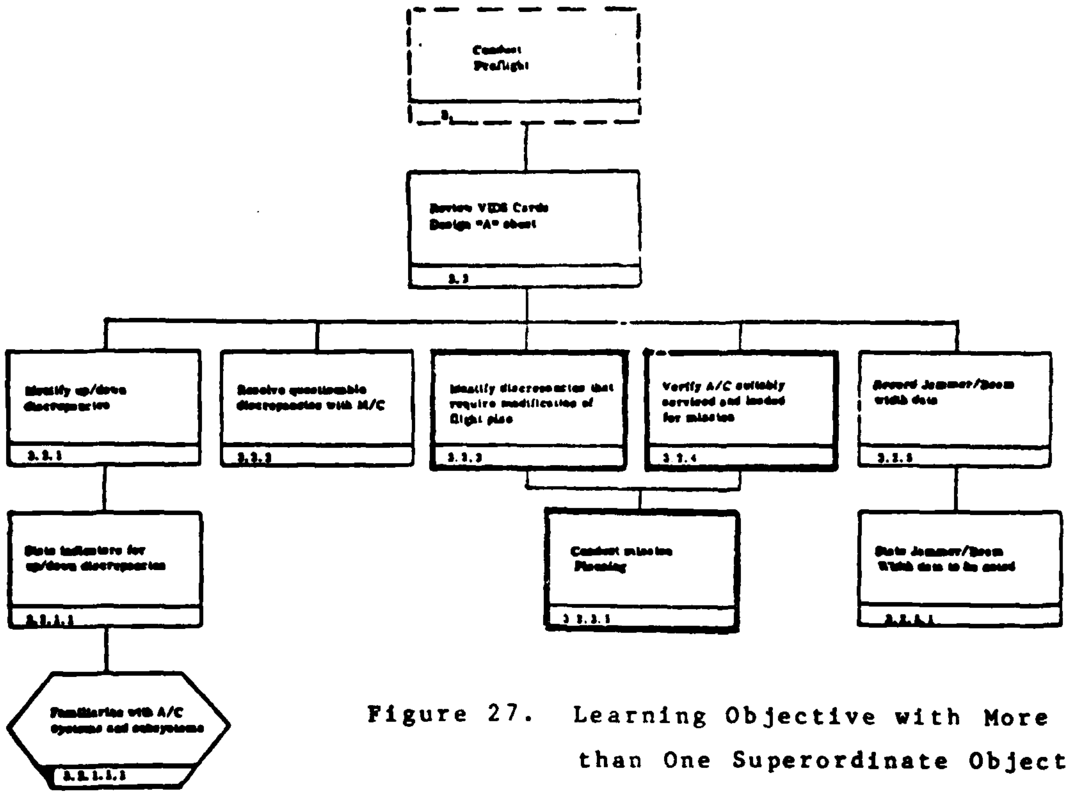


Figure 27. Learning Objective with More than One Superordinate Objective

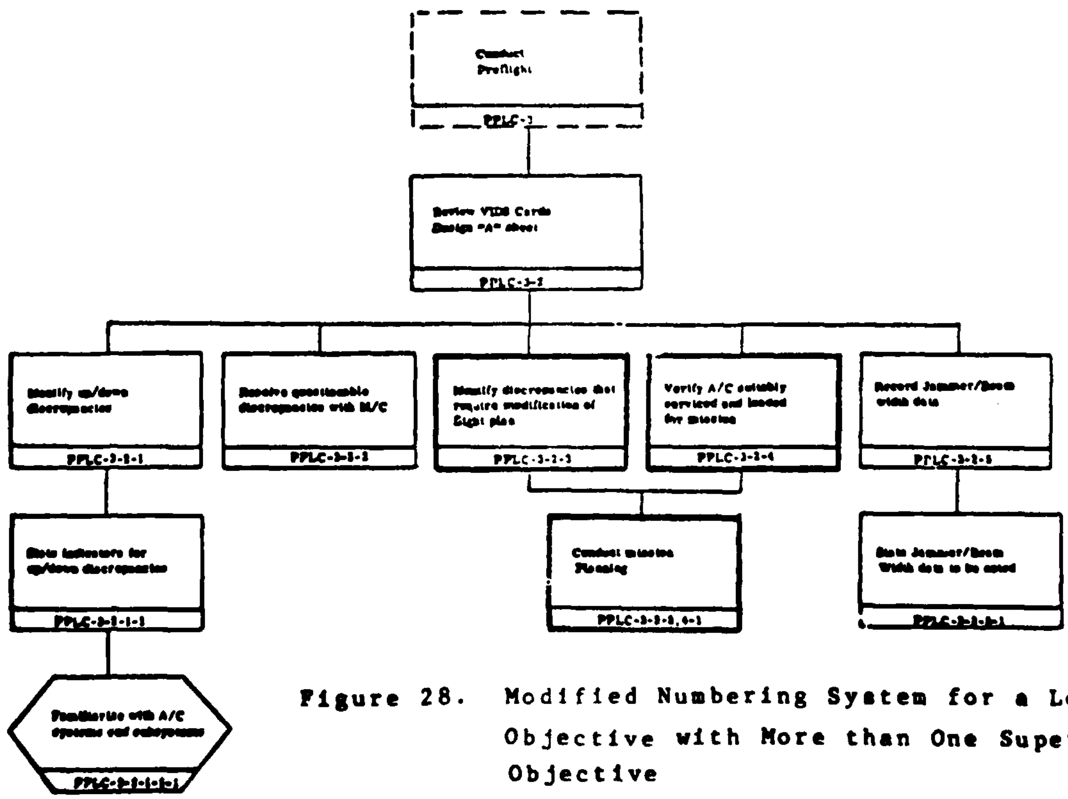


Figure 28. Modified Numbering System for a Learning Objective with More than One Superordinate Objective

CHANGES TO ELIMINATE REDUNDANCY AND INCREASE CLARITY OF THE DIAGRAMS

Two separate but related modifications were made in the display of the hierarchy diagrams. The first involved eliminating redundancy found when a hierarchy must be continued to subsequent pages. The second involved the addition of a visual cue to lead the reader to the pages on which horizontal extensions of the hierarchy are found.

By modifying the procedure for displaying hierarchial relationships for those objectives requiring further analysis on another page, the contractor eliminated redundancies in the hierarchy diagrams. Figure 29 illustrates the hierarchial display convention called for by the DID. The first page of a hierarchy diagram, objective 1.1.1 appears in a "hex box" indicating further analysis on another page. On the page where the analysis for this objective continues, the objective should be shown as the first solid line box on that page. All objectives shown as superordinate to the one in the hex box, page one, must now be shown as broken line boxes above the solid line box on page 2.

Figure 31 illustrates the modified hierarchy display format. This format makes use of the objective coding procedure described above. Thus, the need to include all superordinate objectives on the second page of the hierarchy diagram is eliminated. The hex box from the first page of the hierarchy is represented as a broken line box on the second page and the functional relationships between the objective in the hex box and those subordinate to it are revealed on page 2 by the objective code for that objective in the broken line box.

The second change allows for an objective hierarchy to be extended horizontally to more than one page. For example, during the pre-launch mission phase, the Pilot must perform 267 related aircraft systems checks. Individually, each check is subordinate to the terminal objective, but collectively, all are on the same level in the hierarchy. To solve this format problem, a horizontal arrow box containing the page number for the lateral continuation of the hierarchy was added to the diagram. This change is also shown in Figure 31. The contractor recommends that these changes be incorporated in the appropriate DID. While points 2 & 3 are concerned only with the depiction of the hierarchy block on paper, the first point will impact the ability of the hierarchy to be maintained on an automated system. Since automation appears to be the trend of the present and future, it would seem appropriate to ensure maximum ease in this area.

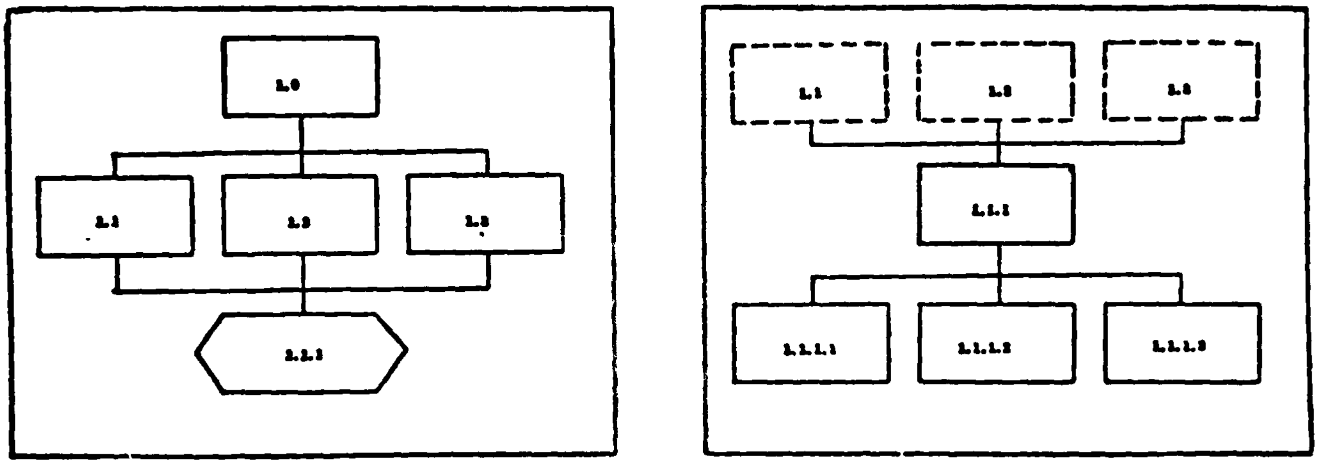


Figure 29. Hierarchical Relationships Between Pages

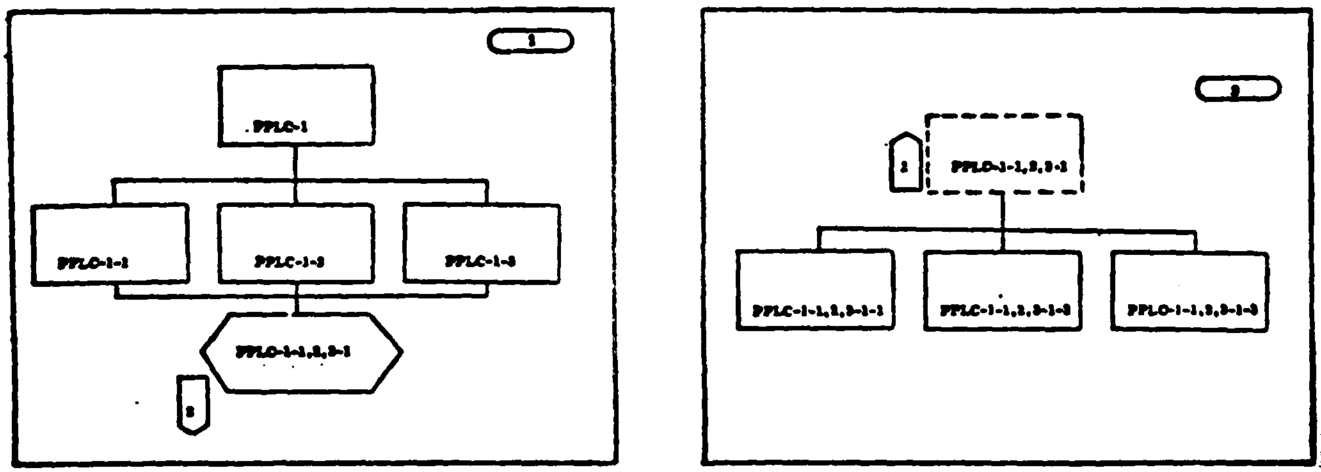


Figure 30. Modified Hierarchical Relationship Between Pages to Eliminate Redundancey

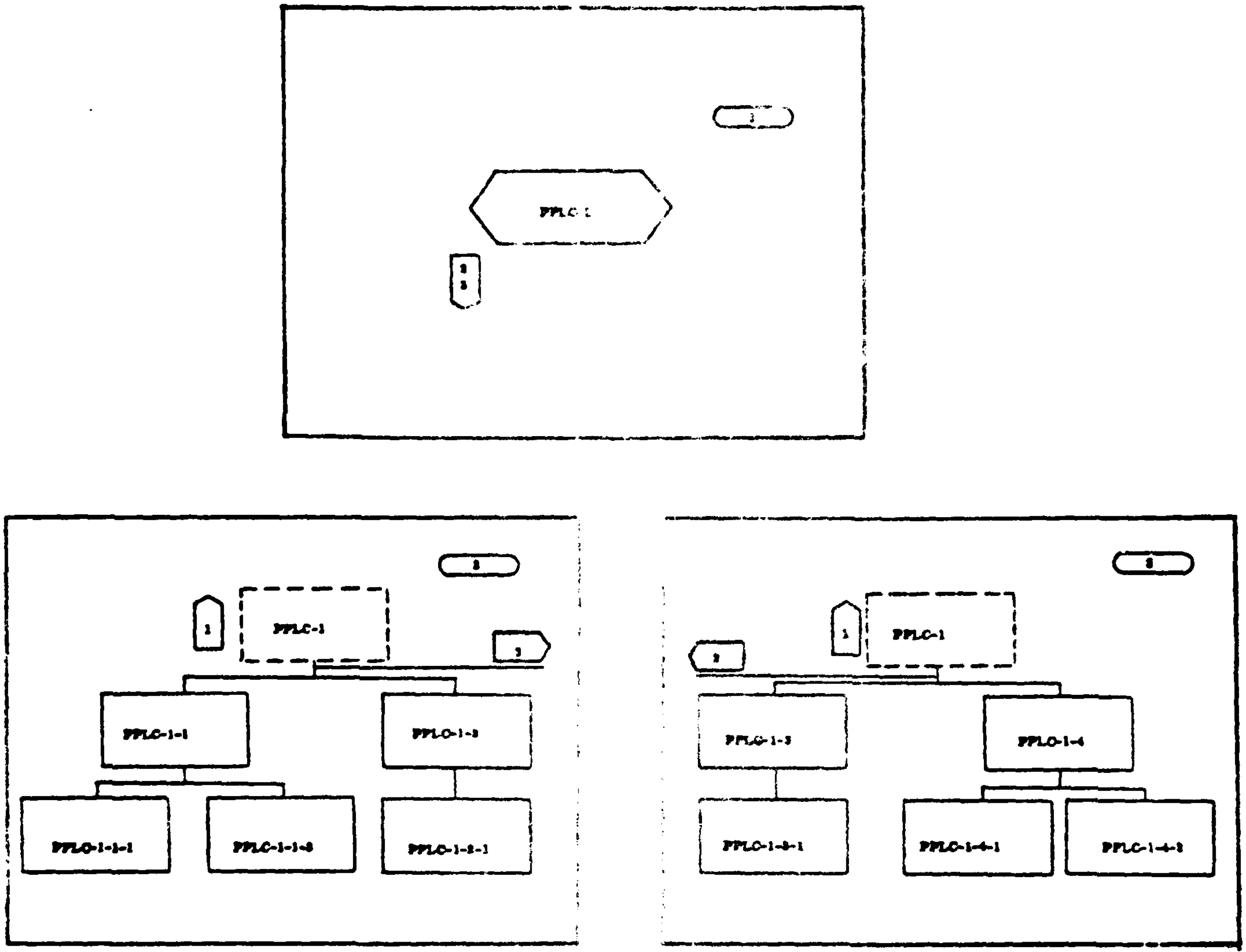


Figure 31. System for Designing Lateral Continuation of Hierarchies Between Pages

MEDIA SELECTION

A point to be made concerning media selection in this project is that in cases where the optimum media selection could not be procured, revisions to the objectives were made in order that they might be accomplished by the media which were available. During the media selection process, each objective was assigned a primary and alternate medium. In many cases, the alternate medium was used or the objective was modified such that the primary medium could be changed to one which was available. The obvious conclusion to be drawn here is that economic and pragmatic constraints sometimes override the instructional theories being used to develop the syllabus.

QUALITY CONTROL

In a project such as this, there are two major areas in which quality control is essential. The first area is in development of the training syllabus by the contractor. The second area is the maintenance of the delivered product by the user organization. Concerning the first area, it was the responsibility of the contractor to develop and adhere to quality control procedures which are acceptable to the contracting agency. This allowed the contracting agency to ensure that quality products were being developed from the start.

The second essential area is that of quality control of the revised syllabus over its life cycle by the user organization. This type of quality control procedure development requires that the contractor analyze the methodologies of the user organization and develop procedures which will work within that organization. In the case of this project, recommendations were made concerning a reorganization of the training management system to achieve the goals of continuing quality in the training system. These recommendations were implemented and a reorganization of the operations department took place.

A final point to be made concerning quality control is that there is no distinction made between replicable and non-replicable events. The processes of formative evaluation and internal quality control must deal with both replicable and non-replicable events. The military specification and DID should be expanded such that procedures be developed for both types of events.

LESSON SPECIFICATION DEVELOPMENT

During this project one lesson specification was developed for each academic event in the syllabus. The one recommendation which could be made concerning the development of lesson specifications in future contracts, is that increased emphasis should be placed on the practice, feedback and testing sections during generality development. It was often found that the SME's had an easier time deciding upon the generality information if they were asked to develop the practice and testing items initially rather than after the generalities had all been developed. In almost every case, the SME's knew what information needed to be tested. If the generalities were developed beforehand, without considering the practice and test items, the later development of the practice and test items often resulted in changes to the generalities.

As stated in the previous paragraph, lesson specifications were developed for each academic event. They were not developed for trainer or flight events. It was determined that the information required for a lesson specification for a trainer or flight event would consist of a plan of events from which a briefing or trainer guide could be developed. It quickly became apparent that this plan of events was directly transferrable into the final format of the trainer or flight events. It was deemed unnecessary to produce a separate document, the lesson specification, when the identical information would be part of the delivered training material. In the case of the trainer and flight briefing guide, reference was made back to the applicable academic lesson specifications if that reference material was needed.

STUDENT SYLLABI

This task resulted in the development of two separate but closely related syllabi. One for the pilot and one for the NFO. In both cases, the events in the syllabi were arranged in hierarchical fashion based upon prerequisite relationships. This combination of separate but related syllabi, organized in a hierarchical fashion, yielded two desired results. The first result was that the front end loading which was so prevalent in the existing F-14 syllabus was reduced. The time from start of syllabus until first flight was maintained or reduced and yet the academic requirements were not increased. Further, the hierarchical arrangement of the syllabus provided increased flexibility in the scheduling of the events in the syllabi. If the resources to perform the desired event were not available, the syllabus was structured such that alternate events could be given for which the resources were available.

IMPLEMENTATION

One of the primary problems associated with implementation was that it had to occur without disturbing the ongoing training program. In the original F-14 training syllabus, a student would enter the syllabus and graduate six months later. A new class of students was starting the first week of each month, therefore, during a six month period of time, six classes would have begun. In implementing the revised syllabus, the problem of having two different syllabi running concurrenlty existed. The students who had begun the training syllabus prior to implementation were some portion of the way through the old syllabus. It was decided early on that it was advantageous to have the students start from the first day with the revised syllabus rather than to implement piecemeal or have them proceed part way through one syllabus and then switch over to the revised syllabus. Implementation was, therefore, somewhat complicated during the initial administration of the course until the last student who had started on the old syllabus had graduated.

The most significant problem which occurred in coordinating these activities was the inability to perform the desired instructor training prior to the implementation date. The demanding work schedule of the instructors at the squdron continuously interfered with the efforts to provide this training. Implementation itself was jeopardized by successive carrier qualification detachments just prior to the date scheduled for implementation. These detachments required the absence from the squadron of approximately 50% of the instructors. These problems required a day to day adjustment by the contractor and by the available Navy personnel.

Concerning prior scheduling, it was felt that the initial implementation plan had been called out too early in the syllabus development sequence to allow an accurate plan to be developed. It was felt that a conceptual implementation plan would have been more timely following the initial delivery of the TSRA. After that, a more detailed implementation plan would have been appropriate following the completion of approximately two-thirds of the lesson specification documents. At that time, the contractor had an extremely accurate view of the syllabus and also had become familiar with the daily operation of the squadrons at which the implementation was to take place. The final implementation report would then have consisted of an update which would have been published just before the actual occurance of the implementation. In this contract, two separate but similar implementation plans were introduced. One plan was for VF-124 and one for VF-101.

TRAINER MODIFICATION AND UTILIZATION

The purpose of the trainer modification and utilization report was to specify how the training devices were utilized and if modifications could be made to those devices which would increase their utility. One major assumption was made prior to the development of this report. That assumption was that no major modifications would be made to the existing suite of trainer devices. Partly as a result of this assumption, and partly because of the immenent delivery of the device 2F112 F-14 WST, no recommendations for modifications either major or minor were made. It was anticipated that the existing training devices in conjunction with anticipated capabilities of the WST would satisfy all the training requirements of the F-14 community.

STUDENT TRAINING COURSE MATERIALS

The student training course materials were the end product of this process of revision of the F-14 syllabus. Each academic trainer and flight event was provided with new training materials which complied with the standards required for this project. One of the major changes which took place concerning the training materials was that criterion reference testing replaced the norm referenced testing which was in existence. While it was still a requirement within the squadron that the students be ranked according to their performance, the basis for this ranking was shifted from the academic enenvironment to the hands-on environments of trainer and flight events. This ranking was achieved by rating the performance of the students after they had reached criterion.

INSTRUCTOR TRAINING COURSE MATERIALS

In the case of the instructor course materials, two separate tasks were joined to produce one deliverable product. Those tasks concerned the instructor training course materials and the training device instructor/operator training materials. It was considered efficient to combine the materials because the recipients for the two sets of material were in fact the same set of instructors.

SECTION VI

RESOURCE UTILIZATION

This section of the report details the resources which were expended during the course of this project. The following tables are included:

Table 13: Task Manpower and Duration

Table 14: Monthly Listing of Mandays Per Task

Table 15: Chronological List of Delivered Reports

The project was performed primarily in San Diego, CA with much of the work being performed on-site at VF-124 NAS Miramar where office spaces were provided for contractor personnel. These spaces were used primarily during the lesson specification development phase at which time the majority of SME interaction took place.

The equipment which was utilized during this project consisted of normal office equipment, i.e., electric typewriters, copying machines and a Lexitron Videotype 94 word processor. This machine consists of a CRT display, a cassette tape record-and-playback unit and a high speed printer and was used for the production of all the lesson specifications. As documents which were reviewed and revised repeatedly, the lesson specifications were far more efficiently handled this way then they could have been on normal typewriters.

A second word processing machine, a Compugraphics Editwriter 7500, was used for the production of authored materials of the print medium. This machine allowed the use of a great variety of type styles and sizes as well as a variety of symbols, lines, etc. Student texts, workbooks, and briefing guides were produced using this machine.

TASK TITLE	CDRL #	MANDAYS							DURATION
		PM	IP I	IP II	IT I	SME	C	TOTAL	
PROGRESS REPORTS	A001							19	AUG 77 - JUN 80
SUBJECT MATTER EXPERT TRAINING MATERIALS	A002/A003	8	11	59	0	5	23	106	NOV 77 - MAR 78
OBJECTIVES HIERARCHIES	A004/A005	84	78	137	46	64	13	422	AUG 77 - MAY 80
MEDIA SELECTION REPORT	A006	0	2	11	0	13	8	34	NOV 77 - APR 78
TRAINER MODIFICATION AND UTILIZATION REPORT	A007/A008	7	11	0	5	36	5	64	FEB 78 - MAY 78
STUDENT SYLLABI	A009/A00A/ A00Z/A010	31	95	47	68	116	79	436	OCT 77 - MAY 80
TRAINING SUPPORT REQUIREMENTS ANALYSIS	A00B/A00C/ A012/A013	37	89	14	67	0	53	260	SEP 77 - OCT 79
STUDENT TRAINING COURSES. LESSON FORMATTING AND SEGMENT SPECIFICATION	A00D/A00E/ A011	99	414	205	397	809	576	2500	NOV 77 - DEC 79
STUDENT TRAINING COURSE MATERIALS	A00F/A016	35	157	234	166	838	483	1913	MAY 78 - MAY 80
STUDENT TRAINING COURSE: LESSON MATERIALS DEVELOPMENT REPORT	A00G	5	6	17	2	0	5	35	FEB 80 - MAY 80
QUALITY CONTROL PLAN	A00H/A00I A014	8	10	36	30	3	8	95	NOV 77 - OCT 79
IMPLEMENTATION PLAN	A00J/A00K	28	39	63	34	8	12	184	SEP 77 - OCT 79
INSTRUCTOR TRAINING COURSE MATERIALS	A00L/A00M	7	9	50	0	16	2	84	APR 78 - FEB 79
TRAINING DEVICE INSTRUCTOR/OPERATOR TRAINING MATERIALS	A00N/A00P A015	4	12	26	5	42	7	96	APR 78 - DEC 79
QUALITY CONTROL REPORT	A00Q	3	5	21	0	0	5	34	AUG 80
TRAINING PROGRAM WORK REPORT	A00R/A00T	10	13	0	2	8	9	42	FEB 80 - JUN 80
MEDIA SELECTION MODEL	A00U	0	7	0	0	0	0	7	SEP 77 - OCT 77
TASK LISTINGS(TARPS)	A00V/A00W	4	27	41	24	2	55	153	AUG 78 - JUN 79
OBJECTIVES HIERARCHIES (TARPS)	A00X/A00Y	2	4	25	15	0	30	76	OCT 78 - DEC 78
TRANSITION SYLLABUS (TARPS)	A017	8	10	66	19	0	95	198	SEP 78 - JUN 79
IMPLEMENTATION SUPPORT		50	9	58	71	34	25	247	NOV 79 - JUN 80
		TOTAL						7005	MANDAYS

Table 13. Task Manpower and Duration

LEGEND:

▲——▲ Proposed Task Duration

[7|16|23] Actual Months In Which Labor (mandays) Was Expended

TASKS	1977					1978												1979												1980								
	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	TOTAL
PROGRESS REPORTS																																						19
SUBJECT MATTER EXPERT TRAINING MATERIALS				21	11	24	19	31																														106
OBJECTIVES HIERARCHIES	119	127	120																							11	11						4	10		20		422
MEDIA SELECTION REPORT				10	8	8	6	4	2																													38
TRAINER MODIFICATION AND UTILIZATION REPORT							7	7	27	23																												64
STUDENT SYLLABI			4	77	129	56	42	49									2	10	20							5	6			12	30	8	4	2				476
TRAINING SUPPORT REQUIREMENTS ANALYSIS		13	5	18	10	8	12	39	47									5	42							10	6								37	8		[illegible]
STUDENT TRAINING COURSES LESSON FORMATTING AND SEGMENT SPECIFICATION				11	34	80	61	48	50	72	174	109	169	143	112	112	67	170	105	170	141	134	180	57	95	40	32	23	15									2500
STUDENT TRAINING COURSE MATERIALS										33	15	15	17	4	17	28	28	19	38	78	96	112	90	250	255	105	210	194	150	85	9	23	20	22				1913
STUDENT TRAINING COURSES: LESSON MATERIALS DEVELOPMENT REPORT																															5	13	9	8				35
QUALITY CONTROL PLAN				21	22																					36	16											95
IMPLEMENTATION PLAN		9	6	12	8	10	16	25	26	35	11															16	10											184
INSTRUCTOR TRAINING COURSE MATERIALS									2	2	9	4	12	8	9	7	6	11	14																			84
TRAINING DEVICE INSTRUCTOR/OPERATOR TRAINING MATERIALS									2	3	9	4	10	6	7	6	1	9	14										25									96
QUALITY CONTROL REPORT																																					36	36
TRAINING PROGRAM WORK REPORT																															1	5	5	5	14	12		42
MEDIA SELECTION MODEL		3	4																																			7
TASK LISTINGS(TAMPS)													83	39							4	28	19															153
OBJECTIVES HIERARCHIES(TAMPS)															22	27	27																					76
TRANSLATION SYLLABUS(TAMPS)														8	22	22	15	37	11	21	28	14	20															198
IMPLEMENTATION SUPPORT																												41	48	25	19	14	13	12	26	26	23	247
																																						7905

Table 14. Monthly Listing of Mandays Per Task

Table 15. Chronological List of Delivered Reports

Date	Title
1 NOV 77	Media Selection Report
1 NOV 77	F-14 Aircrew Behavioral Objectives
3 JAN 78	Quality Control Plan (Draft)
15 FEB 78	SME Training Materials
14 APR 78	Training Support Requirements Analysis (TSRA)
14 APR 78	Student Syllabi
3 APR 78	SME Training Materials
6 JUL 78	Trainer Modification and Utilization Report
12 JUL 78	Implementation Plan
1 JUN 78	Lesson Formatting and Media Selection
22 AUG 78	Comments on Military Specification and DID's
2 OCT 78	Quality Control Plan, 1st Update
17 OCT 78	TARPS Problem Analysis
31 OCT 78	Objectives Hierarchies Update Report
30 NOV 78	Syllabus Update #1
15 JAN 79	TARPS Objectives
1 MAR 79	RF-14 TSRA
1 MAR 79	RF-14 Student Syllabi
19 MAR 79	Instructor Training Course Materials and Training Device Instructor/Operator Training Materials
1 MAY 79	Quality Control Plan, 2nd Update
1 SEP 79	Implementation Plan (Draft)
1 NOV 79	Quality Control Plan (Final)
1 JUL 79	F-14 TARPS Transition Syllabus Development
1 AUG 79	Instructor Under Training Manual
1 OCT 79	Implementation Plan (Final)
1 NOV 79	TSRA
1 NOV 79	Objectives Hierarchies
1 NOV 79	Student Syllabi, 2nd Update
1 APR 80	VF-101 Implementation Plan
1 JUN 80	Student Training Course Lesson Materials
31 JUL 80	Training Program Work Report
30 AUG 80	Quality Control Report
30 SEP 80	Training Support Requirements Analysis Update

APPENDIX A

SME TRAINING MATERIALS, EXAMPLE

MODULE 2: LESSON 1

THE LESSON SPECIFICATION

OBJECTIVES

1. At the completion of this module you will be able to match all the components of a lesson specification with their appropriate definitions.

BACKGROUND

There is a great deal of good, complete, well-designed lesson material existing in the readiness squadron at this time; not only in the form of lesson guides and sound/slide programs, but also in the heads and memories of the squadron instructors. It is not the desire of Veda that this vital technical information be forgotten in the design of the new instructional program. We need this information. In order for this training program to truly be an improvement over what is now in existence, this existing material must be collected, organized in a fashion optimal for instruction, documented so that it can be located, used and modified as necessary.

The lesson specification is the format chosen for organizing and documenting technical information as it relates to each specific lesson or event within the syllabus. Academic events, trainer events and flight events each require a lesson specification. Each specification indicates the precise lesson content, resource requirements and practice and testing provisions for the lesson. It is not the lesson itself. The student will never see it. It is for use as a blue print by the lesson author when developing the actual lecture guide, sound/slide program, briefing guide, etc.

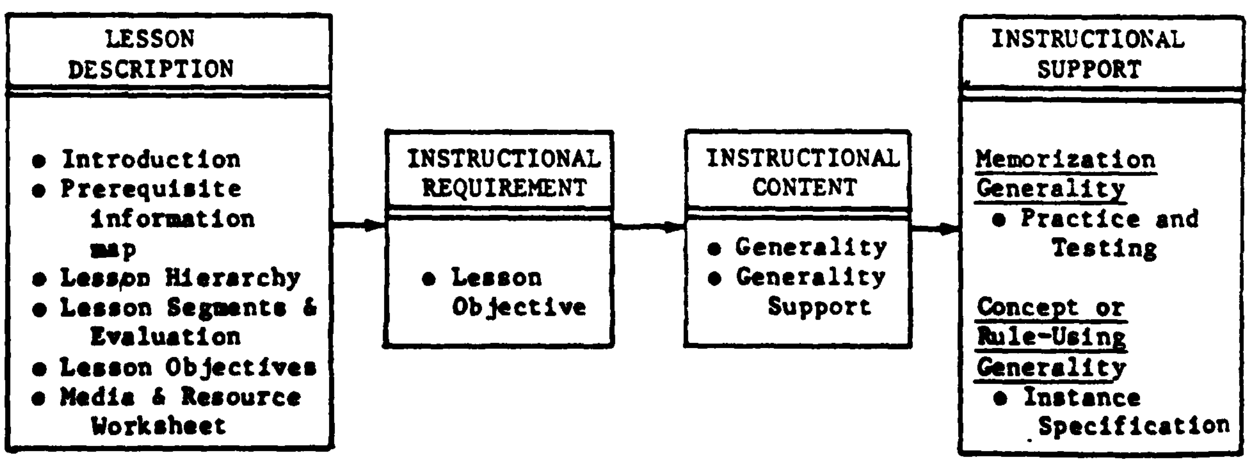
Ideally, the lesson specification should be written so that the lesson author, knowing little or nothing about the technical content, could still write a lesson from the material provided in the specification. If you are getting a little jittery at this point, skeptical of how someone with no technical background can write lessons for the F-14 weapons system, relax for awhile; this is not really going to happen. Fortunately, the people writing the lessons for this training program have a great deal of aircraft and weapon systems knowledge; both with the F-14 specifically, and with other aircraft such as the F-4. They know the language and the operational context in which the lessons, the instructors and the students exist, but they do not have day-to-day, first-hand intimate knowledge of the F-14. Therefore, they are relying on you, the subject matter expert, for thorough and thoughtful review of lesson specification content to ensure that all vital, technical content is included in each lesson. The result of this process will be that when the lesson is written, the content of that lesson is already organized, making the authoring process more efficient and precluding valuable technical information from being forgotten or inadvertantly omitted. Each subject matter expert will be asked to provide inputs to the lesson specifications for the subject areas where he is most knowledgeable. In other words, you are Veda's expert consultant; and Veda, as well as future F-14 students and instructors, rely on you for precise, detailed lesson content.

The following parts of this lesson describe the lesson specification in order for you to more fully understand its contents. A sample lesson specification, developed for a sound slide program on the radar antenna is attached following this lesson, to provide an example and be used as a reference when completing this lesson.

CONTENT

The following illustration depicts the components of the lesson specification and how they relate to one another. The subject matter expert will be asked for inputs only to the instructional content and instructional support portions.

THE LESSON SPECIFICATION



The lesson specification is composed of the following parts:

LESSON DESCRIPTION: This material is made up of administrative information which outlines the lesson and describes its place in the syllabus. The specific components of the lesson description are:

<u>Introduction</u>: *A brief statement of the contents of the lesson* and how it relates to those lessons preceding and subsequent to it.

<u>Prerequisite Information Map</u>: A block diagram illustrating the sequence of lessons and tests immediately surrounding the lesson in question.

<u>Lesson Hierarchy</u>: A block diagram illustrating the sequence in which the lesson objectives will be taught.

<u>Lesson Segments and Evaluation</u>: A statement of how objectives are grouped within a lesson and where they are tested.

<u>Lesson Objectives</u>: A listing of the objectives within the lesson.

<u>Media and Resource Worksheet</u>: A coded matrix enabling precise specification of the resource needs for the lesson.

INSTRUCTIONAL REQUIREMENT: The lesson objectives specify the requirements for instruction within the lesson.

<u>Lesson Objectives</u>: Each objective contained within the lesson description is listed separately and prescribes the instructional content.

INSTRUCTIONAL CONTENT: This portion of the lesson specification describes the information that must be delivered to the student in order for him to meet his objectives.

<u>Generality</u>: A precise statement of the instructional content which must be delivered to the student in order for him to attain the objective. The generality takes different forms, depending on the type of learning required in the objective. The three types of generalities are memory, concept and rule using.

Generality Support: An expanded statement of instructional content which attempts to increase student understanding of the subject matter. The generality support corresponds to the type of generality. A specific type of generality support is required for each of the three types of generalities.

INSTRUCTIONAL SUPPORT: The examples, which describe the lesson content and practice and testing features help to enhance student learning.

Instance Specification: Provides the type and format of examples to be presented to the student in order to enhance the exact meaning of the instructional content. Instance specifications are required only for concept or rule-using generalities. They include several parts:

1. Type description: describes the examples required to illustrate the instructional content.

2. Format description: sets the stage for the examples, i.e., what should the examples look like?

3. Common error analysis: describes mistakes students often make in comprehending the material.

4. Mastery criterion set: describes the types and number of examples required for student mastery.

5. Instance production: describes the type and number of examples to be produced for example purposes, practice purposes and testing.

6. Testing criteria: states the level of performance required of the student in order to prove he has learned the material.

Practice and Testing: Provides directions and sample questions for use within the lesson as practice and later for more formal testing. This page is used for memorization generalities only.

You are needed by Veda in order to evaluate the generality for technical accuracy, remembering that the generality is the critical information that must be delivered to the student so that he can meet the objective. Then, working with a Veda representative, you will be writing generality support and instance specifications. Veda will provide the mastery criterion set, instance production and testing criteria portions of the instance specification.

The following lessons in this module more precisely describe the generality, generality support, instance specification and practice and testing requirements for the lesson specification. First, take a look at the specification for the radar antenna and become familiar with what it looks like. If you have any questions, ask one of the Veda representatives at the Miramar site or call Veda offices in San Diego at (714) 291-8768.

PRACTICE

1. Match the lesson specification component to its appropriate definition.

_____ 1. generality

_____ 2. introduction

_____ 3. instance specification

_____ 4. generality support

_____ 5. type description

_____ 6. common error analysis

_____ 7. format description

_____ 8. practice and testing

_____ 9. lesson hierarchy

DEFINITIONS

a. Describes the examples required to illustrate the meaning of the lesson's instructional content.

b. Describes mistakes students often make.

c. A precise statement of instructional content.

d. The sequence in which the lesson objectives will be taught.

e. An expanded statement of instructional content.

f. Needed only for concept and rule-using generalities.

g. Describes the format of examples.

h. Provides sample questions.

i. A general overview of the lesson

FEEDBACK

The answers to the matching question are:

1. c
2. i
3. f
4. e
5. a
6. b
7. g
8. h
9. d

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