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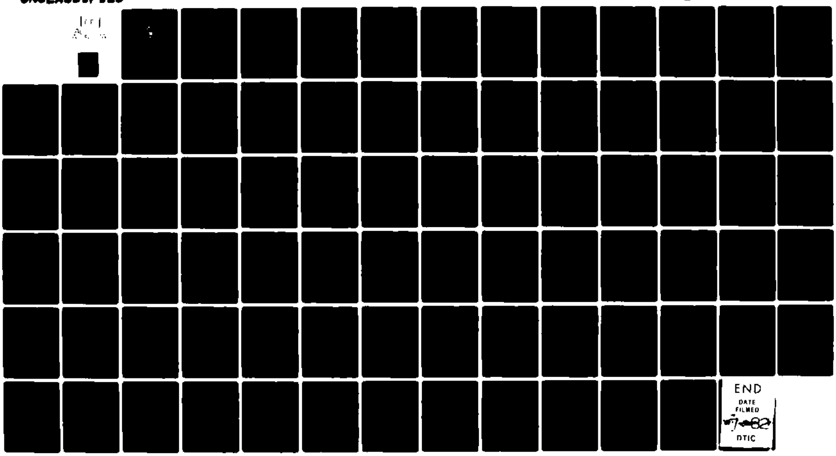

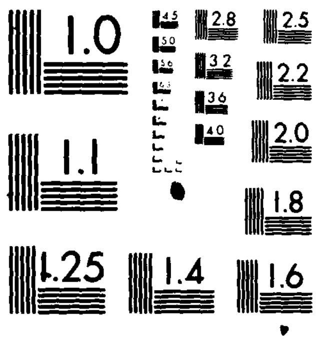

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NAVAL POSTGRADUATE SCHOOL

Monterey, California

THESIS

AN ANALYSIS OF INSTRUCTIONAL TELEVISION
FOR NAVAL AVIATION INSERVICE MAINTENANCE
TRAINING

by

Ralph A. Morgan

March 1982

Thesis Advisor: J. D. Senger

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This study investigates the feasibility of replacing formal lecture and self study with instructional television as the primary method of inservice training for naval aviation squadrons. Two approaches were taken. First an experiment was performed to determine the relative efficiency and effectiveness of the three methods of instruction. Then, using the efficiency data from the experiment, a cost analysis was done to compare the relative costs of instruction via formal lecture and instructional television.

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Based upon the established criteria for efficiency and effectiveness and the statistical data from the experiment, it was concluded that instructional television is both more efficient and effective than either formal lecture or self study. The cost analysis also demonstrated that instructional television is a more cost effective method with repeated uses.

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An Analysis of Instructional Television for
Naval Aviation Inservice Maintenance Training

by

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Lieutenant, United States Navy
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Submitted in partial fulfillment of the
requirements for the degree of

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ABSTRACT

This study investigates the feasibility of replacing formal lecture and self study with instructional television as the primary method of inservice training for naval aviation squadrons. Two approaches were taken. First an experiment was performed to determine the relative efficiency and effectiveness of the three methods of instruction. Then, using the efficiency data from the experiment, a cost analysis was done to compare the relative costs of instruction via formal lecture and instructional television.

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I. INTRODUCTION

History has shown that logistics costs for a typical weapon system vary from 2 to 10 times the acquisition cost over the systems life cycle [Ref. 1], and operations and maintenance of systems, the "human subsystem," account for a major portion of the life cycle cost [Ref. 2]. Studies of systems annual support costs show that manpower consistently consumes over half of the funds appropriated for operation and maintaining the system [Ref. 3]. The operation and maintenance of modern military systems requires special knowledge that military schools and training courses are designed to provide. To be effective, weapons systems require both effective hardware and effective people. It is important to understand that the advanced performance capabilities built into new military system can only be realized if our military personnel are adequately trained to operate and maintain these systems.

The accomplishment of the military training mission is neither easy nor cheap. "In fiscal year 1981, the annual cost of individual training for active-duty and reserve component personnel is approximately 8.8 billion dollars." [Ref. 4] A specific example of the costs associated with training, is the approximate 35 million dollars planned for initial factory training and training system development for the

Navy's F/A-18 aircraft. [Ref. 5] Developing and maintaining the systems needed to produce effective people requires the same management effort that is needed to develop, produce and maintain tactical hardware.

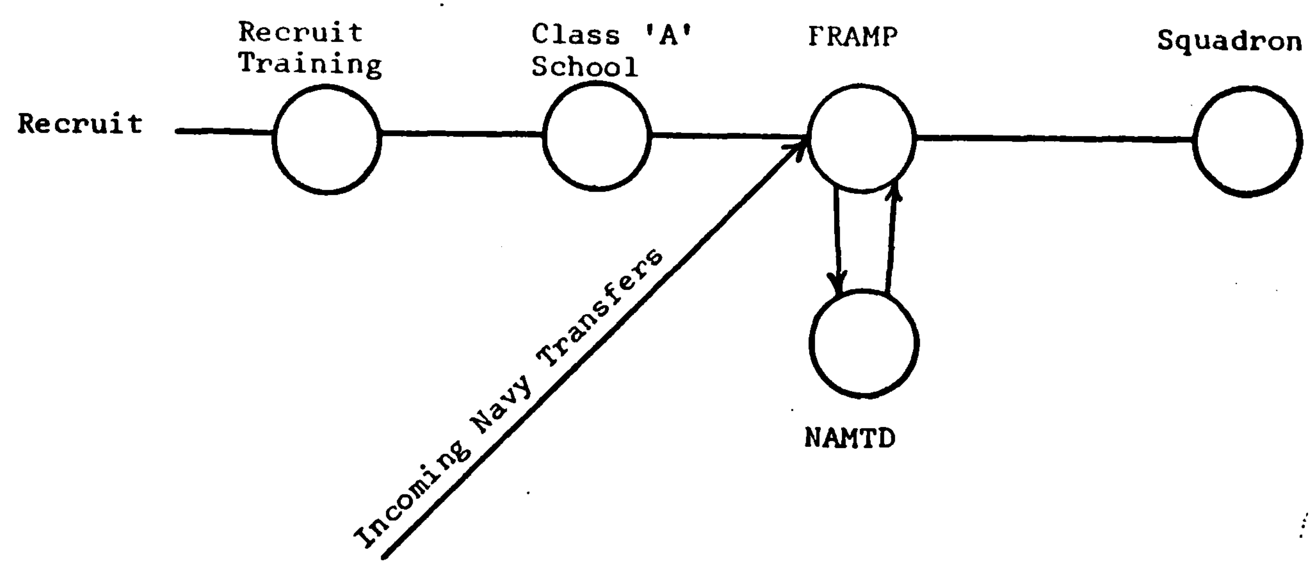
These figures reflect only the types of training that take place in military schools. Upon graduation from these schools, personnel are assigned to operational commands where they will be involved in a continual process of follow-on training. Ideally, new technicians would arrive at operational commands at the journeyman level of ability, however, this is almost never the case and new technicians must go through either an infomal or formal apprenticeship training program. The intent of this thesis is to deal with this aspect, follow-on training, in the Naval aviation squadron environment.

Prior to discussing follow-on training, the Navy's training system for providing new technicians to the aviation squadrons will be looked at and an aspect of learning theory with direct relevance to follow-on training will be addressed.

SUPPLYING TRAINED TECHNICIANS

The logistics channel which provides trained technicians to the maintenance departments of aircraft squadrons, commonly referred to as the training pipeline, is illustrated in Figure 1. Following recruit training, selected

Figure 1: Technician Training Pipeline



individuals received general technical training in a Navy specialty rating, such as; Aviation Machinistmate or Aviation Electronics Technician. This training is highly individualized, consisting of computer based instruction, programmed instructions, demonstrations and on-the-job training. Because it is individualized, in many cases there is no standard length for this training, however, a typical Aviation Electronics Technician will receive approximately 12 months of training in class "A" school. Following the completion of "A" school, a technician with orders to an aviation squadron will attend the Fleet Readiness Aviation Maintenance Personnel (FRAMP) training program to receive specific training on the type of aircraft that his or her future squadron operates. This training can take another three to six months.

Experienced maintenance personnel without previous experience in the squadron's type of aircraft, as well as designated strikers ("A" school graduates), will normally attend FRAMP training. The training program basiclly consists of three distinct phases:

> Phase I, conducted by FRAMP provides the trainee with an introduction to the type aircraft, systems and components, and the PQS program.
>
> Phase II consists of formal classroom training on designated systems and is conducted by NAMTD.
>
> Phase III consists of practical job training designed to reinforce previous instruction and includes training by FRAMP instructors on the aircraft in correct maintenance

procedures and operational and functional checks to "troubleshoot" and repair common maintenance problems encountered in the type aircraft. [Ref. 6]

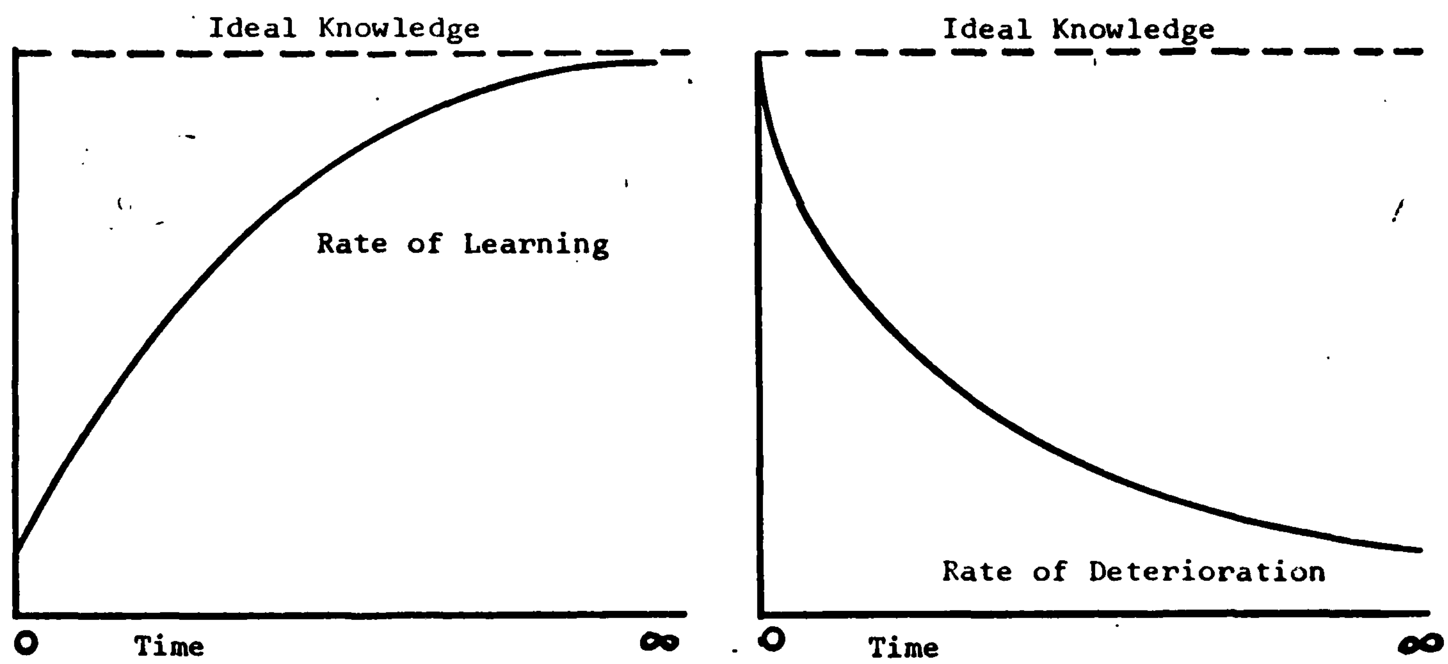
Upon the completion of FRAMP training, the Navy has made a significant investment in the human capital of the new technician who is then sent on to a squadron as a final product of the pipeline training.

SKILL RETENTION

A brief look at learning theory should help set the stage for a sound defense for follow-on training. A learning curve, as illustrated in Figure 2, is a graphical representation of the typical increase in knowledge over a period of training. Note that the initial learning rate is much more rapid and, as time passes, the rate lessens until it becomes asymptotic with the ideal knowledge level. This optimal level will never be reached due to many external contingencies such as trainee peripheral interests, changing state-of-the-art instructional aids, knowledge of instructors, and other reasons. However, for simplicity, it is assumed that these factors have been reduced and the ideal knowledge level may be almost attained. [Ref 7]

Once the student has approached the ideal level of knowledge, he is typically removed from the training environment permanently. When training has ended, it is important to note the negative direction of the curve which depicts the loss of knowledge or the deterioration rate. The primary

Figure 2: Comparison of Learning and Skill Deterioration Curves.



factors of skill deterioration are functions of the final skill level attained prior to the non-use and an inverse relationship to time. [Ref. 8]

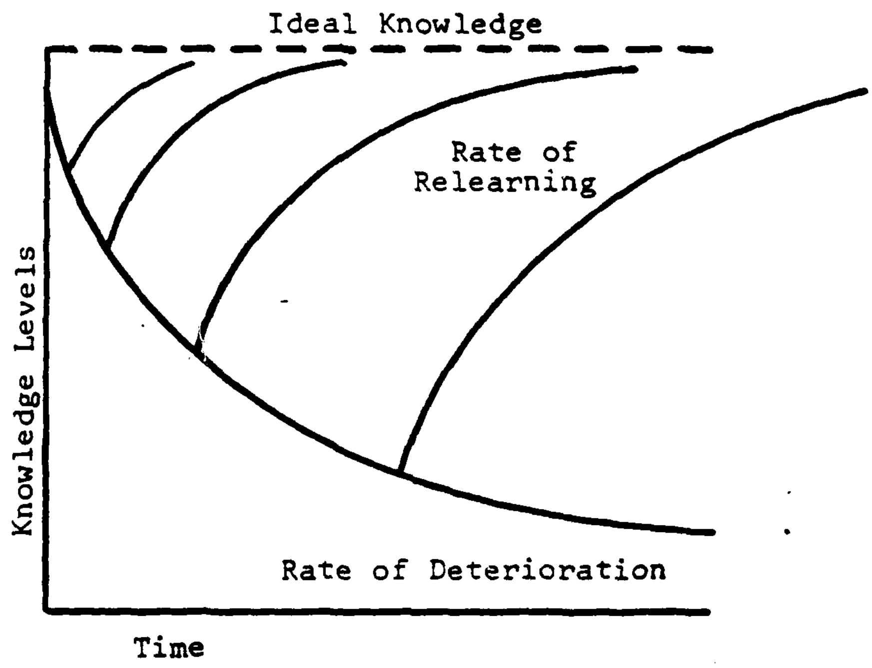
It is important to recognize that the steepest or fastest rate of forgetting occurs at the beginning of the curve. As time passes and training takes place, the trainee will ultimately arrive at a residual knowledge/skill level only slightly higher than his original educational base at time 0 (indicated in Figure 2). At this undefined point, the knowledge would most likely be obsolete due to changes in technology and state-of-the-art in development.

With time, the diminished skill level may be countered by retraining that will return the student to his original knowledge level (see Figure 3). This relearning curve represents the rate at which the knowledge is regained. Relearning requires substantially less time than the initial learning, though the longer the non-use period the less knowledge that is retained. [Ref. 8]

FOLLOW-ON TRAINING

Considering the large financial investment in initial training, skill deterioration can be seen as a significant depreciation of human capital. As is represented by Figure 3, the relearning rate is much more rapid if relearning follows closely after completion of the initial training. Follow-on or continuation training can be considered as

Figure 3: Rate of Relearning at Various Levels of Skill Deterioration.



insurance against deterioration of skills, necessary for the maintenance of the investment in human capital through training.

The purpose of follow-on training is not only to prevent the deterioration of the knowledge and skills gained through initial training, but also to continually increase the skill and knowledge of the maintenance technician. In this way he can advance from the apprenticeship level to the fully qualified journeyman level. Follow-on training is also necessary to keep abreast of technological advances. The ultimate goal of follow-on maintenance training and training in general is increased military readiness.

Within the Naval aviation community there are three distinct aspects of inservice maintenance training:

Formal Inservice Training

Formal inservice training is conducted through locally prepared lectures which are taught by experienced technicians detailed from the squadron Maintenance Department.

Informal Training

On-the-job training (OJT) is the practical instruction of personnel in the performance of maintenance tasks, by demonstration and simulation, under the supervision of experienced personnel in the shop or on an aircraft.

The Personnel Qualification Standards (PQS) Program

The PQS program is a method of qualifying officers and enlisted personnel to perform assigned duties. A PQS, derived through tasks analysis, is in the format of a qualification guide which consists of a written compilation of knowledge and skills required to qualify for a specific watch station, to maintain a specific piece of equipment or system, or to perform as a team member within the assigned unit. The specific goal of the PQS program is to serve as a vehicle for continuous qualification of the individual through school and on-the-job experience and to complement and support formal training programs [Ref. 9]. (An example of PQS may be seen in Appendix E).

It is important to understand that PQS is not a stand alone training program. The success of a PQS based qualification program is dependent upon successful formal and informal training. For inservice PQS training to effectively accomplish the goals of follow-on training, all three of the aspects of inservice training must be effectively performed.

PROBLEM

Current Problems With the Technical Training System

Historically, aviation maintenance training has been a balanced training program between initial apprentice instruction via the "A" school, NAMTD, FRAMP pipeline and continued instruction and qualifying on-the-job training

(OJT) under the supervision of qualified journeymen within the aviation squadron. However, within recent years there has been a significant shift in the balance between journeymen and apprentices within squadron work centers. Also, the experience level of the journeyman grades (E-5 and above) has been declining. Approximately 60% of the people of the journeyman grades in the West Coast P-3 squadrons have no prior P-3 experience before the present tour. [Ref. 6]

As a consequence of the shift in the experience level within the fleet squadrons, their ability to carry on adequate apprentice training and qualification has been significantly degraded. A desirable tradeoff, from the squadron's perspective, would be upgraded pipeline training to compensate for the decreases in instructional and on-the-job training capabilities within the squadrons. However, this is not the case and in many instances pipeline training has been streamlined yielding reduced course lengths and questionable instructional techniques.

> Currently, personnel reporting to squadrons are not capable of effectively contributing to the maintenance effort without close supervision and prolonged on-the-job training. This has placed a heavy training burden on the squadrons--a burden they are ill-equipped to bear because they simply do not have the required number of journeymen personnel to do the job. [Ref. 6]

Training Within Operational Units

As the technology of Naval Warfare has increased in complexity, the difficulty in training and maintaining a sailor's skills and proficiency has become increasingly evident. The difficulty has been accentuated by increases in the rate of technology change, and by the constant shuffling and reshuffling of manning levels. The need for continual training of the maintenance personnel has intensified. In support of the need for continual training, OPNAVINST 4790.2B delineates the responsibility of Naval Aviation Squadrons to provide ongoing inservice training:

> Inservice training is a command responsibility. Since this training represents a major contribution to the Navy's overall efforts, a systematic inservice training program to meet the objectives of OPNAVINST 3500.34 series, Personnel Qualification Standards (PQS), shall be conducted. Both lectures and practial training are integral parts of a successful program and must be coordinated to satisfy each individual activity's particular requirements... [Ref. 9]

Since the previous sections spelled out the need for continual training, it would seem contradictory to disagree with the meaning and content of this statement. However, it is the author's contention that establishment and maintenance of such a formal training program is beyond the capabilities of an operational squadron's Maintenance Department that is in the business of maintaining aircraft. This statement from a study conducted for, Commander Patrol Wings, U.S. Pacific Fleet, is more typical of actual in-squadron training:

> ...management of organizational level maintenance training programs does require improvement. Squadron maintenance training efforts were found to be unstandardized, ineffectively managed, lacking direction and consistency. Dedicated time to conduct maintenance training has not been available in the current operating environment and, as

> mentioned, qualified personnel are often not available to conduct meaningful follow-on maintenance training programs... [Ref. 6]

The Wolkensdorfer study [Ref. 6] went on to conclude that meaningful maintenance training programs did not exist in the Pacific Fleet P-3 squadrons. In an October 1981 point paper, the Patrol Wing TEN Maintenance Officer stated, "the situation has not significantly changed since the Wolkensdorfer Study" [Ref. 10]. The problem is, an effective maintenance training program does not exist within the Pacific Fleet P-3 squadrons.

A critical need exists for meaningful, continual training within the Navy's operational units. Even though most commanding officers and maintenance managers would agree that this need exists, few squadrons if any are manned with the quantity and quality (low experience level) of personnel needed to establish and maintain an effective, ongoing training program.

Another problem that has traditionally plagued maintenance training is the lack of time to train. Repairing aircraft is the primary responsibility and number one priority of every maintenance department with dedicated training time holding a much lower priority.

In the past, very little if any funding has been provided specifically for the development and maintenance of inservice training programs. However, considering the large amount of financial resources invested in the pipeline training of technicians, it would seem reasonable to invest additional funds to develop a continual inservice training program which would help to maintain that large investment in human capital. Operational units could be provided with creative training programs/systems that would help optimize the use of time and remove the responsibility for development and maintenance of a training program from the operational units.

The Personnel Qualifications Standards program is a step in the direction of providing continuous training, however, as has been previously stated, PQS is not in itself a training program but represents the terminal objectives of a training program. For it to be a success, PQS requires either dedicated self study or a comprehensive formal training program. Such a program could be provided through the use of video recorded instructional tapes, a concept known as Instructional Television (ITV).

INSTRUCTIONAL TELEVISION

The Wolkensdorfer Study [Ref. 6] identified some basic problems that exist in the Navy's organizational level in service training:

(1) Squadron maintenance training is unstandardized.

(2) Maintenance training time has not been available.

(3) Qualified personnel are often not available to conduct meaningful follow-on training.

Proponents of video recorded instruction claim the strengths of the ITV concept would directly offset these training problems. Willard Thomas [Ref. 11] stated that video tape, "... standardized content presentations...." If a videotaped program is used as the only method of instruction, every trainee receiving instruction from the video tape will receive exactly the same instruction. As a counter to the shortage of dedicated training time, Sony Corporation [Ref. 12] says,

> Well produced video training modules teach more subject matter, in less time than conventional classroom instruction ... compared to conventional classroom instruction. Well designed video taped technical presentations yield measurably better results in 1/4th to 1/6th the time.

As far as filling in for the qualified instructor that may not be available to conduct training, Keith A. Wilkins [Ref. 13] said that good TV presentations are as effective as a good or average instructor, and may even equal an excellent instructor insofar as the instructor's function is communicating the facts or demonstrating procedures.

The expert opinions of these ITV proponents do present some very interesting possibilities for aviation maintenance training, although emperical evidence to support their views was not cited. Standardization of training through the video tape medium seems obvious enough to be accepted, however the more efficient use of time and comparable effectiveness warrant further investigation. To determine if these claims of increased efficiency and comparable effectiveness hold true in the Navy's organizational level maintenance environment, it was decided to conduct an experiment in which video recorded instruction was compared to formal lecture and self study.

PURPOSE

The purpose of this thesis will be to investigate the feasibility of providing PQS oriented, continual inservice training via the ITV medium. The investigation will test two hypotheses, first, that video recorded instruction (ITV) is at least as effective as or more effective than formal lecture or self study and second that video recorded instruction is more efficient in the use of time than either formal lecture or self study. In addition, a comparative cost analysis will be made to determine if there are any cost savings to be made when substituting video recorded instruction for the traditional formal lecture method.

II. METHOD

SUBJECTS

The experiment was conducted at VP-31 FRAMP (Fleet Replacement Aviation Personnel), an activity that provides P-3 Orion maintenance training for Navy maintenance personnel who are enroute to P-3 squadrons in the Pacific Fleet. The participants in the experiment were selected for their lack of knowledge of the P-3 aircraft and maintenance experience related to it. Initially it was planned that only personnel who had recently completed basic training and were enrolled in the "Basic Airman" course would be included in the experiment. However, to complete the experiment within an acceptable time-frame students waiting to begin other courses of instruction at VP-31 FRAMP were added during the final week of the experiment.

Of the 44 participants in the experiment, 35 were from the "Basic Airman" course and 9 were waiting to begin other courses. The median age of the students was 19 with a range from 17 to 35, 80% were high school graduates, 6 had attended some college and 21 had attended some form of trade school, including Navy schools. There were no female participants. See Appendix A for the demographic data.

PROCEDURES

Three topics for which maintenance training video tapes already existed were selected to be taught during the experiment. They were; Aircraft Washing, P-3 Primary and Secondary Electrical Power Supply and P-3 Brake and Tire Change. Each video tape was reviewed by VP-31 FRAMP instructors who then prepared formal lesson guides to cover the same subject matter. Additionally, the appropriate sections of technical manuals which covered the previously mentioned subject matter were used as self study material. The instructors then prepared multiple choice pre and post-tests insuring that all of the post-test questions were answered by each instructional media; i.e., video taped lecture, lesson guide and self study material.

To avoid the negative effects of Mondays and Fridays, the experiment was not normally conducted on either of those days. Each participant received instruction via a different media (or was in the control group) on each topic. Aircraft Washing was taught on Tuesdays, P-3 Electrical Power Supply was taught on Wednesdays and Brake and Tire Change was taught on Thursdays. For example, on Tuesday section (I) would be assigned to formal lecture, on Wednesday to video tape instruction and on Thursday they would engage in self study or be assigned to the control group. At the same time, section (II) would be assigned to video tape instruction on

Tuesday, self study on Wednesday and formal lecture or control on Thursday. At the conclusion of the first week Aircraft Washing had been taught using formal lecture and video tape, then in the second week it was taught by self study and there would be a control group receiving no instruction.

EXPERIMENTAL GROUPS

At the beginning of each day of the experiment, both sections completed the pre-test for the topic to be taught that day.

Formal Lecture Group

Following the pre-test, the formal lecture group received a lecture presented by a fully qualified, journeyman level technician assigned from the VP-31 maintenance department. Separate instructors were assigned for each of the three topics. Each instructor had viewed the video tape, had been given the previously prepared lesson guide well in advance of his lecture and was allowed to read the pre and post-tests.

When the lecture was completed, the time required for that particular lecture was recorded and the post-test was administered to each of the participants.

Self Study Group

After completing the pre-test, each member of the self study group was given either the appropriate technical manual with a list of pages and paragraphs to be studied or photostatic copies of the applicable pages and paragraphs. The participants were allowed as much time as they individually desired to study the provided material, however, not to exceed three hours. After the individual study was complete, each participant was allowed to have questions answered by a qualified technician and the individual time required for self study was recorded. Following the self study and questions, each participant completed the post-test.

Video Taped Instruction Group

Following the pre-test, the participants in the video tape group viewed the video taped program on the selected topic. The participants were given the opportunity to have any questions answered prior to taking the post-test. It was not necessary to record the time required for instruction via this media as the time for video instruction was fixed at the length of the particular tape.

Control Group

Following the pre-test, this group was assigned to other tasks or classes not related to the experimental topic. Approximately three hours after the pre-test the participants in the control group completed the post-test.

CRITERION FOR EVALUATION

To evaluate the efficiency of the three methods of instruction, the time required for instruction was recorded in all cases and the mean time for each instructional method was used as the measure of its efficiency. The criterion of effectiveness of each instructional method was the mean percentage of correct answers on the post-tests.

III. FINDINGS

The hypothesis that video taped instruction is as effective and efficient as formal lecture or self study was tested by comparing mean test scores from each media form using analysis of variance (ANOVA). Table I displays statistically acceptable and non-acceptable hypothesis and Table II shows the sample means, standard deviations and sample sizes by instruction topic and media. The experimental data for effectiveness and efficiency can be seen in Appendixes B and C.

EFFECTIVENESS

As has been previously stated, the effectiveness model for this experiment is the relationship between the mean test scores from two or more types of instructional media. The relationships will be evaluated using the ANOVA data from Table I.

Video Tape vs Formal Lecture

Analysis of the mean test scores following video taped instruction and formal lecture (see Table II) shows that the video taped instruction mean test score (70.8) is significantly higher than that of the formal lecture (61.4%) at the .01 level, $F(1,60) = 9.4$ (item I.C., Table II),

Table I: Summary of One-way ANOVA

VARIABLES	MEAN SCORE	SUM OF SQUARES	DF	MEAN SQUARE	F	SIG
I. Total Sample						
A. Video Tape	70.8	7869.	3	2623.	19.04	.001
Lecture	61.4	15014.	109	138.		
Self Study	57.5					
Control	47.4					
B. Video Tape	70.8	2546.	2	1273.	7.87	.001
Lecture	61.4	13433.	83	162.		
Self Study	57.5					
C. Video Tape	70.8	1345.	1	1345.	9.40	.01
Lecture	61.4	8585.	60	143.		
D. Video Tape	70.8	2323.	1	2323.	15.90	.0001
Self Study	57.5	7453.	51	146.		
E. Lecture	61.4	2933.	1	2933.	22.50	.0001
Control	47.4	7560.	58	130.		
F. Self Study	57.5	1293.	1	1293.	9.86	.01
Control	47.4	6428.	49	131.		
G. Lecture	61.4	219.	1	219.	1.11	NS
Self Study	57.5	10828.	55	197.		
II. P-3 Electrical Deleted						
A. Lecture	54.8	107.	1	107.	1.09	NS
Self Study	51.4	3624.	37	98.		
III. P-3 Electrical Only						
A. Video Tape	68.5	210.	2	105.	0.87	NS
Lecture	73.1	3033.	25	121.		
Self Study	75.5					
B. Video Tape	68.5	115.	1	115.	0.89	NS
Lecture	73.1	2581.	20	129.		

Table I: (Continued)

VARIABLES	MEAN SCORE	SUM OF SQUARES	DF	MEAN SQUARE	F	SIG
IV. Brake and Tire Change Only						
A. Lecture	54.2	6.	1	6.	0.50	NS
Self Study	53.1	1896.	17	112.		
V. Aircraft Washing Only						
A. Lecture	55.3	215.	2	107.	1.51	NS
Self Study	49.8	1850.	26	71.		
Control	49.6					
B. Lecture	55.3	150.	1	150.	1.61	NS
Self Study	49.8	1672.	18	93.		
C. Self Study	49.8	0.2	1	0.2	0.003	NS
Control	49.6	958.	16	60.		
VI. Control Group						
A. P-3 Electrical	50.0	314.	2	157.	2.97	NS
Aircraft Wash	49.6	1266.	24	53.		
Brake and Tire Change	42.6					

Table II: Summary of Post Test Mean Scores

EXPERIMENT GROUP	SAMPLE SIZE	MEAN SCORE	STANDARD DEVIATION
Aircraft Washing			
Video Tape	10	72.3	7.5
Lecture	11	55.3	9.4
Self Study	9	49.8	9.9
Control	9	49.6	4.7
P-3 Electrical			
Video Tape	10	68.5	10.5
Lecture	12	73.1	12.0
Self Study	6	75.5	9.5
Control	9	50.0	6.5
Brake and Tire Change			
Video Tape	9	70.9	11.8
Lecture	10	54.2	10.2
Self Study	9	53.1	11.0
Control	6	45.3	10.3
Total Sample (includes all of the above)			
Video Tape	29	70.8	9.6
Lecture	33	61.4	13.7
Self Study	24	57.5	14.5
Control	24	47.4	7.8

supporting the argument that video taped instruction is the more effective training media in the squadron maintenance environment.

Video Tape vs Self Study

Analysis of the experimental data indicates that statistically the mean score from video taped instruction (70.8) is significantly higher than the mean score from self study (57.5) at the .001 level, $F(1,51) = 15.9$ (item I.D., Table I), supportiong the hypothesis that video taped instruction is a more effective method of instruction than self study.

Formal Lecture vs Control

The mean score from the formal lecture group (61.4) was significantly higher than the mean score from the control group (no instruction) (47.4) at the .001 level, $F(1,58) = 22.5$ (item I.E., Table I). The assumption that formal lecture is an effective method of instruction is supported by this data.

Self Study vs Control

Analysis of the data from the complete experiment population indicates the self study mean test score (57.5) is significantly higher than that of the control group (47.4) at the .01 level, $F(1,49) = 9.85$ (item I.F., Table I). This evidence supports the argument that self study is an effective method of instruction when compared to no instruction.

Formal Lecture vs Self Study

Analysis of the data in comparison of formal lecture and self study mean scores, 61.4 and 57.5 respectively, indicates that statistically there is no discernible difference between the mean scores at the .05 level, $F(1,55) = 1.11$ (item I.G. Table I), supporting the argument that self study is as effective as formal lecture.

INTERACTION

Using a two-way analysis of variance a significant interaction was found between methods of instruction and topics, this interaction is summarized in Table III. In Figure 4 it can be seen that the order of effectiveness of the various instructional methods was consistent throughout the aircraft washing and brake and tire change topics, however, although the mean scores of self study, formal lecture and video are statistically the same for the P-3 electrical topic, their order of effectiveness is different than in the other two topics. Possible causes of this interaction will be discussed in Chapter V.

EFFICIENCY

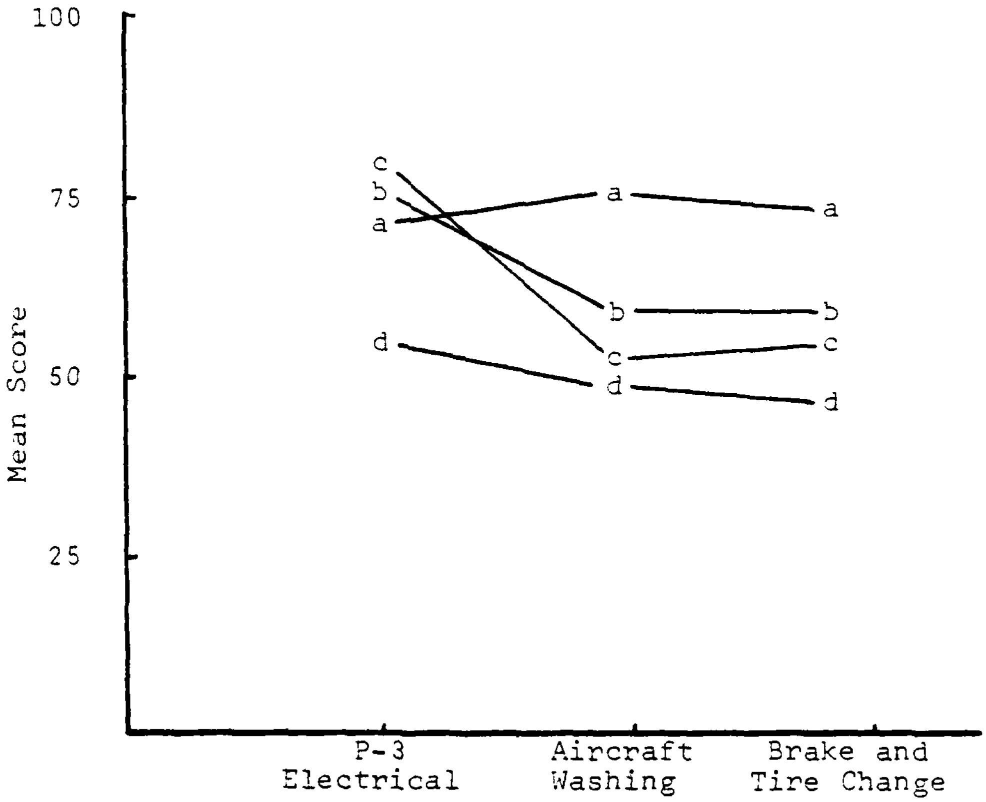
The measure of efficiency of the three instructional methods used in the experiment is simply the mean time for a student to receive instruction by each method. Less time

Table III: Summary of Two-way ANOVA

SOURCE OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	F
Method	3 101	7686.547	2562.182	27.591
Topic	2 101	2786.495	1393.248	15.003
Method x Topic	6 101	3062.440	510.407	5.496
Residual		9379.234	92.864	

*Significance < .001.

Figure 4: Interaction in Two-way ANOVA.



Instructional methods: a = video
b = lecture
c = self study
d = control

required is more efficient, and conversely, more time is less efficient. Table IV shows the mean time of instruction by topic and media.

Based on the established criteria for efficiency, video taped instruction was the most efficient method of instruction used in the experiment. The same amount of material taught via video taped instruction used only 26% of the time required for formal lecture and 32% of the time required for self study. Self study was also more efficient than formal lecture requiring only 83% as much time.

Table IV: Mean Time Required for Instruction.

TOPIC	VIDEO TAPE (minutes)	FORMAL LECTURE (minutes)	SELF STUDY (minutes)
Aircraft Washing	15	90	71
P-3 Electrical	19	80	44
Brake and Tire Change	35	98	120
Aggregate Mean Times	23	88	73

IV. COST ANALYSIS

In addition to evaluating the relative effectiveness of the training methods discussed in the provisions chapters, an analysis of the short and long run costs of two of the methods was made. The analysis dealt only with locally prepared and presented formal lectures (status quo) and instructional television.

CRITERION FOR RANKING ALTERNATIVES

The criterion selected for ranking the two alternatives is fixed effectiveness at minimum cost. By directing four hours of training per week, Commander Patrol Wings Pacific established the standard for comparison, four hours of training per week utilizing formal lecture or an equivalent amount of information covered by video taped instruction.

In addition to higher test scores following video taped instruction (15% higher), it was also found that video required only 27% as much time as the formal lecture method (see Table V). As a result, 65 minutes should more effectively cover the same amount of information as a four hour lecture. What does this mean in terms of comparative costs of the two methods?

Table V: Comparison of Effectiveness and Efficiency Between Formal Lecture and Video Taped Instruction

	VIDEO TAPE			FORMAL LECTURE		
TOPIC	Sample Size	Mean Score (%)	Mean Time (min.)	Sample Size	Mean Score (%)	Mean Time (min.)
Aircraft Washing	10	72.3	15	11	55.3	90
P-3 Electrical	10	68.5	19	12	73.1	80
Brake and Tire Change	9	70.9	35	10	54.2	98

Formal Lecture Mean Time: 86 minutes
Video Tape Mean Time: 23 minutes

Formal Lecture Mean Score: 61.4
Video Tape Mean Score: 70.6

COST ANALYSIS

To estimate the personnel costs associated with four hours of training per week, the manpower structures of three of the six active duty P-3 squadrons currently located at Naval Air Station Moffett Field were analyzed by paygrade with the mean paygrade being E-4.34, which is 34% between an E-4 and E-5 (see Appendix D).

Formal Lecture Cost Model for First Iteration

Assumptions.:

1. Weekly training is normally conducted within each individual work center.
2. Of the 13 people in the typical work center (see Appendix D), on the average, only 9 of them will be present for any given lecture and one of them will be the instructor.
3. The instructor will, on the average, be an E-6.
4. One hour of instructor preparation is required for each hour of lecture.
5. Four hours of lecture are prepared and given by each active duty P-3 squadron on the same topic (24 squadrons total).

Fixed Costs. There are no significant fixed costs associated with formal lectures prepared and presented by squadron maintenance personnel.

Variable Costs:

Instructor cost = (E-6 hourly wage) x (hours of lecture + hours of preparation) = 15.52 x (4 + 4) = 124.16. [Ref. 14]

Trainee cost = (E-4.34 hourly wage) x (hours of lecture x number of trainees) = 11.78 x (4 x 8) = $376.96. [Ref. 14]

Total Costs:

Total cost to the U.S. Navy for four hours of lecture in each active duty P-3 squadron = (Number of P-3 squadrons) x (Instructor costs + trainee costs) = 24 x (124.16 + 376.96) = $12,026.88.

Video Taped Instruction Cost Model for First Iteration

Assumptions:

1. Of the 13 people assigned to the typical work center, only 9 will be present for any given lecture.

2. No instructor or preparation is required.

3. Based on the efficiency data, 65 minutes of video tape instruction is comparable to 4 hours of formal lecture.

4. Video cassette recorder life expectancy is 5,000 hours.[1]

Variables and Values Assigned

1. Video tape production costs are $165 per minute.

2. A blank video cassette costs $12.00.

3. Video tape play back system life cycle costs:
   Video Cassette Recorder cost = $1320
   Television Monitor cost = $638
   Estimated Maintenance costs = $2,000
   Total Life Cycle costs = $3958

---

[1] All video equipment costs and life cycle data received from Mr. John Hood, Chief Engineer, Instructional Television Studio, Moffett Field, Ca.

Fixed Costs:

Video program production cost = (minutes of video instruction x production cost) = 65 x 165 = $10,725.

Duplication cost = (number of squadrons x blank tape cost) = 24 x 12 = $288.

Total fixed costs = 10,725 + 288 = $11,013.

Variable Costs:

Equipment depreciation cost = (number of squadrons x video tape play back system life cycle cost x equipment depreciation rate) = 24 x (3958 x 65/ (5,000 x 60) = $20.58 .

Trainee cost = (number of squadrons x 65 minutes of trainee costs) = 24 x (9 x 11.78 x (65/60)) = $2756.52.

Total variable costs = 20.58 + 2756.52 = $2777.10.

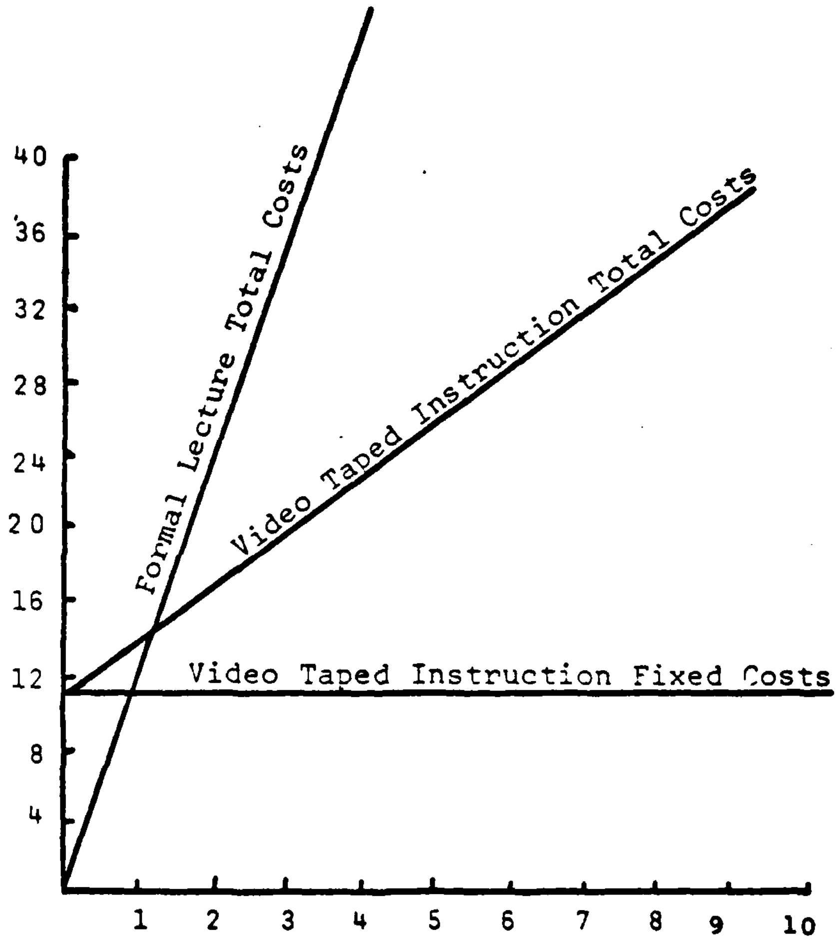
Total Cost to the U.S. Navy for 65 Minutes of Video Taped Instruction:

Total cost = fixed costs + variable costs = 11,013 + 2777.10 = $13,790.10.

Cost Comparison Over Time

The first time a particular topic is taught the total costs of formal lecture are lower than those of video tape (see Figure 5). However, the lower variable costs of video tape cause the total cost of that method to rise much more slowly than formal lecture. As can be seen from Figure 5

Figure 5: Cost Comparison of Formal Lecture and Video Taped Instruction Over Time.



with two or more uses by a typical work center in all of the Navy P-3 squadrons, video tape becomes much less expensive or more cost effective.

Assuming that each lecture is repeated every 18 months to allow for personnel turnover and that the only variable costs associated with repeating video tape instruction are; trainee costs and equipment depreciation costs, Table VI is a comparison of the costs of instruction via formal lecture and video tape.

COST ESTIMATE OF COMPLETE P-3 PECULIAR P.Q.S. COVERAGE WITH VIDEO TAPE INSTRUCTION

The Personnel Qualification Standard (PQS) program was introduced into Naval aviation during the 1970's as a written compilation of knowledge factors, skills and performance criteria necessary to operate and maintain specific equipment/systems or to perform designated tasks, (see Appendix E for an example of PQS). Since its introduction, PQS has become the backbone of Naval aviation maintenance training as the governing directives for maintenance training state that squadron's inservice training programs will directly support the objectives of PQS. [Ref. 9] However, PQS in itself is not a stand alone training program, it only identifies the fundamental and systems knowledge to be acquired and job performance experience to be gained. For successful accomplishment of the PQS objectives, the PQS

Table VI: Cost Comparison of Formal Lecture and Video Taped Instruction Over a Six Year Period.

	INCREMENTAL COSTS		CUMULATIVE COSTS	
Time Taught	Lecture	Video Tape	Lecture	Video Tape
Time Zero	$12,027	$13,790	$12,027	$13,790
Year 1.5	12,027	2,777	24,054	16,567
Year 3.0	12,027	2,777	36,081	19,344
Year 4.5	12,027	2,777	48,108	22,121
Year 6.0	12,027	2,777	60,134	24,898

program must be supported by a training program consisting of; instruction in the knowledge factors (fundamental and systems) and on-the-job training for the maintenance actions (performance experience).

In the past, squadron inservice training programs in the Pacific Fleet P-3 community, based on locally prepared formal lectures and training syllabuses, have been inadequate in supporting the objectives of PQS. [Ref. 6] As an alternative, video taped instruction may be a more satisfactory approach to the PQS Training. In support of this proposal, an estimate of the costs for producing video taped instruction to cover all P-3 peculiar PQS knowledge factors follows.

Video Tape Requirements

To estimate the cost of complete coverage of all P-3 peculiar PQS knowledge factors via the video tape media, an estimate of the required number of video tape minutes was multiplied by the production per minute cost of video taped instructional programs. The number of minutes of video tape required was estimated by counting all of the individual, P-3 peculiar, PQS knowledge factors (knowledge factors common to more than one P-3 PQS standard were counted only once), 6,971 knowledge factors were then multiplied by the average number of video tape minutes required to cover a knowledge factor.

The number of video tape minutes required to cover a knowledge factor was estimated by analyzing eight P-3 maintenance video tapes which were produced by the Patrol Squadron Instructional Television Facility at Naval Air Station Moffett Field, California. The results of that analysis are exhibited in Table VII. From the analysis, the sample mean time required to cover a knowledge factor is 1.255 with a standard deviation of .832 minutes and a confidence interval of .566 to 1.94 minutes at a 95% level of confidence. As a conservative approach, a mean of 1.94 minutes could be used, however, in the past the maintenance training video tapes have not been produced specifically to cover PQS knowledge factors. It is the author's opinion that with more attention to PQS the average tape time to cover a knowledge factor could be significantly reduced, possibly by as much as 50%. For the purposes of this study, a mean time of 1.26 minutes of video tape instruction to cover one PQS knowledge factor will be used.

Video Tape Production Cost Model

The video tape production cost model consists of; the number of P-3 knowledge factors times the video tape minutes required to cover a knowledge factor to determine the total number of video tape minutes required:

6,971 (knowledge factors) x 1.26 = 8783.46 minutes of video tape required.

Table VII: Analysis of Time to Cover PQS Knowledge Factors Via Video Tape

TITLE	PQS STANDARD	TOTAL # KNOWLEDGE FACTORS	TIME (min.)	MINUTES per K.F
Auxillary Power Unit	P-3 Utility/Environmental/etc. P-3 Power Plants	23	25	1.13
Doppler Radar Nav.	P-3 Avionics	6	18.5	3.08
Plane Washing	Corrosion Control	9	15	1.66
Brake and Tire Change	P-3 Structural/ Hydraulics	35	35	1.0
Hydraulic Systems Fam	P-3 Structural/ Hydraulics	10	11	1.1
Primary Power Supply	P-3 Electrical	11	11	1.0
Secondary Power Supply	P-3 Electrical	19	8	0.421
Engine Fire Detection and Extinquishing System	P-3 Electrical	17	11	0.647

Sample mean = 1.255 minutes of video tape instruction per PQS knowledge factor.

Sample standard deviation = .823 minutes. 95% Confidence interval = .566 to 1.94.

For the total cost estimate, the minutes of video tape instruction required is multiplied by the average per minute production cost of the Instructional Television Facility, which was $165.00 per minute during fiscal year 1981. [Ref. 15] The estimated cost to produce video taped instruction to cover all P-3 PQS knowledge factors is:

8783.46 (video tape minutes) x 165 = $1,449,271 (production cost est.).

The incremental costs of complete production and implementation of P-3 maintenance video tape instruction consist only of the master tape poduction costs and the dubbing costs of producing copies of the master tape for the user squadrons. From the ITV Facility's Audio Visual Report for 1981, the average duplicating costs were $1.10 per program minute. [Ref. 15] The cost of production equipment at the ITV facility and video cassette players within the user squadrons are sunk costs as they are now in existence and consequently are not considered in the overall cost estimate.

To compute the total implementation cost estimate, average duplication costs and the cost of 585 tapes per squadron (8783 minutes required / 15 minutes average tape length = 585 tapes) are added to production costs:

(8783.46 x 1.10) + (24 x (12 x 585) + 1,449,271 = $1,627,412 implementation cost estimate.

V. DISCUSSION

There are a number of interesting findings when the experimental data is examined, there are also certain considerations that must be taken into account to accurately interpret the results.

It was found that the performance of the experimental groups was considerably different on the P-3 Electrical Power Supply topic than on the other two topics. In Electrical Power Supply the self study group had the highest mean score (75.5) and the video taped instruction (68.5) was the lowest mean score, unlike the results for the other two topics. Also, the Electrical Power Supply formal lecture mean score (73.1) was higher than video taped instruction. Possible explanations for these different results could include the following:

(1) This interaction between methods and topics (see Table III and Figure 4) may be indication that self study and lecture are more effective than video taped instruction for teaching electrical topics. However, the next two considerations seem to be more likely causes of the interaction.

(2) The entire self study group for Electrical Power Supply came from the last week of the experiment and three of the participants in this group were class "A" school graduates, two of which were graduates of Avionics "A" school. Consequently, this group had a higher knowledge level of

aviation maintenance and electronics prior to the experiment, thus possibly contributing to an unexpectedly high mean score (75.5) in self study.

(3) Formal lecture on the Electrical Power Supply topic was taught on three different occasions and by two different instructors. The first instructor confined his lecture to the classroom and the mean test score under his instruction (67.7) was lower than the video taped instruction mean score (68.5). Using an entirely different approach, the second Electrical Power Supply instructor taught the entire lectures in the P-3 aircraft, demonstrating locations and relationships throughout the lecture. The mean test score from the second instructor (74.9) was considerably higher and moved the total Electrical formal lecture mean score (73.1) above video taped instruction.

Although the "A" school graduates grades may have prejudiced the Electrical Power Supply scores in favor of self study, it did not change the relationships between the mean scores of the various media when analyzing the data from the complete experiment population. With the Electrical data deleted, there is no statistically discernible difference between the formal lecture (54.8) and self study (51.4) mean scores at the .05 level, $F(1,37) = 1.089$ (Table I, item II.A.). With the Electrical Power Supply data included, there is still no statistically discernible difference between the mean scores (61.4 and 57.5) at the .05 level, $F(1,55) = 1.11$ (Table I, item I.G).

To determine the comparative difficulty of the three different exams (P-3 Electrical, Aircraft Washing and Brake and Tire Change), the difference between the three control group mean scores was analyzed. Statistically, there was no discernible difference between the mean scores, (50), (49.6) and (42.6) respectively, at the .05 level, $F(2,24) = 2.97$ (Table I, item VI.A), indicating that the exams were comparably equal in degree of difficulty. Based on this statistical support, differences in mean scores between topics can be considered to result from differences in effectiveness of instruction and not a difference in the difficulty of the exams.

It is interesting to note that self study proved to be a more time efficient method of instruction than formal lecture and equally as effective. This is contrary to what the author expected prior to the experiment, especially considering the popular opinion that the reading ability of military recruits is declining.

EVALUATION OF ALTERNATIVES

Formal Lecture

The effectiveness model for the formal lecture is based on experimental data gained from a nearly ideal training environment. The instructors had adequate time to prepare, were motivated to do an effective job and were eager to participate in the experiment. The environment for inservice training in the fleet aviation squadrons is seldom ideal and the effectiveness of formal lecture (test score or transferred knowledge) in the fleet environment would probably be lower than what was used in this study. Consistency and standardization of training also suffer when lesson guide preparation is the responsibility of each individual squadron.

One of the primary, if not the number one problem that currently faces inservice maintenance training, is the lack of time to hold formal training. It has been appropriately stated, "If it weren't for OJT there would be no squadron inservice training." It is very costly, in both wages paid and maintenance time lost, to halt production of a squadron maintenance department for four hours of training. There are few squadrons, even though they may be directed to, that maintain such an active training program. However, maintenance training is considered to be a key factor in the Navy's operational readiness and few would dispute its importance.

In the past, locally prepared and presented formal lectures (status quo) have not proven to be a very effective method of supporting the PQS objectives.

Video Taped Instruction

Two important qualities of video taped instruction are; (1) ease of use and (2) its use as an individualized form of instruction. The fact that video taped instruction requires no preparation time by squadron personnel makes it a less demanding method of training as compared to locally prepared formal lectures. It would be a reasonable assumption that ease of use would be an influential factor in how extensively a training system is utilized.

As has been previously stated, to interrupt all maintenance production is very costly and, as a result, is resisted. There are, however, many short periods of inactivity on the part of maintenance personnel due to normal delays. For example, a maintenance crew may wait twenty to thirty minutes to have an aircraft moved to a maintenance spot, or an inexperienced person may have to wait for the availability of a journeyman technician to demonstrate or supervise a maintenance task. Short periods of awaiting to do maintenance could be constructively utilized for individual instruction via video tape, with no disruption of the maintenance process.

Another important consideration is the variability in the quality of instruction. Where the quality of instruction via formal lecture may vary between instructors, the quality of video recorded instruction is relatively fixed. The significance of variance in the quality of formal instruction is that a high quality lecture may be as effective as or more effective than video taped instruction, however, an average or low quality lecture may be little more effective than receiving no training. In this regard, it was interesting to note that in this study, "on-site" lecture/demonstration in an aircraft was found to be the most effective means of training (and probably the most expensive). This may be an isolated example, but if the lecture method were to be continued, the "onboard" method of instruction should be further investigated. It may well be advantageous to move the training out of the shop and onto the aircraft.

SUMMARY AND CONCLUSIONS

To investigate the feasibility of replacing formal lecture and self study with instructional television as the primary method of inservice training for Naval aviation squadrons, two dimensions were investigated. First the relative efficiency and effectiveness of three methods of instruction was experimentally investigated. Then, using the efficiency data from the experiment, a cost analysis was done to compare the relative costs of instruction via formal lecture and instructional television.

Based upon the established criteria for efficiency and effectiveness and the statistical data from the experiment, it is concluded that video taped instruction (instructional television) is both more efficient and effective than either formal lecture or self study. The cost analysis also demonstrated that instructional television is a more cost effective method with repeated uses. However, it must be considered that this experiment was conducted to evaluate the feasibility of the use of video taped instruction in the naval aviation squadron maintenance department and the experiment was designed to simulate that environment. The conclusions the author has drawn from the experimental data are directed only at this audience. It is not the author's contention that instructors and conventional classroom instruction should be universally replaced by video taped instruction, but it may be the most efficient and effective method of instruction currently available for squadron maintenance department's inservice training.

VI. RECOMMENDATION

The U.S. military services invest vast sums of time and money each year to train new recruits in technical skills and a large majority of these young men and women will return to civilian life after a three or four year enlistment. This training provided by the military is a significant contribution to the growth of human capital in the American society, however, the direct improvement of society through military training is not its intended purpose. The purpose of military training is simply to improve military readiness. The Wolkensdorfer Study, which has been referred to frequently throughout this thesis, questioned whether military training was successfully accomplishing its purpose when it stated,

> A review of performance indicators over the past several years indicates that maintenance capabilities in Pacific Fleet P-3 squadrons have steadily deteriorated to the point where the total readiness of the P-3 force to fulfill all mission requirements is in question.... [Ref. 6]

The instructional television concept has been examined to determine its feasibility as an alternative to conventional training methods, an alternative that may compensate for many of the problems that currently impede inservice training from accomplishing its purpose. The direct impact that an ITV training program would have on military readiness has not been addressed. This thesis has only attempted to demonstrate that video recorded instruction is an efficient and effective method for transferring technical knowledge to naval aviation technicians. Any conclusions of the impact ITV would have on military readiness, based upon extrapolation of the experimental data, would be very subjective. The effects that a more efficient and effective training program would have on readiness is a separate subject that merits further study.

A study to investigate the effects that enriched inservice training through increased use of ITV would have on readiness could easily be conducted within the Navy's P-3 community. ITV programs could be produced to cover nearly all PQS knowledge factors for only one work center, e.g., the power plants work center. The power plants ITV tapes would then be provided to all Pacific Fleet P-3 squadrons, an experimental group, while the Atlantic Fleet P-3 squadrons, the control group, would not receive the tapes. Over a period of time, e.g., twelve to eighteen months, the power plants systems readiness data from the two groups would be analyzed to determine if there was any correlation between improved readiness (based on standard readiness reporting procedures) and video recorded instruction.

The technologies that are available today should be applied to the military's human systems as well as the hardware systems. It's time to exploit technology in direct support of our people who keep our ever increasingly technical weapon systems operational.

In the naval aviation community we have been unsuccessful in accomplishing effective inservice training through the conventional methods of formal lecture and self study, although we have been trying to make it work for many years. The results of this study would suggest that it is time to try a different approach to inservice maintenance training.

APPENDIX A

DEMOGRAPHIC DATA OF EXPERIMENT PARTICIPANTS

AGE	HIGH SCHOOL GRADUATE	TRADE SCHOOL ATTENDANCE	COLLEGE ATTENDANCE	PRIOR SERVICE
18	Yes	No	No	No
19	Yes	No	No	No
17	Yes	No	No	No
24	Yes	Yes	Yes	No
18	Yes	No	No	No
32	Yes	No	No	No
20	No	No	No	No
20	No	No	No	No
24	Yes	No	No	Yes (Army)
19	Yes	Yes (Elect.)	No	No
23	Yes	No	No	Yes (Navy)
20	Yes	No	No	No
18	Yes	Yes (Auto Mech.)	No	No
19	No	Yes (Welding)	No	No
18	Yes	Yes (Auto Mech.)	No	No
19	Yes	Yes (Bartending)	No	No
19	Yes	Yes (Building)	No	No
18	Yes	No	No	No
17	No	No	No	No
23	Yes	No	Yes	No
18	Yes	No	No	No
20	Yes	No	No	No
19	Yes	Yes (Building)	No	Yes (Army)
19	No	Yes (Lithog.)	No	Yes (Army)
19	Yes	No	No	No
19	Yes	No	No	No
18	No	No	No	No
20	Yes	Yes (AV "A")	No	No
35	Yes	Yes (ADJ "A")	No	Yes (Navy)
20	Yes	Yes (AV "A")	Yes	No
23	Yes	Yes (AV "A")	Yes	Yes
18	Yes	Yes (ADJ "A")	No	No
18	Yes	Yes (Auto Smog)	No	No
19	Yes	Yes (Welding)	No	No
18	Yes	No	No	No
20	Yes	No	Yes	No
18	No	No	No	No
18	Yes	Yes (Auto Mech.)	No	No
17	No	No	No	No
19	Yes	Yes (ADJ "A")	No	No

APPENDIX A

(Continued)

17	No	No	No	No
19	Yes	Yes (ADJ "A")	No	No
19	Yes	Yes (ADJ "A")	Yes	No
19	Yes	Yes (ADJ "A")	No	No

APPENDIX B

EXPERIMENT TEST SCORES

TOPIC	VIDEO TAPE	LECTURE	SELF STUDY	CONTROL
P-3 Electrical Power Supply	75	79	85	47
	77	76	83	50
	44	68	71	53
	74	76	76	65
	79	82	59	47
	76	85	79	50
	68	74		50
	68	68		47
	62	74		41
	62	50		
		94		
		71		
Aircraft Washing	74	57	54	54
	66	40	37	46
	74	51	34	46
	80	63	46	46
	63	51	57	54
	77	74	49	43
	83	54	51	57
	66	60	66	49
	77	49	54	51
	66	63		
		46		
P-3 Brake and Tire Change	81	75	55	39
	56	63	64	52
	63	53	33	48
	82	47	55	39
	73	50	49	33
	91	53	55	61
	61	55	55	42
	61	58	70	30
	70	36	42	39
		52		

APPENDIX C

TIME (IN MINUTES) REQUIRED FOR INSTRUCTION

TOPIC	VIDEO TAPE	LECTURE	SELF STUDY
P-3 Electrical Power Supply	19	90 90 60	45 45 45 55 30 45
Aircraft Washing	15	90 90	90 90 90 90 35 35 70 70 70
P-3 Brake and Tire Change	35	105 90	120 120 120 120 ? ? ?
MEAN TIMES	23 minutes	87.9 minutes	72.9 minutes

APPENDIX D

SAMPLE OF P-3 WORK CENTER STRUCTURES BY PAYGRADE

WORK CENTER/ PAYGRADE	E-2	E-3	E-4	E-5	E-6	MEAN GRADE	NUMBER
			SQUADRON A				
110	1	3	6	7	0	4.1	17
120	4	5	2	3	2	3.63	16
121	1	1	3	1	0	3.66	6
130	0	1	3	1	2	4.57	7
210	0	2	3	10	4	4.8	19
220	0	1	7	4	2	4.5	14
230	0	1	2	4	5	5.08	12
310	2	2	3	1	1	3.66	9
315	0	1	2	6	7	5.13	16
			SQUADRON B				
110	0	3	8	4	4	4.47	19
120	0	3	8	4	2	4.29	17
121	1	1	5	1	0	3.75	8
130	0	3	2	2	2	4.33	9
210	0	3	10	7	3	4.43	23
220	0	2	3	4	2	4.55	11
230	0	0	4	5	2	4.82	11
310	2	2	0	0	0	2.5	4
315	0	2	0	2	13	5.53	17

APPENDIX D
(Continued)

SQUADRON C

110	4	3	3	5	2	3.88	17
120	0	5	3	3	2	4.15	13
121	0	2	1	2	0	4.03	5
130	0	1	1	2	1	4.6	5
210	0	3	4	7	5	4.74	19
220	1	4	4	3	3	4.2	15
230	0	4	2	7	5	4.72	18
310	2	6	1	0	1	3.2	10
315	0	0	2	2	10	5.75	14

Mean paygrade within any work center = E-4.34

Mean number of people within any work center = 13

PERSONNEL QUALIFICATION STANDARD

FOR

CORROSION CONTROL

CHIEF OF NAVAL EDUCATION AND TRAINING

FEBRUARY 1978

0501-LP-222-5600

This is a brief explanation on how to use your Personnel Qualification Standard. A more detailed description on the use of the PQS system is contained in NAVEDTRA 43100-1A (HANDBOOK ON MANAGEMENT AND IMPLEMENTATION PROCEDURES FOR PERSONNEL QUALIFICATION STANDARDS).

Do not become concerned with the thickness of this book and the number of words on each page. Broad knowledge of a subject may be affirmed by brief answers to the questions.

Your Personnel Qualification Standard was developed by determining the skills you need at your watchstation. General theory and equipment systems were then identified to ensure you have the background knowledge to properly perform your duties.

This Standard has four main subdivisions: Theory (100 Section), Systems (200 Section), Watchstations (300 Section), and Qualification Card (400 Section). Note that the pocket-sized Qualification Card questions match those in the Watchstation section and provide a space for your supervisor's signature.

As you look through the Standard booklet you will notice that the Theory Section contains the facts, principles, and fundamentals concerning the subject you are qualifying for. The Systems Section deals with the major working segments or components of an installation, organization or equipment which requires specific attention. The last section in the booklet, the Watchstation Section, defines the actual duties, assignments and responsibilities which you will be performing to obtain your qualification.

The first thing to do on your road to qualification is to open your Qualification Card. You will see that at the beginning of each Watchstation, the supporting Theory and Systems Sections are listed. Turn to your PQS booklet and answer the Theory and Systems questions applicable to the Watchstation you are working on. Once the supporting Theory and Systems are completed, you are ready to start accomplishing the tasks leading to "QUALIFICATION" in your Watchstation.

When you have answered the Watchstation questions and demonstrated your proficiency performing the Watchstation tasks, your Supervisor (qualifying petty officer) will sign his name in your Qualification Card as you complete each task. Your qualification may range from informal observation of your watchstanding performance to a formal qualification board. Your Commanding Officer's signature on the front cover of the Qualification Card is the final authority qualifying you to perform your Watchstation duties.

If you have suggestions for improvement of this Qualification Standard, use the Feedback Form in the back. It is a direct input from you to the PQS Development Group and you will receive a prompt reply from the product manager who maintains the status of your Standard.

Good Luck!

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CONTENTS

NOTE: Letters and numbers in brackets [ ] in the Fundamental and System sections indicate the reference and location (section, chapter, appendix, etc.) where the answer may be found. Small references without chapters or sections shall be indicated by letter only.

101 BASIC CORROSION CONTROL FUNDAMENTALS

This section directs your attention to BASIC CORROSION CONTROL FUNDAMENTALS. References used were:

a. NAVAIR 01-1A-509
b. NAVAIR 15-01-500
c. OPNAVINST 4790.2, Vol. II

101.1 TERMS

.11 Define the following terms as used in corrosion control: [a-Sec III]

a. Corrosion
b. Anode
c. Cathode
d. Electrolyte
e. Metallic path

101.2 Define, identify and explain the cause of corrosion on the basic metals of naval aircraft: [a-Sec III]

.21 Direct surface attack (uniform etch)
.22 Pitting
.23 Intergranular
.24 Exfoliation
.25 Concentration cell
.26 Fretting
.27 Stress
.28 Fatigue
.29 Filiform
.210 Microbiological
.211 Galvanic

101.3 CORROSION PREVENTIVE MATERIALS

.31 State the application and use of the following materials: [a-Sec IV, App A]

a. Dry cleaning solvent, PD-680, Type II
b. Aircraft cleaning compound, MIL-C-43616
c. Aircraft cleaning compound, MIL-C-25769
d. Corrosion preservative compound (water-displacing), MIL-C-81309 Types 2/3
e. Corrosion preservative compound, MIL-C-16173 Grades I/IV
f. Corrosion preservative compound (water-displacing, AML guard), MIL-C-85054
g. Lubricating oil, VV-L-800
h. Cleaning compound, MIL-C-81302
i. Cleaning compound (avionics), MIL-C-81964
j. Hydraulic fluid (preservative), MIL-H-6083

101.4 CORROSION EVALUATION AND TREATMENT

.41 State the four classes of damage and the appropriate action to correct each. [a-Sec VI]
.42 Explain the steps required for treatment of aluminum and magnesium surfaces. [a-Sec VI]
.43 State the reasons and procedures for temporary treatment. [a-Sec IV]

101.5 OPERATIONAL PRESERVATION

.51 State the purpose(s) of naval aircraft preservation. [b-Sec I]
.52 State the general areas of application for type(s) E, D and C preservation. [b-Sec I]
.53 State the application area(s) for each type of preservation. [c-Chap II]

302 WATCHSTATION - CORROSION CONTROL NONSUPERVISORY TECHNICIAN

302.1 MAINTENANCE INSTRUCTIONS

For the maintenance instructions listed below:

A. Describe the steps of this procedure.
B. Explain the reasons for each step of this procedure.
C. Discuss the control/coordination required when using this procedure.
D. Discuss the parameter indications that must be monitored.
E. Discuss the safety precautions that must be observed.
F. Perform the steps of this procedure.

		A	B	C	D	E	F
.11	Properly identify and evaluate corrosion damage	X	X			X	X
.12	Properly set up, operate, secure and stow portable dry honer IAW applicable MRC's/operator manual	X	X		X	X	X
.13	Mechanical removal of paint IAW NAVAIR 01-1A-509	X	X	X	X	X	X
.14	Chemical removal of paint IAW NAVAIR 01-1A-509	X	X	X	X	X	X
.15	Corrosion removal IAW NAVAIR 01-1A-509	X	X	X	X	X	X
.16	Properly prepare surface IAW NAVAIR 01-1A-509	X	X			X	X
.17	Apply chemical conversion coating IAW NAVAIR 01-1A-509	X	X	X	X	X	X
.18	Set up, operate, secure and stow spray paint equipment IAW local instructions	X	X		X	X	X
.19	Mix and apply primer IAW NAVAIR 01-1A-509	X	X	X	X	X	X
.110	Mix and apply sealants IAW NAVAIR 01-1A-509	X	X	X	X	X	X
.111	Mix and apply topcoats IAW NAVAIR 01-1A-509	X	X	X	X	X	X
.112	Remove masking materials IAW NAVAIR 01-1A-509	X	X			X	X
.113	Document corrosion treatment IAW OPNAVINST 4790.2 (Series)	X	X				X

302.2 MAINTENANCE OPERATIONS

A. There are no maintenance operations to be discussed.

302.3 ABNORMAL CONDITIONS that could lead to DISCREPANCIES and/or MALFUNCTIONS

A. There are no abnormal conditions that could lead to discrepancies or malfunctions to be discussed.

302.4 DISCREPANCIES and/or MALFUNCTIONS

For the discrepancies and/or malfunctions listed below:

A. Describe all indications and alarms that would be received by the Corrosion Control Nonsupervisory Technician.

302.4 DISCREPANCIES and/or MALFUNCTIONS (CONT'D)

B. List or recite the steps of procedure for the immediate action portion of this discrepancy and/or malfunction.
C. Explain the reason for each step of this discrepancy and/or malfunction procedure in terms of:

   1. Corrective action provided.
   2. Protection provided.
   3. Investigative action performed.

D. Indicate an understanding of this discrepancy and/or malfunction by describing:

   1. Probable causes.
   2. Operating limitations imposed by this discrepancy and/or malfunction.
   3. Other discrepancies and/or malfunctions that may arise if this discrepancy and/or malfunction is not corrected.
   4. How this discrepancy and/or malfunction affects other watchstations.

E. Outline the followup action required.
F. Perform when practicable or simulate the corrective action for this discrepancy and/or malfunction.

		A	B	C	D	E	F
.41	Chemical conversion coating fails to perform correctly	X	X	X	X	X	X
.42	Primer coating fails to perform correctly	X	X	X	X	X	X
.43	Sealant material fails to perform correctly	X	X	X	X	X	X
.44	Topcoat material fails to perform correctly	X	X	X	X	X	X
.45	Severe material/corrosion condition	X	X	X			X

302.5 INFREQUENT and/or ABNORMAL MAINTENANCE

For the infrequent and/or abnormal maintenance listed below:

A. Describe the steps of this procedure.
B. Explain the reasons for each step of this procedure.
C. Discuss the control/coordination required when using this procedure.
D. Discuss the safety precautions that must be observed.
E. Describe the limitations imposed by this infrequent and/or abnormal maintenance.
F. Describe the conditions that require this infrequent and/or abnormal maintenance.
G. Perform when practicable or simulate this infrequent and/or abnormal maintenance.

		A	B	C	D	E	F	G
.51	Temporary corrosion treatment IAW NAVAIR 01-1A-509	X	X	X	X	X	X	X

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