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Cost analysis of two methods of instruction in P-3 Fleet Replacement Squadrons.

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COST ANALYSIS OF TWO METHODS OF INSTRUCTION IN P-3 FLEET REPLACEMENT SQUADRONS

by

David M. Johnshoy

June, 1990

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In 1979, a P-3 aircrew training program, designed using the Instructional Systems Development process, was implemented in the two P-3 Fleet Replacement Squadrons. One squadron adopted workbooks recommended by ISD, One continued with lectures. This thesis compares the cost differences arising from two different methods of instruction now in use in P-3 training programs. A conceptual model is developed to compare the opportunity costs associated with the selection of one training method over another. The results indicate that the lecture method of instruction is least costly.

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Cost Analysis of Two Methods of Instruction in P-3 Fleet Replacement Squadrons

by

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ABSTRACT

In 1979, a P-3 aircrew training program, designed using the Instructional Systems Development process, was implemented in the two P-3 Fleet Replacement Squadrons. One squadron adopted workbooks recommended by ISD, one continued with lectures. This thesis compares the cost differences arising from two different methods of instruction now in use in P-3 training programs. A conceptual model is developed to compare the opportunity costs associated with the selection of one training method over another. The results indicate that the lecture method of instruction is least costly.

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I. INTRODUCTION

This thesis will compare the cost differences arising from two different methods of instruction, a technology based method that uses workbooks as the primary means of information transfer, and a conventional instruction method that uses lectures. The purpose of the comparison is to determine which method has higher life-cycle costs. Because the selection of one training method over another has opportunity costs associated with it, many of those costs will also be discussed in an attempt to provide the decision maker with a complete description of pecuniary and non-pecuniary costs which are relevant to training method selection.

Efficient and effective training is of critical concern to the Navy because of the thousands of men and women that must be trained annually. Navy training systems typically cost more than civilian programs because Navy students are paid while attending training. Additionally, the consequences of poor training are high in the Navy because of the ramifications of poor performance while serving in one of the many billet's with critical responsibilities. [Ref. 1: pp. 1,3]

The high costs of military training programs drive the need for the military to weigh carefully alternative methods of instruction so the lowest cost alternative that accomplishes the desired level of training effectiveness can be selected. Kearsley, in his book *Training and Technology*, suggests that technology based training programs are almost always cheaper in the long run than a conventional method of instruction [Ref. 2: p. 153]. Though this perception may sometimes be true, an appropriate training method should be selected only after a cost-effectiveness study closely examines each method. Unfortunately, because of the unique requirements of different training programs, detailed cost data for ready comparison is lacking [Ref. 3: p. 22].

A. BACKGROUND

1. Military Training and Readiness

The military has training programs because its readiness is critical to its mission. Military readiness is dependent on personnel readiness which in turn is affected by training, job experience, leadership, motivation, selection and other factors. Training design technologies have been applied to military training programs in an effort to improve readiness. [Ref. 1: p. 1] The technology commonly used in the Navy for designing training programs is a method called Instructional Systems Development.

2. Instructional Systems Development in the Navy

Instructional Systems Development (ISD) was mandated for training program development by the Chief of Naval Operations in the mid 1970's. The ISD method is a performance based system that uses a step by step procedure to design and develop training programs by first identifying the required on-the-job performance. Following performance determination, job tasks are determined from which training objectives can be developed. In later steps the training objectives are sequenced in a logical order, the delivery media are selected and developed, and the program is implemented. The final stage of the ISD process is a control phase based on continuing internal and external evaluation to revise the training.

3. ISD and the P-3 Aircraft Training Programs

The Navy contracted with a civilian firm in 1975 to revise the aircrew training program for the landbased P-3 anti-submarine warfare aircraft using ISD methods [Ref. 4: p. v]. Revision was felt to be essential because of numerous shortcomings is the training program that were identified in an audit conducted by the P-3 training squadron and the Naval Training Device Center [Ref. 5: pp. 13,14]. The Chief of Naval Operations directed that the new training program follow a format similar to the one used for the S-3A aircraft, which is a carrier based aircraft with a mission similar to the P-3 [Ref. 4: p. 1]. The new P-3 aircrew training program was intended to replace existing training at the two P-3 Fleet Replacement Squadrons (FRS), Patrol Squadron Thirty-One (VP-31) located at Naval Air Station (NAS) Moffett Field, California, and Patrol Squadron Thirty (VP-30) located at NAS Jacksonville, Florida.

4. Media Selection for the P-3 FRS

During the ISD process, the instructional media for the training program were selected. The media selected were workbooks, slide-tapes, videotapes, and lectures/seminars. [Ref. 4: pp. 9,b1-b8] The workbooks were structured in a manner similar to programmed instruction, which allows students to proceed through the units at their own pace. However, due to the need for group instruction in simulators, aircraft labs, and flights, the workbook curriculum remained group-paced.

As time went on, using a static medium (workbooks) to present frequently changing information led to a high number of content errors in many workbooks. The production process used to update the workbooks could not make workbook changes as fast as they were occurring. Because of dissatisfaction in the workbook method, VP-30, the east coast training squadron, changed its training program to a lecture based system. VP-31, the program manager for the curriculum, continued to use the workbooks as the primary method of instruction but added lectures as necessary to make up for the workbook shortcomings.

B. RESEARCH QUESTIONS

This study compares the costs of the two methods of instruction used in the United States Navy's P-3 aircraft Fleet Replacement Squadron's. One method uses workbooks, which require a complex production system to maintain and update materials but has the potential for reducing manpower requirements. The other method is a conventional training system that uses lectures. Since the fleet squadrons of the east and west coast continue to operate at high levels of readiness even though the graduates that join the squadrons are taught with different instructional media, this study assumes that both training commands are meeting the minimum required level of effectiveness, and that the effectiveness of both training commands is the same. The costs used in this study include only those that are related to the classroom training methods. Other costs such as aircraft, fuel, spare parts, aircraft maintenance, simulators, and squadron administration are not examined.

This study gives a detailed description of the data required to measure the costs of a training method. Two different methods of instruction used in the Navy are compared to determine which method is more costly over the life-cycle of the course. The opportunity costs of various attributes associated with the training media are also compared.

C. ORGANIZATION OF THE STUDY

Chapter II presents a brief historical background of Instructional Systems Development and its subsequent use to develop the P-3 training program, and discusses several problems arising from the media chosen during the Instructional Systems Development process. Chapter III is a literature review of works that are pertinent to this study. In chapter IV, the cost model used to compare training alternatives is developed. Chapter V presents the data and results from using the cost model. A summary and conclusions are presented in chapter VI.

II. HISTORICAL DEVELOPMENT

This chapter presents a brief historical account of the events leading to the training programs now in use at VP-31 and VP-30, and a description of the Instructional Systems Development process upon which the training programs were based. The historical development is useful because it illustrates how two programs, though based on the same training development methodology, can differ significantly in their teaching methods. It also serves as a reminder of some of the problems that can arise when adopting a new training methodology. Since the costs of the training methods of the two squadrons will be compared in this study, this discussion provides a useful framework for understanding how those cost differences developed.

A. INSTRUCTIONAL SYSTEMS DEVELOPMENT IN THE MILITARY

Because of the importance of training in the military, the military services have been active participants in the development and use of new training technologies. A curriculum development technique called Instructional Systems Development (ISD) evolved from the belief that the systems analysis approach, developed in the 1940's, could be used to simplify training program development. This technique has been the required standard for training program design in the Navy since the mid 1970's. [Ref. 1: p. 2]

The ISD approach gained popularity in all military service branches during the 1960s, and has been the most pervasive and influential of the training development methods [Ref. 2: p. 83]. Without a formal approach to training development, media selection and course development is more of an art. The ISD method turns course development into a sequenced procedure that identifies training requirements and uses set procedures to ensure that the training program meets the training objectives. Two major goals of ISD are:

> to make training (1) job relevant (meaning it would ultimately prepare the trainee for his or her function[s] in Navy readiness) and (2) cost-effective and efficient (meaning it would use the most efficient training methods to do the training). [Ref. 1: p. 4]

Although ISD is often mistakenly confused with teaching methods or techniques it is much broader than that. Teaching methods are selected during one phase of the ISD process, and a training program developed with ISD could include several teaching methods such as lectures, self-paced study, or computer based instruction. [Ref. 1: p. 4]

B. THE PROCESS OF INSTRUCTIONAL SYSTEMS DEVELOPMENT

1. The Instructional Systems Development Method

Kearsley, in his book *Training and Technology*, describes ISD as "a set of procedures for developing instructional programs in a consistent and reliable manner." [Ref. 2: p. 83] Developing training requirements based on explicit job performance criteria is the cornerstone of the ISD process. The content of a training program is determined only after an in-depth study of the job tasks of the position to be filled. [Ref. 2: p. 83]

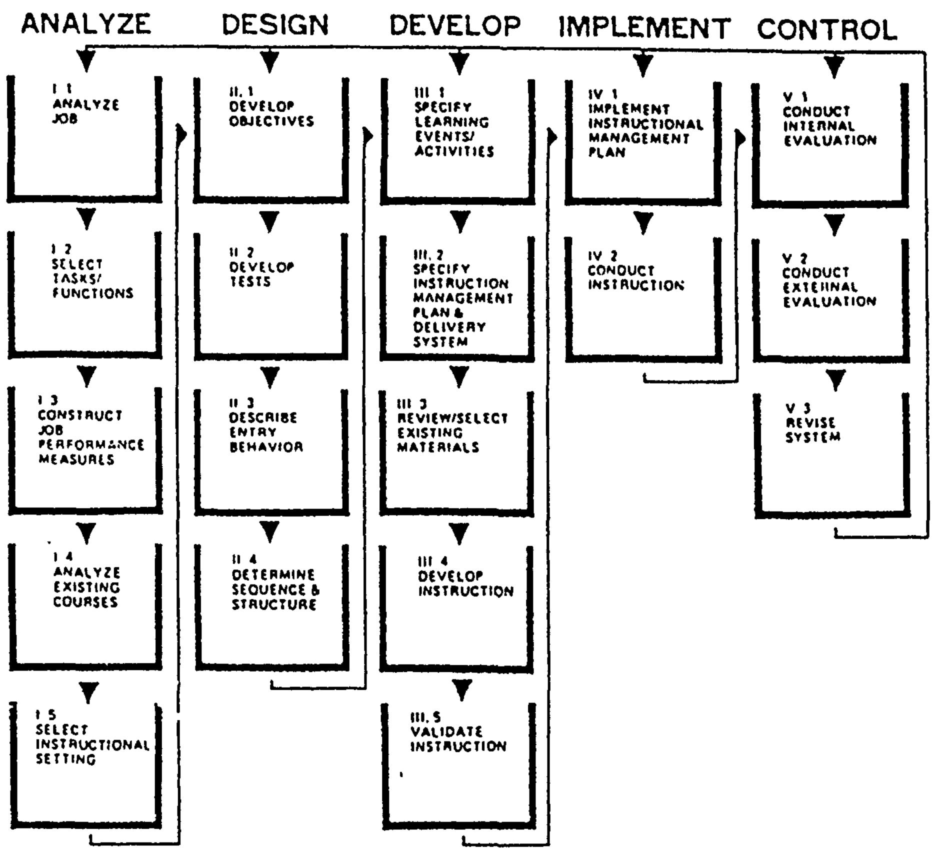
Differences between ISD and the traditional method of training program development are summarized in Table 2.1.

TABLE 2.1. COMPARISON OF INSTRUCTIONAL SYSTEMS DEVELOPMENT AND TRADITIONAL APPROACHES TO INSTRUCTION

ISD Approach	Traditional Approach
Content is based upon performance requirements.	Content is based upon topics to be covered.
Instructional objectives are explicitly stated.	Instructional objectives are implicit.
Content is developed by multidisciplinary team.	Content is primarily developed by instructor.
Evaluation is part of development process.	Evaluation occurs after training is implemented.
Media, strategies, and sequencing are analytically derived.	Media, strategies, and sequencing are intuitively selected.
Materials take into account students capabilities and differences.	Materials are designed for ideal or average student.
Development process is consistent and reliable across individuals.	Development process is idiosyncratic and varies with instructor.

[Ref. 2: p. 84]

Training program development in the Navy using the ISD method was set forth from a series of documents published by the Navy as *Interservice Procedures for Instructional System Development* (NAVEDTRA 106A). Figure 2.1 depicts the ISD process as described in NAVEDTRA 106A. In this model, five phases are used to develop a training program. The



Adapted from Ref. 5: p. 26.
Figure 2.1. Five Phases of the ISD Model

first and most important phase is the analysis phase. This phase determines if a need exists for the training in the first place, and, if the need exists, what will be taught. Job analysis, during this phase, identifies the criteria of effective job performance. These criteria become the basis for the material to be taught. [Ref. 6: p. 1.1]

The course of instruction is designed during the second phase using the material from the analysis phase. The objectives of the course are identified, and the sequence of instruction over which the learning objectives will be presented is determined. Criterion referenced tests that measure the degree to which the students have attained the learning objectives are written. These tests are designed to determine the student's performance relative to the external job requirements. [Ref. 6: pp. 2.1,2.3]

During phase three, the different learning strategies which will be used to teach the students the knowledge required by the performance based objectives are specified. The knowledge objectives are those that require the student to recall information but not apply it directly. Performance objectives require the student to use the information learned to solve a problem or operate equipment.

Also in phase three, a curriculum outline is made by the program developers to aid in planning the course, and it subsequently serves as a curriculum approval document. Instructional materials are also developed. Writing the tests before developing the instructional material helps keep the program lean in the sense of limiting the instruction to the material needed to develop student proficiency in the objectives.

Validation of the instructional materials is conducted through internal review by the designers, individual student trials using rough drafts of the training materials, and, finally, group trials using rough drafts that have been changed to reflect any problems noted during internal and individual validation. Final validation is conducted on a regular class in the normal training environment, and measures student entry level behavior and course completion performance. [Ref. 6: pp. 3.1,3.70,3.100,3.174-3.186]

Phase four is the implementation phase. Here, the procedures used to conduct the course, such as scheduling, instructing, and monitoring, are specified. The final phase, phase five, is the controlling phase of the ISD program. In this phase, the training program is continuously evaluated with respect to meeting the training requirements using internal measures such as student and instructor feedback reports, and an in-depth annual course review. An external evaluation is conducted to determine if the graduates can do the job for which they were trained. External evaluation methods can range from informal discussions between the course instructors and those who supervise the course graduates, to surveys and structured interviews. [Ref. 6: pp. 4.1,5.1-5.32]

2. ISD as Applied to the P-3 Training Squadrons

In the mid 1970's, Courseware, Incorporated, was contracted to redesign, develop, implement, and evaluate the P-3 aircrew training program. Courseware worked with a Navy and Civil Service team of subject matter experts and training specialists to develop the new program using ISD methods. [Ref. 4: pp. 1,2]

To select the instructional media for the P-3 training program, a media selection algorithm adopted from the S-3A training program was used. To use the algorithm, answers were obtained from a series of five questions for each of the objectives being taught. The questions identified the expected student behavior during testing (such as recall, recognition, or rule using), the level of content being taught (such as familiarization or memorization), the display requirements of the material, and the extent of the memorization requirements. The algorithm output provided a priority listing of the optimal media for delivery of the instructional materials. In many instances, computer based instruction was the first choice. However, because of cost constraints, computer based instruction was rejected and the instructional media selected were wor books, slide-tapes, videotapes, and seminars. [Ref. 4: pp. 9,b1-b8]

The P-3 Instructional System Management Plan, which was the implementation document for the newly developed training program, shows that workbooks were the principal media for information transfer, and that lectures were not developed under the original ISD plan. Seminars, not to be confused with lectures in which an instructor teaches new material, were included in the training plan. Seminars were originally conceived as informal and impromptu get-togethers to provide an opportunity for the instructor to present updated information not yet included in the workbooks, and to encourage students to discuss areas from the workbooks in which they were having difficulty. [Ref. 7: pp. 5,6]

C. MEDIA DEVELOPMENT

Workbook development for the P-3 training squadrons required a massive effort by the training program development team. Providing lessons in the form of workbooks for all P-3 aircrew positions meant creating roughly 850 different lessons averaging 35 pages per lesson [Ref. 7: p. k-5]. Using workbooks also meant that a major production system had to be established to support initial development and the later revisions resulting from changes to the aircraft and operating procedures. The production system included an educational specialist, editors, secretaries, a graphics shop, a print shop, and a library.

Once the materials were developed, the validation phase should have been conducted. Because of delays in workbook production and the lack of suitable test subjects, only about five per cent of the instructional material was validated [Ref. 4: p. 15]. Even though procedural changes were made based on the validation of this small sample of materials, doubt was cast on the remaining materials. Had all of the material been validated perhaps some of the future problems encountered with the workbooks could have been avoided.

With the same training program and media to be used for the east and west coast P-3 training squadrons, one squadron, (VP-31), was assigned model manager responsibilities for the training program. As model manager, VP-31 was responsible for curriculum oversight, which included producing and updating the training materials for the two training squadrons. The production system was set up in hangar one at NAS Moffett Field, California. Workbook production incorporated the resources of two commands, VP-31 and Fleet Aviation Specialized Operational Training Group, Pacific Fleet. VP-31 formed an ISD department that was responsible for "ensure[ing that] courseware materials (including testing instruments) for all syllabi are developed and maintained using the most current content information available." [Ref. 7: p. 22] The Specialized Training Group's responsibility was to provide secretarial and graphics support for ISD materials, to print ISD materials as required for both Fleet Replacement Squadron's, and to issue ISD materials to students attending the training at VP-31 [Ref. 7: p. 25].

D. EVOLUTION OF THE P-3 TRAINING PROGRAMS

The training program developed using the ISD process was implemented at VP-31 in January of 1979, and at VP-30 in January of 1980 [Ref. 5: p. 10]. By 1984, both training commands had added substantial lecture time because of problems with the workbooks. Numerous errors in the workbooks fostered frustration and a lack of confidence in the workbook system. These errors were the result of a production system originally set up to handle a much smaller workbook revision load. The inadequate staff was quickly overwhelmed by the changes needed because of aircraft modifications, changes in operating procedures, or changes in the tactical employment of the aircraft. The volume of changes led to lengthy backlogs in workbook revisions--some revisions required over a year to move through the system. In an instructional systems status letter, the Commanding Officer, VP-31 stated " . . . by early 1983 the quality of the information contained in the system had slowly deteriorated to a point that the courseware no longer reflected current operating procedures." [Ref. 8: pp. 1-4] The lectures were added to the training program to compensate for the workbook shortcomings because they could easily incorporate current information. An added bonus was later noted by a VP-31 commanding officer who observed that lectures and workbooks, along with other media in the curriculum, lead to a richer mix of media and a greater opportunity for the students to grasp the objectives.

Presently, VP-31 is predominantly workbook oriented, i.e., workbooks remain the primary media for information transfer. A large number of lectures have been added, however, so that the present ratio of workbooks to lectures is one to one, measured over all aircrew tracks. VP-30 has changed its curriculum so that it is a lecture oriented training program. Many of the workbooks are still used at VP-30, but only for supplemental reading assignments.

As part of the evolutionary process within the training command, subject matter experts are changing the workbooks so that material subject to frequent change is deleted. With this material deleted, the student is referred to appropriate source publications where the material is more frequently updated. This new method should reduce the revision requirements, shorten the revision backlog, and reduce the student and staff frustration resulting from out-of-date materials.

III. LITERATURE REVIEW

A. COST ANALYSIS METHODS

1. Cost-Benefit Analysis

Over the past 20 years there has been a dramatic increase in the analytic studies that are conducted to support public policy decisions. Some of the generic names applied to such analyses are environmental impact statements, cost-benefit analysis, risk-analysis, and decision analysis. These analyses, supposedly explicit evaluations of risks and benefits, theoretically provide the tools for "regulatory openness." Clear evaluations of policies required that the assumptions and numbers used to derive the estimates also be made available. Unfortunately, as emphasized by Firschhoff in *The Art of Cost-Benefit Analysis*, "these analytic techniques have both inherent limitations and potential for misuse." [Ref. 9: p. 1.1] For analyses to be useful, the interested observers should be aware of the techniques that were used and know when the conclusions should be heeded. [Ref. 9: pp. 1.1,1.2]

The basic premise of a cost-benefit analysis is that benefits and costs should be measured for the proposed action, and that a new technology or policy should be adopted only if the anticipated benefits outweigh the anticipated costs. The major challenge of a cost-benefit study lies in the correct and complete enumeration of all costs and benefits. [Ref. 9: p. 2.1]

2. Cost-Effectiveness Analysis

Because the quality of graduates from Navy training programs affects the Navy's readiness, training program effectiveness is a major concern. Most of the studies conducted to evaluate or compare the effectiveness of military training programs have used a cost-effectiveness approach. The studies are often undertaken to determine program cost or program effectiveness and not to determine if the benefits outweigh the costs. Often, the benefits of the military training program(s) being measured or compared are already assumed to outweigh the costs.

Cost-effectiveness analysis provides a means of assessing decision alternatives among training programs. When more than one means of achieving an objective is available, cost-effectiveness analysis theoretically provides a means of identifying the least cost alternative. Orlansky suggests addressing the following three questions in a cost-effectiveness study [Ref. 3: p. 6]:

1. Does the new technology, device, or method of instruction actually improve the effectiveness of training and, if so, by how much?
2. How much does the new technology, device, or method of instruction cost (preferably on a life-cycle basis) compared to present practice?
3. If the effectiveness of training is actually increased, is the amount of improvement worth its cost?

These questions suggest several possible combinations of cost and effectiveness. The possible combinations, along with the decision each combination supports, is shown in Figure 3.1. If a training alternative is judged to have greater effectiveness at less cost or the same effectiveness at less cost it would appear to be a preferable choice. If the alternative has less effectiveness at the same or greater cost, or the same effectiveness at higher cost, rejecting the alternative would be the preferred choice. The choice is less clear cut when cost and effectiveness are both determined to be less, the same, or more than the other alternatives being compared. If cost and effectiveness are both higher, it must be determined whether the higher effectiveness justifies the higher cost. If the effectiveness is lower but cost is also lower it then becomes a question of whether the lower effectiveness is acceptable. If no difference in cost and effectiveness exists among alternatives, then final selection will depend on other important features such as the flexibility of the method under different student loading or instructor manning scenarios. [Ref. 3: p. 6]

		EFFECTIVENESS		
		LESS	SAME	MORE
COST	LESS	?	adopt	adopt
	SAME	reject	?	adopt
	MORE	reject	reject	?

Adapted from Ref. 3: p. 7.
Figure 3.1. Decision Matrix for Cost and Effectiveness

The questions about costs and effectiveness presented by Orlansky imply that other features such as flexibility to operate under different student loading, do not have a cost. However, close observation of a training program may reveal ways to measure or estimate the costs of "other features" that are often not included in a cost-effectiveness evaluation. Many features that are often overlooked by the analyst are features of the training program that have an opportunity cost associated with them.

3. Opportunity Cost of an Alternative

When making a choice between alternatives, there is an opportunity cost involved in that choice. To have something, other things must have been given up, or an opportunity to acquire an alternative thing must have been forgone. The forgone alternative is called the opportunity cost of that choice. Resources used on one project, for example, are no longer available for other uses. When operating with limited resources, a decision to proceed with one project has an implied decision not tc undertake other projects. [Ref. 10: p. 110] This means that if all resources are used on the operational front, nothing remains for training, research, development, and logistics. At a less aggregate level, the choice to buy one more aircraft may mean fewer flight hours will be allocated to operate the aircraft. It is therefore in the opportunity cost where the real cost of the purchase is found. Using opportunity costs rather than strict accounting costs can help the decision makers determine the true costs of the alternatives during the decision process.

B. COST-EFFECTIVENESS STUDIES COMPARING MILITARY TRAINING MEDIA

The common definition of effectiveness, as used in military cost-effectiveness studies, is described by Hall, Rankin and Aagard as " . . .

(measures of) the degree to which a training course or system achieves the goals established for it." To measure effectiveness, the training goals must be converted into behavioral terms that can be measured, e.g. performance. [Ref. 11: p. 12]

Many studies that have compared the effectiveness of different instructional media used in military training commands have concluded that no medium ranks significantly higher than the others in effectiveness. This result could be because most of the military's training consists of mixed media programs. Although one medium, such as lectures or workbooks, may be used more than the others, additional media or instructor attention may compensate for its shortcomings.

A comparison between individual and conventional instruction was made by Freda and Hall [Ref. 13] in an attempt to determine the differences in effectiveness and efficiency. Data for the study were obtained from 19 military training programs and over 5000 students. Their methods for the comparison involved statistical regression using data obtained on five predictor and four criterion variables. The five predictor variables were: the method of instruction, (conventional or individualized), the trainees' ability level, (based on armed forces qualification test scores), the type of training task, (fact, category, procedure, rule, or principle), gender of the graduate, and the location of the school. The four criterion variables chosen were divided into effectiveness measures and efficiency measures. The effectiveness measures were end-of-course grades and training adequacy ratings (performance survey from graduate's first level supervisor). The efficiency measures were cost of the course and time to complete the course.

Freda and Hall concluded that individualized and conventional instruction were equally effective ways of preparing sailors for their jobs. Within the two categories, students of individualized instruction with greater ability (mental categories 1 and 2) had higher course grades and finished in a shorter time than lower mental category students, but in conventional instruction, no differences were seen among mental categories. [Ref. 12: p. 69]

Freda and Hall were not able to make a definitive judgement that one training method was more expensive than the other. For the courses compared, the cost of individual instruction was higher than that of conventional instruction, but the courses compared were of different lengths and were not similar in type of material. To determine costs, the researchers used the "per capita course costing data base" from the Chief of Naval Education and Training. This data base does not contain research and development costs and also lacks many of the investment costs, so the comparison is primarily based on differences in student and instructor salaries. [Ref. 12: pp. 69,D.1]

Braby and Evans conducted a study that was a comparison of six elements of quality between individual and conventional instruction for 37 courses. The quality of instruction in each type of course was determined with a 50 question survey administered to the 1,090 students, 170 instructors, and 54 course supervisors. A structured interview was also conducted at the training command of each of the 37 courses with the person that was "deemed 'most knowledgeable' of the course by one of the two principal investigators." [Ref. 13: pp. 15,17] The concluding remarks of Braby and Evans were:

> Instructional strategy (II vs CI) [individual instruction vs conventional instruction] is not the determining factor in overall course effectiveness of current Navy courses. Rather, effectiveness is mediated by the extent to which good instructional practices are used within the courses and ultimately determined by the degree to which proper practices can be employed within various instructional strategies. Since it is possible for properly executed II and CI to be equally effective, a choice of strategy should rest primarily on the relative cost efficiencies of the two approaches. [Ref. 13: p. 33]

There are many ways to approach a cost-effectiveness study but it is difficult to compare the costs of policies or programs with conclusions from analyses using different methods. In a 1977 Rand Corporation paper [Ref. 15] Marks and Massey examined several cost models used in Air Force programs and various case studies of non-Air Force programs. They concluded that many of the studies: were inadequate as a basis for making "a sound resource decision," were lacking in the depth of analysis required for cost elements, and, used "poorly defined baselines against which to measure the cost impact of alternative cases." [Ref. 14: pp. 5,12,14]

In 1983, Knapp and Orlansky developed a cost element structure for defense training with the purpose of providing a standardized approach to determining the costs of a training program, regardless of size. The cost element structure is a listing of areas where costs should be measured and is relevant to a diverse range of cost studies if the analyst simply disregards the cost measurement areas not applicable to his study. The format recommended in the study requires determining program costs by measuring costs of research and development, investment costs, and operating costs. [Ref. 15: pp. 1,8-16] The format adds only slightly more detail than previous studies and doesn't provide information on how to obtain the costs. The study describes all costs that Knapp and Orlansky feel would have an effect on the budget of an organization, but a weakness of the approach is a resulting ignorance of the opportunity costs that are associated with a specific training program.

Many studies have been conducted using a strategy similar to that of the cost element structure. Several have compared different military training methods. In 1981, Corey compared the costs of training at RM-A and IC-A school in an attempt to determine whether individualized instruction or conventional instruction was cheaper. As in the cost element approach, Corey's approach was to identify the resources required for the instruction and then to estimate the cost of the resources. The least cost alternative producing a given output was taken to be the most efficient. For this study, output was defined as the number of graduates trained to a certain level. All methods of instruction were assumed to have the same level of effectiveness. [Ref. 16: p. 13]

Cost comparisons were made using estimated investment and operating costs of the training programs. The one-time investment costs included costs for curriculum development, specialized programming, class facilities. and equipment. The annual operating costs included costs of staff, students, hardware lease costs, facilities, maintenance, supplies, and curriculum maintenance costs. The staff costs used the Navy Life-Cycle Billet Cost Model, which estimates annual costs to the government of maintaining billets of various rates and ratings. These costs include the individuals' pay, allowances, and benefits. [Ref. 16: pp. 14,15]

Using a billet cost model that includes the cost of past instructor training as in this study could be misleading. The past training is a sunk cost that was expended to develop the expertise of the instructor for his operational squadron and is not relevant to determining the present costs of training alternatives. If the required manning of the alternatives being compared is identical, then the added training cost will cause the total cost of an alternative to be overinflated, but will not affect the outcome of the decision among alternatives. If the manpower requirements of the programs differ, and alternatives are available, then the Billet Cost Model could influence the choice. Billet costs that include aircrew training would tend to become very high because of the expense of aviation training.

The results of Corey's study show that individual instruction is less costly than conventional instruction over a 15 year program life. This result however, is sensitive to student loading and course length. When student loading was less than 440 students per year, conventional instruction was less expensive than individualized instruction. The higher cost of conventional instruction above the 440 students per year point is attributed to the longer period of time (longer than individual instruction) required for the student to remain in the training command. Sensitivity analysis suggested that if the conventionally taught RM-A course was shortened to eight weeks, conventional instruction was less costly. It is interesting to note how the student loading or course length swings the balance of which course is more expensive.

A potential weakness of the study is that for the comparisons a hypothetical, conventionally taught training program was used. The hypothesized conventional method of instruction was estimated to require 20% more time to complete than individualized instruction. The estimate was based on previous studies that examined learning rates associated with different methods of instruction. Another possible weakness is a failure to use measures of opportunity cost when comparing the alternatives.

Another cost model to determine the costs of potential changes in a training program was developed by Thode and Walker. Fortunately, Thode and Walker were involved in the ISD effort conducted at VP-31 in the late 1970's and detailed cost information of the ISD effort and of VP-31's training program are available. Their model uses a structure similar to the cost element structure proposed by Knapp and Orlansky. The study provides a working example of the model with a comprehensive analysis of all major costs of the P-3 training program as envisioned by the ISD process including aircraft, maintenance, administrative, instructor, and student costs. [Ref. 17: pp. 1-4]

Lacking in the Thode and Walker study is any comparison of alternative teaching methods, although the model could be used to make such a comparison. Their model improves on other cost studies by including the opportunity costs associated with updating the media, and provides greater detail on the origin of the costs. Because of the way in which the cost data were aggregated in the study, it is impossible to determine many of the costs that would be useful for a comparison of media development and update costs.

The work presented here avoids the estimations required for a hypothesized training program because the training commands studied have identical training goals although they use different training media to achieve those goals. In addition, opportunity costs are included in the cost comparison of the training programs.

IV. METHODOLOGY

A conceptual model is useful for categorizing and evaluating opportunity costs when comparing the costs of alternative instructional media. The conceptual model developed in this chapter is an adaptation of the Thode and Walker model. It categorizes costs as plant and equipment, development, or operating costs, and extends the Thode-Walker model by identifying the opportunity costs associated with each alternative. The model is used to compare the costs of the instructional media of workbooks and lectures as used in the classroom segment of the P-3 aircrew training programs; as stated previously the training costs incurred by such things as aircraft, maintenance, facilities, and administration, are assumed constant. The model, shown in Figure 4.1, divides costs into three major categories, plant and equipment, development costs, and operating costs for media comparison. Cost comparisons were done for seven different training tracks within the Fleet Replacement Squadron's. The tracks were, Pilot, Naval Flight Officer, Acoustic Operator, Non-Acoustic Operator, Flight Engineer, In-Flight Technician, and Ordnanceman.

The instructional media were determined in an early phase of the Instructional System Development (ISD) training program design. The costs to develop the selected media can vary considerably among alternatives. For materials development done in-house, cost estimates require a working knowledge of the system that produces the materials.

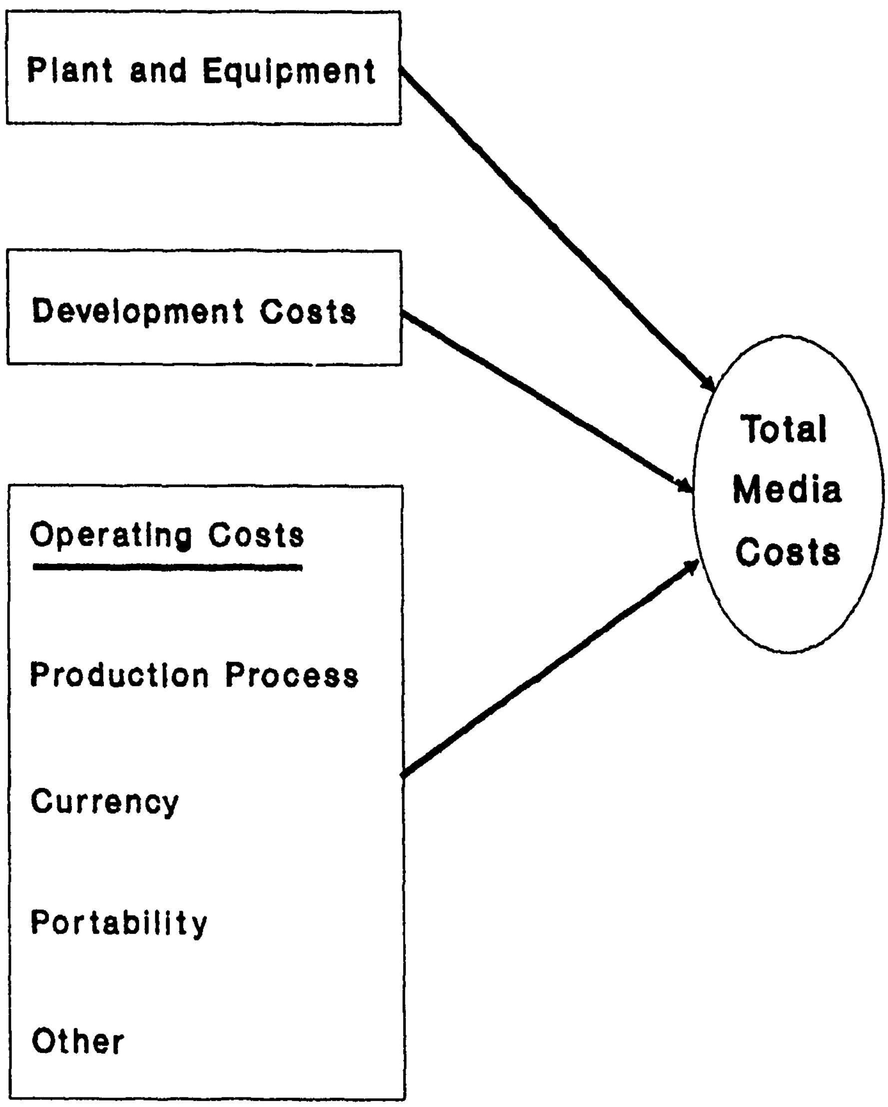


Figure 4.1. Conceptual Model to Determine Training Media Costs

For development done under contract, contracted prices should be available. If one medium requires substantially more organizational effort and labor in the production process, then higher costs will result because of increased manpower requirements. If the training squadron cannot adjust its manpower, then that medium will result in higher opportunity costs for the squadron because the increased administrative workload must generally be handled by the instructors. Areas given up by the increased workload are things such as instructor training time which increases instructor proficiency, less attention applied to other jobs held by the instructor, longer working hours, and, possible decreases in job satisfaction. The training squadrons compared in this study are manned equally, so if one medium requires more management effort, that increased effort imposes additional costs on the squadron. The additional costs may be poor lecture preparation, degraded instructor teaching performance, and lower morale if there is not enough time to accomplish all jobs satisfactorily.

A. PLANT AND EQUIPMENT

If workbook or lecture development, and later revisions, are done in-house, the organization must have or create a structure that can handle the development and revision. Each medium has different worker and equipment requirements necessary for development and revision. The purchase price of the equipment and its subsequent maintenance cost should be considered in comparing the costs of different media.

The equipment costs of the workbook method of instruction were determined after discussions with the division supervisors of the production process and other experts in the program. All major equipment needed to develop or revise the workbooks were noted and prices were assigned based on the present purchase price of the equipment. The major equipment costs were computers, printers, graphics equipment, and printing equipment. Equipment costs of lecture presentation, i.e., overhead projectors and slide projectors, were ignored because these items are required for both squadrons and are therefore not relevant to the comparison.

B. DEVELOPMENT COSTS

The development costs of the workbooks used by VP-31 were estimated by determining the amount of time required for the military subject matter experts in each track to write the books and adding it to an estimate of the amount of time required for all others in the production process to produce the books. Others in the process were: aircrew track managers, educational specialist, typists, editors, graphics artists, and printers. The time estimates for each production worker were based on a survey of the military track managers. The calculation of hourly wages for the subject matter experts multiplied by the production hours, summed over all workbooks, plus two years of worker salaries for the ISD, graphics, and printing departments, were used to determine the total workbook development cost.

The lecture development cost was estimated by multiplying the time required for an instructor to produce a lecture (obtained from instructor estimates) by the hourly wage of the instructor in the training track for which the lecture is used. The costs for all lectures in all tracks were summed to arrive at the total cost of lecture development.

C. OPERATING COSTS

Media operating costs are the costs associated with a specific training medium used to produce the product--the graduate. Included here are the costs that are a function of the graduate production process, the costs of keeping training media current, and costs of other attributes of media such as media portability and the ability of media to respond to changes in student loading.

In the aviation training program, the production process is a conglomerate of training activities that provides the student with the knowledge, skills, and abilities to do the job at the completion of training. The aviation training program uses a media mix that includes workbooks, lectures, videotapes, aircraft simulators, aircraft labs, and flights. While all of these media are critical to the training program, the workbooks and lectures teach nearly all of the theoretical knowledge in the program.

Teaching the theoretical knowledge is a time consuming process, and one medium may be able to accomplish it in less time than another. Self-paced instruction using workbooks can theoretically reduce training time because students can proceed at their own pace. More recently, computer based instruction is making the same claim. In order to take the possibility of reduced training time into account the number of hours the students spend with the workbooks and lectures was determined from the training syllabi of each of the seven training tracks.

Measuring the difference in training time alone may be misleading because the ability of the students upon course completion may be different. If a student is sped through an aircrew training program and sent to the fleet inadequately prepared, there is an additional cost imposed on the fleet squadron receiving the undertrained graduate. The additional cost arises from the additional time a supervisor must spend with the new person, the gas and maintenance incurred by remedial flight training, and the reduced readiness of the squadron because of inadequately trained people.

There are no indications that the effectiveness of the squadrons compared in this study is different. Fleet squadrons on the east and west coasts enjoy high levels of readiness, and neither training squadron is receiving complaints about its training product. If the training squadrons are conforming to the training goals established during the ISD process, then they are, by definition, teaching only to the specified level of objectives, and the effectiveness of both squadrons should be the same.

Along with reduced training time, reduction in manpower requirements brought about by the self-paced nature of the workbooks were expected by the developers. The manpower reduction was not realized to the extent originally expected. A "sterile" workbook environment was felt to impede learning because it bored the students, and in 1982, VP-31 began assigning instructors to student study areas, also called the learning center, to provide assistance, answer questions, and get the students together for informal seminars in cases when many students were having difficulty with a particular area of study. This new policy increased the opportunity cost of the workbook method of instruction because the instructors now lost productive time from their other responsibilities; even though an instructor was on a fixed salary and was paid the same amount regardless of what he was doing, the instructor's productivity in his other assignments was decreased by added duties.

An estimate of the costs of the production process for workbooks and lectures uses the student and instructor training time that is associated with the particular medium. It is not correct to simply apply the entire instructor and student salary to these estimates because a large proportion of the training is conducted with other media outside of the classroom or learning center, i.e., in ground trainers, aircraft device sessions, and flights.

Determining the training time requirements for the individual media was done by obtaining the curriculum descriptions of the seven different aircrew training tracks of both training squadrons. The hours required for the workbook and lecture medium were determined from the curriculum descriptions. These hours were converted to dollars by multiplying instructor hourly earnings times the number of hours required for the particular medium, multiplying the student hourly earnings times the number of hours required for the particular medium, and adding the two together.

1. Media Currency

A continuing problem for the P-3 training program is the fact that the instructors must maintain training material currency. In the last ten years there have been seven variants of the P-3 aircraft to teach at the training command each with its own characteristics (P-3B mod, P-3C baseline, P-3C mod, P-3C UI, P-3C UII, P-3C UII.5, P-3C UIII). As a result the content of the training program undergoes frequent revision in an effort to keep up with equipment modifications to the aircraft and changes in the aircraft tactics that are used in the fleet environment. With frequently changing material, a desirable feature of any training medium would be the ability to make changes at relatively low cost. Lectures and workbooks differ substantially in this respect: major workbook revisions may require six months or more to go through the production system, but changes to lectures can usually be accomplished in several hours and the new material can be presented at the next lecture.

Workbooks developed under the ISD process take up to year to revise because revisions to them require the efforts of many people. Subject matter experts must review the old workbooks for content currency, note areas that need revision, and write new sections to reflect the aircraft hardware changes. Track managers who administer the workbooks assigned to their tracks must note changes to the aircraft or software and initiate the change procedure. Educational specialists must take the input from the subject matter experts and make the changes necessary to ensure that the workbook continues to accomplish its original purpose. Editors, typists, and graphic artists work to make the final copy. Only then can the new material go to press, which requires the efforts of the people in the printing division. In contrast, an instructor updating his lecture may request some graphics support for updating transparencies or class handouts, but the normal delay is a matter of hours. In the case of major revisions, revising lectures may require several days at the most.

The costs of maintaining media currency can be determined by estimating the costs to revise the media. Measures of revision costs are not readily available because they vary from one type of training to another and depend on how frequently the course content changes. Estimates of these costs must be obtained from the person that makes the changes. Even then the quoted number of hours are usually estimates of what is perceived as typical, and are not based on specific records. For this study, however, estimates of the number of revisions per year and the size of the revisions are based on the records kept for workbook revision. The revision costs of workbooks used by VP-31 were estimated in a manner similar to development cost estimates.

The time estimates for each person in the revision process were based on a survey of the military track managers. The hourly wages of those involved in the changes were multiplied by the time required to make the changes. Total costs were obtained by summing the changes for all workbooks over all aircrew tracks. The wages of production workers other than instructors who were assigned to the ISD, graphics, printing departments, were included because they exist to make the revisions. The annual operating budgets of these divisions were also included, and provide an estimate of the cost of supplies used in the process.

The costs to revise the lectures used by VP-30 and VP-31 were estimated by multiplying the time required for an instructor to revise a lecture by the hourly salary of the instructor responsible for the lecture. The costs for all lectures of all tracks were summed to arrive at the total cost of lecture revision. Because it is difficult to determine how many lectures needed revision, the percent of workbooks revised was assumed to reflect the number of lectures needing revision. A percentage of the wages of VP-30 graphics people and their operating budget were included in the lecture revision costs for VP-30 because the graphics division exists in part to support their lectures.

It could be argued that using the hourly wage of the instructors making the revisions is not valid because the military instructors are being paid regardless of how many changes they make. While that observation is true, a cost measurement must be made in order to compare the opportunity costs of one medium with another. If the instructor was not doing revisions, he could have been engaged in some other productive or useful activity, and this is in fact the cost associated with the changes.

2. Media Portability

Another attribute of a training medium that is often desirable is one of portability if training must be provided away from the usual training site. Within aviation commands, the aircraft are occasionally upgraded to a newer model. When a squadron transitions to a different model of aircraft, the fleet squadron must train its aircrewmen on the new equipment and software. The training required for the transition can be done at either the Fleet Replacement Squadron by bringing all aircrewmen to the training site, or at the operational squadron's location.

In the case of workbooks and lectures, both media are portable but transferring these incurs different costs. The workbooks can be bundled up and mailed off, or the instructors can catch the next plane. The cost of bringing training to the fleet squadron rises quickly if many instructors are required to conduct the training. A problem with sending many instructors away from their training command is that the instructors remaining behind must fill in for the absent instructors. Filling in for the absent instructors may result in a tired staff and dissatisfaction resulting from overwork. A training program structured around workbooks may cost less to transport because workbooks do not require instructors.

A cost measure of media portability has been developed by using a scenario in which a four week training program is assumed to take place at the operational squadron's location. The assumptions are that under the workbook program two instructors per aircrew position are required along with the workbooks, and that three instructors are required to do the training using the lecture method. The costs are computed by multiplying the instructor's hourly wage times the number of hours of instruction, adding travel expenses and summing these amounts over all aircrew positions. The costs could also be determined for a scenario where the fleet aircrewmen report to the Fleet Replacement Squadron for the training.

3. Staff Absence, Student Loading, Standardization, and Turnover

Other cost advantages occur because some instructional programs can function better than others in the face of instructor absences. Navy training programs operate under rigid time lines with very little time allowed for making up missed training events. Instructor absence cannot, therefore, be easily accommodated. A medium such as workbooks, which presents the training material without the presence of an instructor, has a cost advantage over a lecture method that would require a replacement instructor to keep the training program on schedule.

However, the production workers are critical to the revision process of the workbook medium. If staffing level is at the level required for the useful flow of changes, someone's absence for a lengthy period or a job unfilled because of a hiring freeze, can lead to a large revision backlog and long periods with inaccurate workbooks. The lecture medium requires few production workers, and those do not hold critical positions, so their absence has little affect on a lecture program.

Some training programs may also be faced with surges or declines in student loading. The workbook medium can easily deal with a temporary surge in student loading as long as the books are available. Printing extra workbooks is relatively inexpensive and should not require too much lead time. With lectures, when increased student loading exceeds the class capacity additional instructors are required. Because instructors have numerous other responsibilities in the training command, the added demand imposes a cost because of the reduced productivity in other areas of responsibility. Student loading in P-3 training is typically stable so an operating cost resulting from changes in student loading was not determined, however, in a qualitative sense workbooks should have a cost advantage if students increase or decrease.

The ease with which a training program can be standardized will vary from one program to another depending on the media used in the training program among other things. Poor standardization in the training program may lead to a failure to meet the objectives for which the training program was established. The gap between what a squadron is really teaching and what should be taught as determined by the training objectives has an opportunity cost associated with it. That cost is manifested in the extra effort required by the fleet squadron to bring the graduate to the level he should have been upon reporting.

People are probably the source of the greatest variability in training courses. Student learning can vary greatly depending on instructor knowledge, instructor teaching ability, and student classroom attention. Instructor knowledge and teaching ability can vary greatly from one instructor to another. Some instructors are far better at recognizing when a student is having difficulty, and at figuring out other ways to present the material. Students have their good and bad days, and their attention in the class is not always the same. Any material presented by the instructor during a student's attention lapse is lost to the student.

A workbook presents information the same way every time. This reduces variability due to the instructor. With a workbook, a student may continuously gauge his performance relative to the exact requirements of the course using the quizzes provided. Poor performance in certain areas prompts a student to go back and study the areas that were not learned well enough. Students completing the workbooks ahead of schedule may have the opportunity to expand their knowledge of advanced material. An attention lapse does not have the same affect as in the lectures because the student still has the course material in front of him. By design, the workbook method with its fixed presentation and more structured change mechanism, is better standardized than lectures.

Staff turnover is a problem incurred regardless of the media used for instruction, but there may be differences in the media that makes one less costly in terms of staff turnover than the other. With rapid staff turnover, an instructor is often transferred shortly after developing his expertise. A longer time in a position is usually accompanied by a greater proficiency within the position. Since aircrew training is accomplished with military instructors, rapid turnover is common as people routinely leave the training organization after several years of duty.

Instructors involved with a lecture method of instruction spend several weeks or more learning to present lectures, an activity not required for a workbook method of instruction. However, the greatest cost arising from rapid turnover in an ISD developed training program may be from the changes that are made to the training program. People with experience and an in-depth understanding of the ISD process from which the training program was developed are rare. Someone without sufficient knowledge may make changes to the training program, the workbooks, or the lectures, that are not consistent with the objectives of the training program. The cost of rapid turnover may then depend on how much damage was done by those who made the incorrect or unnecessary changes. In the P-3 training program, the workbooks require less instructor preparation time, but damaging changes to the training program could be made by the staff in either method of instruction.

There may be other attributes that are important to evaluate when considering different training media. When evaluating media alternatives, conventional instruction is usually thought of as the baseline in the comparison. Instructor or student prejudice may make the use of an alternative difficult. A teaching method may not be readily accepted by either the instructors or the students because it is different or unfamiliar. The lecture method of teaching is something that all students grew up with and usually expect when entering the training command. The instructors may have a natural bias towards lectures because they envision lectures as the proper way to teach and are unfamiliar with other methods.

In aviation training, most instructional hours are devoted to teaching technical material. It is a very tedious process to learn the material with a static medium such as workbooks. Learning through lectures seems to ease this burden. As mentioned earlier, this was the reason VP-31 instituted a learning center instructor in 1982. This indicates that the costs of a workbook program must also include the costs of instructor interaction required to maintain similar levels of training.

V. DATA AND ANALYSIS

This chapter compares the costs of the workbook and lecture training programs in use at VP-31 and VP-30. Tables 5.13, 5.14, and 5.15 present the costs for the comparison in the same format as the cost model described in chapter four, and the other tables in this chapter show how those costs were derived.

Table 5.1 shows the approximate annual student enrollment for the different aircrew positions. The student loading was determined by calculating the fleet squadron's manpower demands for the twelve operational squadrons supported by its Fleet Replacement Squadron. The calculations were based on each squadron requiring three pilots, two naval flight officers, two flight engineers, two acoustic operators, one non-acoustic operator, one ordnanceman, and one inflight technician per P-3 crew. Each operational squadron was assumed to require ten crews. The length of tour used in the calculation was three years for flight engineer, ordnanceman, and inflight technician, and three and a half years for all others.

The military salaries used in these computations are shown in Table 5.2 and were obtained from NAVCOMPTNOTE 7041 of 8 NOV 1989 which lists the composite standard rates for military people. These rates are prescribed for use when the costs of military services are determined on a statistical basis. Civilian salaries were obtained from the general

TABLE 5.1. FLEET REPLACEMENT SQUADRON STUDENT LOADING

Aircrew Position	Annual Number of Students
Pilot	120
Naval Flight Officer	80
Flight Engineer	80
Acoustic Operator	69
Non-Acoustic Operator	35
Ordnanceman	40
Inflight Technician	40

schedule salary table number 75, authorized by Executive Order 12698 of December 23, 1989, and were multiplied by a fringe benefit factor of 1.184. The addition of the fringe benefit factor provides a better estimate of the actual costs of employing civilian workers. For military and civilian workers, the hourly wage was based on 2080 working hours per year as specified in the NAVCOMPT manual.

TABLE 5.2. MILITARY AND CIVILIAN WAGE RATES

Rank/Rate/Grade	Annual Cost	Hourly Cost
03	64,336	$30.93
02	49,450	23.77
01	37,394	17.98
E-7	44,152	21.23
E-6	37,085	17.83
E-5	30,760	14.79
E-4	25,530	12.27
E-3	21,621	10.39
GS-12	43,830	21.07
GS-11	36,570	17.58
GS-9	30,226	14.53
GS-7	24,708	11.88
GS-5	19,949	9.59
GS-4	17,830	8.57
GS-3	15,883	7.64

Table 5.3 provides estimates of the hours per course spent by students and instructors in the two instructional programs. The estimates were arrived at using the curriculum descriptions for each of the seven aircrew training tracks at the Fleet Replacement Squadrons. For VP-31, the student learning center hours represent the scheduled hours that the students spent studying the workbooks and taking the unit tests. At VP-31, an instructor is required to be present in the learning center during the time that students are assigned there. The reason that the instructor learning center hours are less than the student hours is because of an overlap in classes. For example, four different classes of Naval Flight Officers are at different stages of VP-31's training program simultaneously. If students from each of the four classes are scheduled for the learning center on the same day, only one instructor is required for all four classes. Learning center usage at VP-30 is mostly for self-study of reference materials other than workbooks, and instructors are not usually assigned. However, instructors are still required to administer tests. The student's rank or rate which is needed for later cost comparisons, is indicated in parenthesis.

The hours shown for flight engineer, ordnanceman, and inflight technician do not represent the total hours of training which these aircrew positions receive prior to graduation. The training program for these positions is divided among different commands making it difficult to compare training hours with the given media. The hours shown under VP-31 are the hours spent in lectures or the learning center at VP-31. The training program at VP-30, for the same aircrew positions, was so different that a direct comparison could not be made. VP-31's training

TABLE 5.3. LEARNING CENTER AND LECTURE HOURS PER COURSE AT VP-31 AND VP-30

Aircrew Position	VP-31 Learning Cntr. Student	VP-31 Learning Cntr. Inst.	VP-31 Lecture	VP-30 Learning Cntr. Student	VP-30 Learning Cntr. Inst.	VP-30 Lecture
Pilot (O1)	400	134	75	249	18	126
Naval Flight Off.(O1)	258	86	114	228	27	186
Flight Eng. (E-5)	88	16	224	88	16	224
Acoustic (E-4)	239	80	219	200	65	166
Non-Acoustic (E-4)	275	92	282	175	60	288
Ordnanceman (E-3)	2	0	88	2	0	88
Inflight Tech. (E-4)	28	20	19	28	20	19

hours were used on both sides of the equation which provided the ability to count the hours associated with the workbooks at VP-31, and later, the costs. The training conducted at VP-30 was assumed to be conducted with lectures. Because the flight engineer and ordnanceman training tracks at VP-31 use more lectures than workbooks, this assumption could bias the study. If the lecture method is more expensive, the assumption increases the costs of VP-31's training, if the lecture method is less expensive, it will cause VP-31's costs to be lower.

Annual hours for each training program were computed by multiplying the hours per course by the number of courses annually. VP-31 operates its training program using a 24 day schedule. Each 24 days is called a phase. Most of the students in the different aircrew tracks require four phases, or 96 training days, to complete their training. At VP-31, classes begin after the rotation of a phase, or every 24 days. VP-30's training program is 90 training days long and is divided into three phases, each phase being 30 days long. Dividing the training program into three or four phases means that VP-31, with the four phase system, teaches ten new classes per year. VP-30 with the three phase system teaches eight new classes per year. The number of classes per year is needed for later calculations.

Since the number of students is identical in both training programs, operating with fewer classes each year, as done at VP-30, increases the number of students in each class. An interesting result of having eight instead of ten classes annually is the reduced instructor hours. For example, ten pilot classes at VP-31 will require 2,090 instructor hours annually (learning center instructor plus lecture instructor times ten). If VP-31 changed its schedule to a three phase system with each phase being 32 days long, just under eight classes could be taught annually requiring roughly 1,672 pilot instructor hours, or 418 less hours. Changing to a three phase system would save 818 officer and 2,080 enlisted instructor hours annually over all training tracks. Changing from ten to eight classes annually will change the pilot class size from 12 to 15 students and the naval flight officer class size from eight to ten. Changes of this magnitude are negligible, and should not affect the quality of training or the instructor effort required to teach the class. Larger differences, caused by eliminating one of the Fleet Replacement Squadrons, would increase class size to around thirty. Teaching thirty students would create a significantly heavier demand on instructor time, and create new problems not seen with the change from 12 to 15. One cost of changing to a three phase system is the loss in productivity of the students because the students will be delayed in reporting to their operational squadrons by the same amount of delay in starting the training program. Another problem is that the program set up with eight courses per year must schedule more aircraft trainers and aircraft flights during the flight phase of instruction to accommodate the increased number of students. Thus, while a change from 12 to 15 students may be negligible, the same cannot be said of an increase from 12 to 30.

In order to determine the cost of media development and the cost of maintaining media currency, an estimate of the time it takes to develop or revise a workbook or lecture is needed. A survey completed by several VP-31 track managers and discussion with the VP-31 educational specialist provided the information used to make these estimates. Table 5.4 shows the time needed for major or minor revisions to workbooks and the time taken annually for workbook review averaged across all seven training tracks. Major revisions required because of substantial equipment changes usually require a complete remake of the workbook. Minor revisions may require up to several pages of changes. An annual review is the time spent reviewing a workbook without having to make changes. Roughly 33 percent of the 850 workbooks in the system require major revisions annually and 66 percent require minor revisions. Twenty two percent of the workbooks are reviewed annually with no changes. These percentages exceed 100 percent because some workbooks require more than one revision annually. The total hours shown represent the hours required for all training tracks and come from a mix of different wage earners in the revision process. A breakdown of the hours required for the different functions in the revision process is shown to provide an idea of the effort involved in workbook revisions.

The annual cost for revisions is shown in Table 5.5. Computing this cost required determining the wages of all people in the revision process, determining the hours required to make the revision, and determining how many revisions are made within the different training tracks.

The revision costs associated with subject matter experts and track managers were calculated as follows. A total of 850 workbooks are required in the training program to teach the information associated with all the different models of P-3's. Of these, 350 are used in the pilot and naval flight officer tracks. For major revisions in the officer tracks, the 350 workbooks were multiplied by 33.67 percent (the number of major revisions annually). This number was multiplied by the average hours required for major revisions (27 hours) and by the hourly wage rate for officers at the O3 level ($30.93). The computation for the enlisted tracks was done in a similar manner. The remaining 500 enlisted workbooks (850 total workbooks - 350 officer workbooks) was multiplied by 33.67 percent, by the revision time of 27 hours, and by the E-6 wage rate of $17.83. The officer and enlisted revision costs were then added together.

Production workers in the ISD, graphics, and printing departments, are employed to keep the workbooks current. Because these departments engage in some activities not related to workbook revision, only a percentage of their annual salaries, determined during supervisor interviews, were used. One hundred percent of the ISD salaries, 60% of

VP-31's graphics salaries, and 90% of the salaries of the graphics and printing departments under the Fleet Aviation Specialized Operational Training Group (FASO) were used. These salary percentages were divided between the major and minor revisions based on the estimated effort required for each type of revision.

TABLE 5.4. TIME REQUIRED FOR MAJOR AND MINOR REVISIONS, AND ANNUAL REVIEW OF WORKBOOKS

Position	Average Hours/Workbook	Total Hours Per/Year
MAJOR REVISION		
Subject Matter Expert	27.0	8182
Track Manager	18.8	5707
Educational Specialist	4.0	1212
Editor	4.0	1212
Typists	16.0	4848
Graphics	8.5	2576
Print	2.0	606
MINOR REVISION		
Subject Matter Expert	3.8	2202
Track Manager	4.8	2777
Educational Specialist	2.0	1149
Editor	1.5	862
Typists	7.0	4021
Graphics	4.2	2394
Print	2.0	1149
ANNUAL REVIEW		
Subject Matter Expert	1.7	340
Track Manager	2.0	408

TABLE 5.5. COSTS FOR MAJOR AND MINOR REVISIONS, AND ANNUAL REVIEW OF WORKBOOKS

Position		Cost For Revisions
MAJOR REVISION		
Subject Matter Expert		$179,460
Track Manager		124,960
ISD Department		84,750
Graphics		71,340
Print		48,000
	Sub Total	$508,510
MINOR REVISION		
Subject Matter Expert		$47,890
Track Manager		60,490
ISD Department		72,190
Graphics		60,770
Print		70,080
	Sub Total	$311,420
ANNUAL REVIEW		
Subject Matter Expert		$7610
Track Manager		8950
	Sub Total	$16,560
	TOTAL	$837,310

Original workbook development was a major undertaking during the instructional system development (ISD) process. To estimate the workbook development costs shown in Table 5.6, the development hours per workbook for the subject matter experts and track managers were assumed to be the same as the hours required for a major workbook revision. The development cost estimate is based on developing 850 workbooks, each of which has 35 pages. The computations are identical to the computations for major workbook revision, except that 100 percent of the workbooks underwent development. These hours, and the costs determined from the hours, probably underestimate actual development time and cost because a development process usually requires many more iterations to produce the print ready-copy than a revision process because the workbook form has already been decided. When making revisions, less effort is required to organize the material for orderly presentation.

The development cost estimate for ISD, graphics, and printing, cannot be computed by using a percentage of annual costs as done for revision costs, because more than one year would be required for development. Here, two years of total annual salaries for ISD, graphics, and printing are assumed. A two year cost estimate still probably underestimates these development costs. The actual original curriculum development costs were $7,962,000 as presented by the Thode-Walker study [Ref. 17]. But, these costs represent the development costs for the entire curriculum and include developing other course media such as videotapes and aircraft events.

TABLE 5.6. COST OF WORKBOOK DEVELOPMENT

Position	Total Development Time (Hrs)	Total Development Cost
Subject Matter Expert	22,950	$532,900
Track Manager	15,980	371,060
ISD Department	20,400	313,870
Graphics	7,225	370,240
Print	1,700	262,410
	TOTAL	$1,850,480

Lecture development and revision time was more difficult to measure because these times vary considerably depending on the technical nature of the lecture and the expertise of the person developing it. From discussions with instructors and responses to the author's survey, 12 hours was chosen as the estimate for the time required to develop one hour of lecture. This same time was used as an estimate of the time required for a major revision for one hour of lecture. Two hours of revision time was used as the time required for a minor revision. The revision frequency was assumed to be that used for the workbooks, i.e., 33% of the lectures had major revisions annually and 68% had minor revisions annually. The time and cost of lecture development and revision are shown in Tables 5.7 and 5.8.

TABLE 5.7. COST OF LECTURE DEVELOPMENT

	VP-31		VP-30	
Position	Development Time (Hrs)	Development Cost	Development Time (Hrs)	Development Cost
Pilot	900	$27,840	1520	$47,020
Naval Flight Off.	1368	42,320	2240	69,290
Flight Eng.	2688	47,930	2688	47,930
Acoustic	2628	46,850	1992	35,520
Non-Acoustic	3384	60,340	3456	61,620
Ordnanceman	1056	18,830	1056	18,830
Inflight Tech.	228	4,070	228	4,070
TOTAL		$248,180		$284,280

TABLE 5.8. COSTS OF LECTURE REVISIONS BY TRAINING TRACK

Instructor	Major Revision Hours	Major Revision Dollars	Minor Revision Hours	Minor Revision Dollars
VP-31				
Pilot (O3)	297	$9,190	102	$3,160
Naval Flight Off. (O3)	451	13,950	155	4,800
Flight Eng. (E-6)	887	15,820	304	5,420
Acoustic (E-6)	867	15,460	297	5,300
Non-Acoustic (E-6)	1116	19,900	383	6,830
Ordnanceman (E-6)	348	6,210	119	2,130
Inflight Tech. (E-6)	75	1,340	25	450
TOTAL		$81,870		$28,090
VP-30				
Pilot (O3)	499	$15,440	171	$5,290
Naval Flight Off. (O3)	736	22,770	253	7,830
Flight Eng. (E-6)	887	15,820	304	5,420
Acoustic (E-6)	657	11,720	225	4,020
Non-Acoustic (E-6)	1140	20,330	391	6,980
Ordnanceman (E-6)	348	6,210	119	2,130
Inflight Tech. (E-6)	75	1,340	25	450
TOTAL		$93,630		$32,120

The graphics and printing departments exist to support revisions to the workbook media so their operating budgets were included in the cost estimate for media currency and are shown in Table 5.9. Because some of their functions are not workbook related, only ninety percent of FASO's graphics and printing department budgets were used. VP-31's graphics department budget was not included because it would exist even if the workbooks were not in the training program, just as VP-30's graphics department exists. The percentages were determined through interviews with the respective supervisors.

TABLE 5.9. ANNUAL BUDGET OF DEPARTMENTS ASSOCIATED WITH WORKBOOKS

Department	Annual Dollars
Graphics	$11800
Print	9720
TOTAL	$21,520

The labor cost of each course, which was estimated as the time that the instructors and students are involved with the media, is shown in Table 5.10 and 5.11. The costs shown in the these tables were determined by multiplying the wage rate for the instructors and students by the hours spent with the media as shown earlier in Table 5.3.

TABLE 5.10. COSTS PER COURSE FOR INSTRUCTOR TIME WITH MEDIA

	VP-31		VP-30	
Instructor	LC*	LECT*	LC	LECT
Pilot	$4150	$2320	$560	$3900
Naval Flight Off.	2660	3530	840	5760
Flight Eng.	290	4000	290	4000
Acoustic	1430	3910	1160	2960
Non-Acoustic	1640	5030	1070	5140
Ordnanceman	0	1570	0	1570
Inflight Tech.	360	340	360	340
Sub Total	$10,530	$20,700	$4,280	$23,670
TOTALS (LC+LECT)	$31,230		$27,950	

* LC stands for learning center, LECT stands for lecture.

TABLE 5.11. COSTS PER COURSE FOR STUDENT'S TIME WITH MEDIA

Instructor	VP-31 LC	VP-31 LECT	VP-30 LC	VP-30 LECT
Pilot	$86,310	$16,190	$67,160	$33,990
Naval Flight Off.	37,120	16,400	41,000	33,450
Flight Eng.	10,420	26,510	13,020	33,130
Acoustic	20,240	18,550	21,170	17,570
Non-Acoustic	11,810	12,120	9,400	15,460
Ordnanceman	90	3,660	110	4,580
Inflight Tech.	1,380	940	1,720	1,170
Sub Total	$167,370	$94,370	$153,580	$139,350
TOTALS (LC+LECT)	$261,740		$292,930	

The cost of portability, shown in Table 5.12, was determined using a scenario that assumed instruction was required at an out-of-town training site. For this scenario, the workbook method of instruction was assumed to require two instructors per aircrew position and the lecture method to require three. Under these assumptions, four officer and ten enlisted instructors were required to teach with the workbook method, while six officer and 15 enlisted were required for the lecture method. Training was assumed to take one month, with five working days per week, or a total of 160 training hours per instructor. The training time was multiplied by the instructors' wages. A daily per diem rate of $24 per day per instructor was added.

TABLE 5.12. COST OF PORTABILITY

VP-31 No. of Instructors	Dollars	VP-30 No. of Instructors	Dollars
4 Officers (O3)	$22,680	6 Officers (O3)	$34,020
10 Enlisted (E-6)	35,730	15 Enlisted (E-6)	53,600
TOTAL	$58,410		$87,620

The plant and equipment costs for VP-31 are shown in Table 5.13. These costs are the purchase costs of the equipment needed to support changes to the workbooks and are measured in current dollars. Equipment costs to support changes to lectures were assumed to be negligible.

Table 5.14 shows the combined opportunity costs estimate associated with developing the workbooks and lectures at VP-31 and the lectures at VP-30. The development costs for lectures at VP-31 and VP-30 are nearly the same which indicates that a large number of lectures have been instituted at VP-31. The high workbook development cost is the result of the great amount of time required to develop textbooks.

Development costs are sunk costs and of importance only if a new development effort is contemplated. Table 5.15 compares the present operating costs based on the opportunity costs associated with the actions required to support either medium. The production process costs shown are fairly similar, indicating that both training programs spend about the same amount of time presenting the theoretical information. The large difference in the currency costs is due to the effort required of the subject matter experts and track managers, and the extra manpower required in the ISD, graphics, and printing departments, to revise the workbooks. The cost differences in portability, as shown in Table 5.15, indicate that the workbooks have a portability advantage. This portability advantage results from the fact that workbooks can substitute for instructors.

TABLE 5.13. PLANT AND EQUIPMENT COSTS AT VP-31

Department	Equipment Cost
ISD	$37,575
Graphics	45,700
Printing	57,600
TOTAL	$140,875

TABLE 5.14. DEVELOPMENT COSTS

Media	VP-31	VP-30
Lectures	$248,180	$284,280
Workbooks	1,850,480	0
TOTAL	$2,098,660	$284,280

TABLE 5.15. ANNUAL OPERATING COSTS

Measure	VP-31	VP-30
Production Process	$2,929,700	$2,567,040
Currency	968,790	125,750
Portability	29,210	43,810
TOTAL	$3,927,700	$2,736,600

The costs from Tables 5.13, 5.14, and 5.15, were used to determine the life-cycle costs of the training programs over a ten year period. These costs are shown in Table 5.16. To compute the life-cycle costs, 50% of the plant and equipment costs were assumed to depreciate to zero and need replacing at the end of ten years. The replacement costs of plant and equipment were assumed to increase at an annual inflation rate of 4%. Development costs were assumed to be a one time cost with no replacement costs. The annual operating costs are composed mostly of salaries, and these salaries were assumed to increase at an annual rate of 3%. For the net present value comp. .ations, a discount rate of 9% was used. To account for inflation, the discount rate was combined with the inflation rate using the formula

$$\text{nominal rate } (i) = \text{real rate } (r) + \text{inflation rate } (\pi) + r\pi.$$

TABLE 5.16. TEN YEAR LIFE-CYCLE COSTS

Cost Category	Ten Year Costs VP-31	Ten Year Costs VP-30
Plant and Equipment		
ISD	$45,510	$0
Graphics	55,360	0
Printing	69,770	0
Development Costs		
Lectures	248,180	284,280
Workbooks	1,850,480	0
Production Process	17,433,770	15,275,690
Currency	5,764,980	748,300
Portability	173,820	260,700
TOTAL	$25,641,870	$16,568,970

Scheduled aircraft transitions are expected to reduce the number of P-3 aircraft models used at operational squadrons from seven to three by 1992. The reduced number of models could reduce the number of workbooks from roughly 850 to 550. A substantial savings in opportunity cost will be realized with fewer workbooks because of reduced revision costs. Further savings in workbook revision will result from a workbook design change presently in progress. The design change modifies the workbooks so that frequently changing material will be removed and the students will be referred to reference manuals that are identical to the manuals used the fleet squadrons. With this new system, a 90% revision reduction time is estimated for the subject matter experts and track managers. The costs incurred by the ISD, graphics, and printing departments, will not decline with a reduction in the number of workbooks or revisions because nearly all of their costs are assigned to workbook revision. Their total costs will remain the same because ISD, graphics, and printing are now staffed at a minimum functional level so that further reductions are not likely. The cost of maintaining workbook currency with fewer workbooks and the new workbook design is shown in Table 5.17. The "new system" cost also includes the operating budgets from Table 5.9 as before. Tables 5.18 and 5.19 show the costs of workbook and lecture revisions that were consolidated in Table 5.17.

TABLE 5.17. THE CHANGE IN CURRENCY COST WITH FEWER WORKBOOKS AND LECTURES

Measure	VP-31	VP-30
Old Currency $	$968,790	$125,750
New system	528,320	81,740
Difference	$440,450 (45% less)	$44,010 (35% less)

TABLE 5.18. COSTS FOR MAJOR AND MINOR REVISIONS, AND ANNUAL REVIEW OF WORKBOOKS*

Position		Cost For Revisions
MAJOR REVISION		
Subject Matter Expert		$11,670
Track Manager		8,140
ISD Department		84,750
Graphics		71,340
Print		48,000
	Sub Total	$223,900
MINOR REVISION		
Subject Matter Expert		$3,140
Track Manager		3,960
ISD Department		72,190
Graphics		60,770
Print		70,080
	Sub Total	$210,140
ANNUAL REVIEW		
Subject Matter Expert		$690
Track Manager		590
	Sub Total	$1,280
	TOTAL	$435,320

* Based on 550 workbooks and 90% less revision time for subject matter experts and track managers.

TABLE 5.19. COSTS OF LECTURE REVISIONS BY TRAINING TRACK*

Instructor	Major Revision Hours	Major Revision Dollars	Minor Revision Hours	Minor Revision Dollars
VP-31				
Pilot (O3)	297	$9,190	102	$3,160
Naval Flight Off. (O3)	451	13,950	155	4,800
Flight Eng. (E-6)	887	15,820	304	5,420
Acoustic (E-6)	867	15,460	297	5,300
Non-Acoustic (E-6)	1116	19,900	383	6,830
Ordnanceman (E-6)	348	6,210	119	2,130
Inflight Tech. (E-6)	75	1,340	25	450
TOTAL		$53,220		$18,260
VP-30				
Pilot (O3)	499	$15,440	171	$5,290
Naval Flight Off. (O3)	736	22,770	253	7,830
Flight Eng. (E-6)	887	15,820	304	5,420
Acoustic (E-6)	657	11,720	225	4,020
Non-Acoustic (E-6)	1140	20,330	391	6,980
Ordnanceman (E-6)	348	6,210	119	2,130
Inflight Tech. (E-6)	75	1,340	25	450
TOTAL		$60,860		$20,880

* Based on a 35% reduction in the number of lectures that require revision brought about by reducing the number of aircraft models used in the fleet.

The Navy is faced with force cutbacks and base closures which could affect the number of students in the Fleet Replacement Squadrons. Table 5.20 shows the annual demand for students under two different scenarios. The numbers under "fewer" are the annual number of students that would require training after cutting one P-3 squadron from each coast and reducing the number of crews per squadron to nine. The numbers under "more" are the number of students that would require training if the same cuts anticipated in the first scenario were made and if aircrew training was consolidated at either VP-31 or VP-30.

TABLE 5.20. FLEET REPLACEMENT SQUADRON STUDENT LOADING

Aircrew Position	Number of Students Status Quo	Fewer	More
Pilot	120	99	198
Naval Flight Officer	80	66	132
Flight Engineer	80	66	132
Acoustic Operator	69	57	114
Non-Acoustic Operator	35	28	56
Ordnanceman	40	33	66
Inflight Technician	40	33	66

The variability of production costs over a range of student loading, shown in Table 5.21, was estimated using the number of students displayed in Table 5.20. The costs of the instructor time spent with the media were assumed to stay the same as those computed in Table 5.10. Student costs were computed in the same manner as earlier. The costs shown in Tables 5.22 and 5.23 are the costs that were used to derive these production costs. The production cost, which was defined as the time the students and instructors spend with the training medium, is higher for VP-31 over all ranges of students. As student loading increases, the costs for both methods increases at the same rate.

TABLE 5.21. THE CHANGE IN PRODUCTION COST WITH CHANGES IN STUDENT LOADING

Measure	Workbooks	Lectures
Status Quo	$2,929,700	$2,567,040
Fewer Students	2,465,800	2,152,400
More Students	4,619,000	4,080,480

TABLE 5.22. COSTS PER COURSE FOR STUDENTS TIME WITH MEDIA*

	VP-31		VP-30	
Instructor	LC	LECT	LC	LECT
Pilot	$71,200	$13,350	$55,410	$28,040
Naval Flight Off.	30,620	13,530	33,820	27,590
Flight Eng.	8,600	21,870	10,740	27,340
Acoustic	16,720	15,320	17,490	14,520
Non-Acoustic	9,450	9,690	7,520	12,370
Ordnanceman	70	3,020	90	3,780
Inflight Tech.	1,140	770	1,420	970
Sub Total	$137,800	$77,550	$126,490	$114,610
TOTALS (LC+LECT)	$215,350		$241,100	

* Based on 11 squadrons per coast and nine crews per squadron.

If the workbook training method had worked as originally designed, lectures and learning center instructors would not have been required. The learning center hours shown in Table 5.24 under VP-31 are the learning center hours prescribed by the original ISD design. As an estimate of the opportunity costs incurred because of these changes, the

TABLE 5.23. COSTS PER COURSE FOR STUDENTS TIME WITH MEDIA*

	VP-31		VP-30	
Ir ~tructor	LC	LECT	LC	LECT
Pilot	$142,410	$26,700	$110,810	$56,070
Naval Flight Off.	61,240	27,060	67,640	55,180
Flight Eng.	17,180	43,740	21,480	54,670
Acoustic	33,430	30,640	34,970	29,030
Non-Acoustic	18,900	19,380	15,030	24,740
Ordnanceman	140	6,040	170	7,550
Inflight Tech.	2,270	1,540	2,840	1,930
Sub Total	$275,570	$155,100	$252,940	$229,170
TOTALS (LC+LECT)	$430,670		$482,110	

* Based on 22 squadrons and nine crews per squadron.

cost of the originally designed method was estimated and is shown in Table 5.25. The table also compares the present currency cost of workbooks only, and the 1980 Thode-Walker estimate [Ref. 17] of maintaining workbook currency. The present workbook currency cost was obtained by subtracting the costs required to maintain lecture currency from the currency cost in Table 5.15. The developer estimate was obtained by applying current salaries to the computations used in the Thode-Walker study, and adding the graphics and printing department costs that were not included in their study.

TABLE 5.24. LEARNING CENTER AND LECTURE HOURS PER COURSE AT VP-31 AND VP-30*

Aircrew Position	VP-31 Learning Cntr.		VP-31 Lecture	VP-30 Learning Cntr.		VP-30 Lecture
	Student	Inst.		Student	Inst.	
Pilot (O1)	248	18	0	249	18	126
Naval Flight Off.(O1)	386	27	0	228	27	186
Flight Eng. (E-5)	265	16	0	88	16	224
Acoustic (E-4)	229	65	0	200	65	166
Non-Acoustic (E-4)	154	60	0	175	60	288
Ordnanceman (E-3)	40	0	0	2	0	88
Inflight Tech. (E-4)	28	20	0	28	20	19

* The student hours listed under VP-31 were determined during the ISD process used to design the original training program.

TABLE 5.25. PRESENT ANNUAL COSTS COMPARED WITH COSTS ESTIMATED AT INCEPTION

Measure	VP-31 Now	Developer Est.
Production Process	$2,929,700	$1,736,860
Currency	858,830	582,990
TOTAL	$3,788,530	$2,319,850*

* Includes graphics and printing department costs which were not included in the Thode-Walker study.

VI. SUMMARY AND CONCLUSIONS

This study compares two methods of instruction, workbooks and lectures, as presently used in P-3 Fleet Replacement Squadrons, to determine which method of instruction is more efficient. The study compares the training program at VP-31 that uses workbooks and lectures in a nearly one to one ratio, with the training program at VP-30 that supplements lectures with only a few workbooks. It is again important to emphasize that this study does not look at the training costs incurred by such things as aircraft, maintenance, facilities, and administration costs.

The lecture training method at VP-30 is much more efficient than the workbook-lecture method at VP-31 based on the operating costs presented in Table 5.15, assuming equal effectiveness of both training systems. As seen in Table 5.15, the total annual opportunity costs associated with teaching the majority of the theoretical information through lectures, are 70% of the costs of the workbook and lecture method used at VP-31.

The higher costs of the workbook-lecture method are due to higher student production and revision costs. Production costs at VP-31 are higher primarily because of the additional time instructors are assigned to the learning centers; a requirement which was unanticipated when selecting the workbook medium. Revision costs are higher at VP-31 because of the extensive effort required to keep the workbook medium current as new software, equipment, and tactics, enter the fleet.

Production costs were estimated for a range of student loadings that could result from two possible scenarios; reduced student loading from lowered fleet demand because of fleet squadron reductions, and increased student loading caused by closing one of the Fleet Replacement Squadrons. In both cases, the lecture method was still found to be the most efficient method of instruction.

The cost of maintaining media currency may decrease for both training commands in the future. Substantially fewer revisions to workbooks and lectures are expected as a result of a reduced number of P-3 aircraft models, and as a result of a new workbook design that removes the most frequently changing information. VP-31's training program will benefit the most from fewer revisions but the currency cost at VP-31 will remain considerably higher than VP-30. The higher currency cost under this scenario is due primarily to the manpower requirements of the workbook revision process.

The workbook-lecture method used at VP-31 does have a lower portability cost. Even though the immediate need for portability appears to be declining because the changes to fleet squadron aircraft should be completed by 1992, new aircraft models will follow, and the portability of a medium will always be a consideration.

Certain qualitative attributes should also be considered when evaluating the efficiency and effectiveness of training programs. The workbook method appears to have an advantage in its ability to contend with instructor absences and its ability to maintain instructional material standardization although it can be hindered by production worker absence.

If the workbook method of instruction had been maintained exactly as designed by the Instructional Systems Development (ISD) program, the workbook method would now cost much less than VP-31's present program, and only 87% of the lecture method now used at VP-30. At VP-31, the production process costs are much higher than anticipated because of the necessity of adding a learning center instructor, and the requirement to add numerous lectures to compensate for inadequate workbooks. The currency cost is higher than anticipated as a result of underestimating the revision effort. Revisions were required far more often and required the efforts of many more workers than planned for.

The cost differences between VP-31's present costs and the "what should have been costs" based on the original design indicate that the ISD system that chose the workbook method for the primary means of instruction is flawed because the workbooks were not entirely satisfactory for instruction. The ISD program failed to allow for the boredom associated with studying workbooks for hours on end without student-instructor interaction. Implementation of the workbook system failed to take into account the ramifications of applying the rapidly changing information to a fixed and difficult to change medium.

The ISD system could also have problems because it is not well adapted to the realities of the military. The ISD system uses a few experts to organize and lead a team of subject matter experts to develop a training program, but once the program is developed it is used in a command composed mostly of transient military people who are given the responsibility to maintain the curriculum as it was designed but who are unfamiliar with ISD. Within a few years of introducing the P-3 ISD designed training program, few if any of the major changes made had been validated. Even more problematic is that during those early years fleet reports of poorly trained students motivated many of the changes which did occur. This raises the question of whether or not the original ISD program was more effective than the program it replaced. The training programs now in place at VP-31 and VP-30 are meeting the fleet needs through training programs that have evolved considerably from the original ISD design, and those changes were made by instructors doing what they thought was best without heavy development, implementation, and validation costs.

Because millions of dollars are spent by the Navy on ISD programs, whether or not training effectiveness is increased as a result of using the ISD process to design a curriculum would be an interesting future research topic. Perhaps it is better to save the millions of dollars and instead rely on the intuition and expertise of the managers and instructors in the training program to make changes as needed.

When selecting training media alternatives, a cost-benefit analysis that compares the opportunity costs associated with the alternatives should be used as the measure for comparison. To be accepted, a new method of instruction should compare favorably with conventional instruction. A cost-benefit analysis that evaluates a new technology should be careful not to underestimate the effort required to maintain the currency of the material presented by the technology and not underestimate the manpower demands of using the new technology.

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6.	Dr. Henry Smith Patrol Squadron Thirty-one NAS Moffett Field, CA 94035-5008	2
7.	LCDR Bill Rose Patrol Squadron Thirty NAS Jacksonville Jacksonville, FL 32212-0024	2
8.	LCDR D.M. Johnshoy 38 Revere Road Monterey, CA 93940-5000	2