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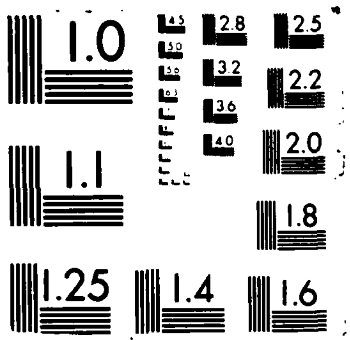
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NAVAL POSTGRADUATE SCHOOL

Monterey, California

THESIS

COMPARISON OF P-3C ACOUSTIC PROCESSING CAPABILITY WITH ACOUSTIC OPERATOR CAPABILITY

by

Ronald R. Arnold II

March 1987

Thesis Advisor: Henry H. Smith

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The purpose of this thesis is to determine if the requirements for operation of the acoustic processing equipment now installed aboard P-3C aircraft is too complex for the acoustic operators, given their current amount of training. This was accomplished using a test scenario designed to test for all of the skills and knowledge required by the acoustic operator in the performance of his duties during the passive portion of the prosecution of a target. The results seem to suggest that the students that successfully complete the P-3C "AW" training pipeline are acquiring an acceptable level of operator capability. In addition, this study seems to suggest that fleet operators who are recognized in fleet squadrons as master journeyman, are operating their ASW acoustic processing equipment

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Comparison of P-3C Acoustic Processing Capability With Acoustic Operator Capability

by

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Lieutenant, United States Navy
B.S., Auburn University, 1980

Submitted in partial fulfillment of the requirements for the degree of

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ABSTRACT

The purpose of this thesis is to determine if the requirements for operation of the acoustic processing equipment now installed aboard P-3C aircraft is too complex for the acoustic operators, given their current amount of training. This was accomplished using a test scenario designed to test for all of the skills and knowledge required by the acoustic operator in the performance of his duties during the passive portion of the prosecution of a target. The results seem to suggest that the students that successfully complete the P-3C "AW" training pipeline are acquiring an acceptable level of operator capability. In addition, this study seems to suggest that fleet operators who are recognized in fleet squadrons as master journeyman, are operating their ASW acoustic processing equipment to its fullest capability and without apparent operator deficiencies.

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ACKNOWLEDGMENT

I would like to thank the many people of both Patrol Squadron 31 and FASOTRAGRUPAC Det Moffett who provided assistance during this study. Very special thanks goes to AWC Pete McCabe of the Acoustic Training Division of FASOTRAGRUPAC Det Moffett. He helped in the design of the scenario used in this study, and acted as the scenario administrator and grader. Without his exceptional expertice and continued help beyond those areas already mentioned, this study would not have been possible.

Special thanks also goes to Dr. Hank Smith, Instructional Systems Coordinator for Patrol Squadron 31. His continued support and patience as my thesis advisor is forever appreciated.

I. INTRODUCTION

A. BACKGROUND

1. History of Anti-Submarine Warfare

The notion of using aircraft to hunt and kill submarines dates back prior to World War I. But it was not until the morning of September 15, 1916 when two Lohner flying-boats of the Imperial Austro-Hungarian Naval Air Arm took off in search of a submarine sighted just minutes before, surfaced off the coast of the Austrian naval base at Cattaro (now Kotor in Yugoslavia) in the southern Adriatic. (Ref. 1: p. 3)

After approximately 40 minutes of search the planes sighted the French submarine FOUCAULT, which they bombed and sank. Miraculously, the entire crew of the FOUCAULT was saved. Since this birth of Aviation AntiSubmarine Warfare both the submarine and the aircraft used in Antisubmarine Warfare (ASW) have become more technically advanced than ever perceived during the times of this first kill. The submarines of today rely on their stealth, silence and quickness to sneak into enemy convoys and battle groups to sink shipping and wreak havock among the sometimes unsuspecting cargo ships and surface combatants.

It is the job of the P3C ASW aircraft to seek out and destroy enemy submarines while they are still many miles from U.S. and Allied shipping. And it is the Anti-Submarine Warfare Operators (AW's) who operate and ananlyze the information from the sensing devices used to detect these enemy submarines.

2. History of Patrol Squadron 31

Patrol Squadron Thirty-One (VP-31) is the Fleet Readiness Squadron (FRS) that has provided much of the necessary training for the aviation personnel in the Patrol (VP) Navy on the west coast since 1960. Training is provided for officer and enlisted flight crew as well as maintenance/ground crew personnel. (Ref. 2)

A detachment of Fleet Aviation Specialized Operational Training Group, Pacific (FASOTRAGRUPAC or FASO) has worked hand in hand to train the tactical crew members of the P3C aircrew since 1963. These crew members are the officers and the enlisted personnel of the Anti-Submarine Warfare Operators (AW) Rating. The AW's are divided into two groups, these being the acoustic operators, who operate and analyze the presentations of the installed acoustic analysis equipment, and the nonacoustic operators, who operate and analyze the presentations of the nonacoustic sensors which include the RADAR, Electronic Sensor Measures (ESM) and Magnetic Anomaly Detection (MAD) equipment.

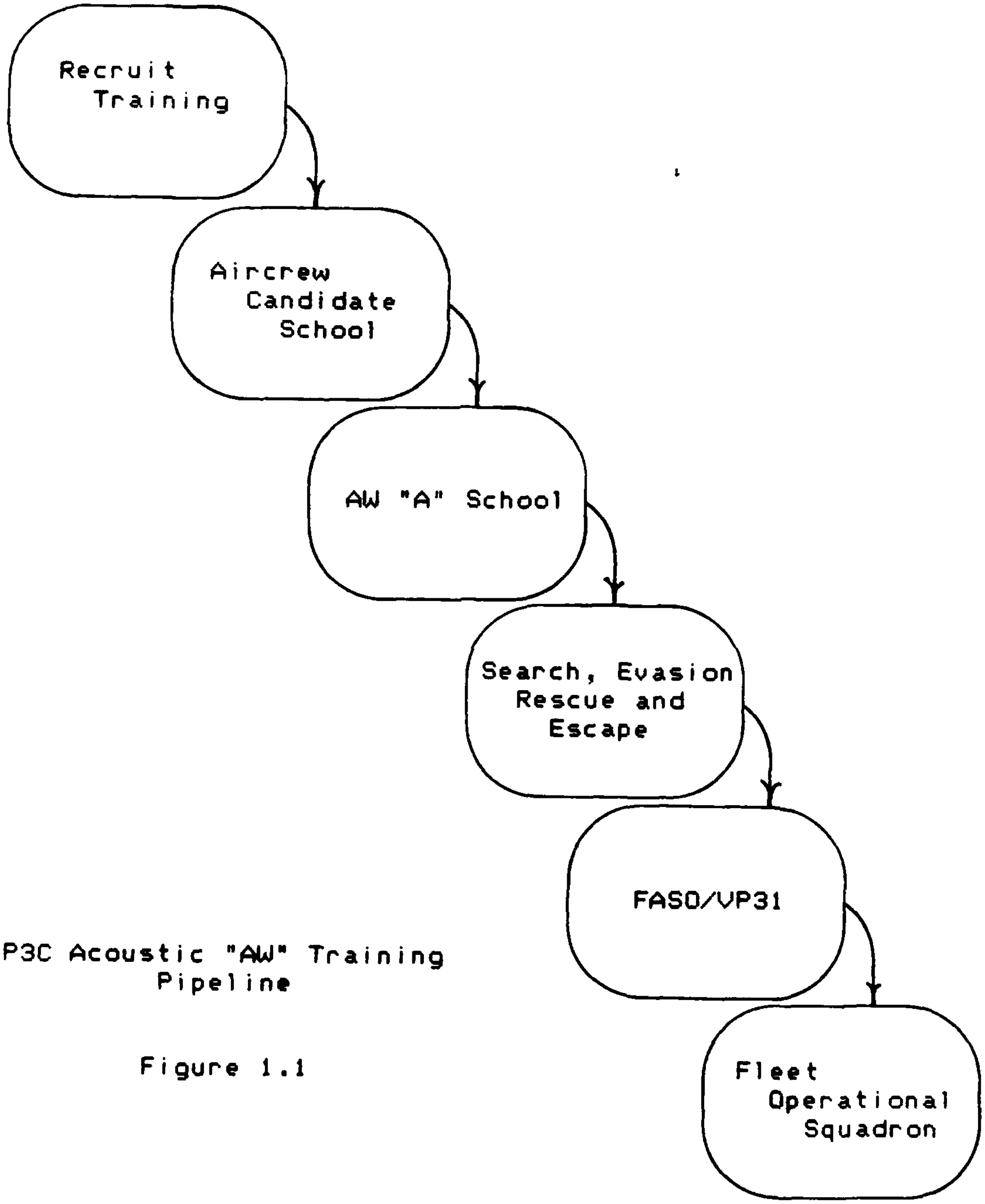
3. Training of AW Acoustic Operators

All enlisted personnel in the U.S. Navy start their careers with recruit training. Recruit training is currently nine weeks. During this nine weeks the recruit will be provided with the training necessary to make a smooth transition from civilian to military life. The instruction he receives includes training in basic seamanship, small arms training and numerous military subjects designed to adapt the recruit to the military environment. This training also prepares him for the follow-on training he may receive in his selected rating.

Either before or during recruit training, the specialties, or ratings, of the recruits are determined. This selection is based upon the needs of the Navy and the contractual agreements made upon recruitment. Those selected for the AW rating are sent to a series of schools which are depicted in Figure 1.1.

After recruit training the AW selectees join other aircrew destined personnel and are sent to NAS Pensacola, Florida for Aircrew Candidate School. Aircrew Candidate School is a two week course of instruction which provides the aircrew selectees with the skills and knowledge necessary for service as an aviation aircrewman. This training is applicable to all enlisted personnel who will be assigned duty as an aircrewman and is not specifically designed to provide training for any one aircraft type or mission.

Following Aircrew Candidate School, the AW selectee is sent to AW "A" School. This is an 11 week course of



P3C Acoustic "AW" Training Pipeline

Figure 1.1

instruction designed to introduce the enlisted man to the AW rating. During this period the student is schooled in basic oceanography, physics of sound, SONAR (SOund Navigation And Ranging) principles, basic acoustic intelligence and sound source identification techniques. Some lofargram analysis is also taught but emphasis is on frequency recognition rather than source identification. A lofargram is a common type of frequency presentation display normally used in acoustic analysis equipment. Lofar display presentations of some of the various sound sources (eg. screw/blade cavitation, diesel and nuclear propulsion plants and associated auxillaries) are also introduced. During this time the use of static linear grams are used. A static linear gram is the paper printout of the lofargram presentation. These are examples of the presentation of actual submarine sounds in lofargram form.

In addition to acoustic training, the students are introduced to nonacoustic methods of submarine detection. These include Electronic Sensor Measures (ESM) and Magnetic Anomaly Detection (MAD). Upon successful completion of AW "A" School the enlisted man has then earned classification as a "Designated Striker" in the AW rating. A designated striker is a member of the rating who has not reached the rate of Petty Officer Third Class.

Those AW's destined for an assignment to an operational Patrol Squadrons are then sent to Warner

Springs, California for SERE (Search, Evasion, Rescue and Escape) training. This one week course provides the student with an introduction of what he can expect if he finds himself downed in his aircraft behind enemy lines.

After successful completion of SERE training, the student is then transferred to NAS Moffett Field, Ca where he enters the Acoustic Operator Course at Patrol Squadron Thirty One (VP-31). This sixteen week course prepares the individual for specific duties as an acoustic operator on a P-3C ASW aircraft.

The Acoustic Operator Course includes the course E-210-0042 Difar Operator Course which is taught by by FASOTRAGRUPAC DET MOFFETT, more commonly known as FASO. The subjects in this 48 day course include a review of mathematics, acoustic analysis, nuclear and diesel submarine signatures, surface fleet signatures and basic acoustic tactics.

The acoustic analysis portion includes lofar gram analysis. It is in this course that sound source identification is stressed. The students are expected to learn to identify not only whether the contact gained is a surface or subsurface unit, but more specifically, which type of surface or subsurface unit is emitting the sounds being detected. The student should also learn how to determine other tactical data, based solely on the presentation of the detected sounds by the onboard acoustic equipment. This tactical data includes target speed, depth, course and bouy to contact closest point of approach (CPA). Additional acoustic tactical data is also required for proper tactical ASW pursuit and the acoustic AW also learns to provide this as needed by the tactical crew.

4. Disparity

Of great importance to the mission of the P3C is its ability to detect and classify sound sources being produced by enemy submarines. As previously mentioned, it is the job of the Acoustic AW to operate his acoustic analysis equipment and to correctly identify the origin of the sounds being produced and detected in the ocean.

An apparent disparity seems to exist between the equipment's capability to present target information and the equipment operator's ability to proficiently operate that equipment and to correctly analyze the information being presented. The existence of this disparity has long been perceived by individuals who evaluate operators after training sessions and actual onstation missions. (Ref 2) (Ref. 3) It appears as though many of the acoustic operators fail to operate their equipment to its fullest capability and thereby do not perform to the levels necessary to attain the desired results of detection and proper interpretation of acoustic signals.

B. OBJECTIVES

The purpose of this thesis is not to help establish whether this disparity actually exists, but to determine if the requirements for operation of the acoustic analysis equipment now installed aboard a P-3C aircraft are too complex for the acoustic operators with the current amount of training.

To attain these objectives, the author must first determine if the training pipeline provides the student AW with the knowledge and skills necessary to utilize the equipment in every mode and submode for which it was designed.

C. RESEARCH METHODOLOGY

The data used in this analysis consisted of the results of a testing procedure involving 8 students graduating from the Acoustic Operator course of study from VP-31.

This testing procedure involves a specially designed scenario that is administered to the students on the 14B44 Acoustic Trainer. This scenario is specifically designed to test for all of the skills and knowledge required by the acoustic operator in the performance of his duties during the passive portion of the prosecution of a target. The 14B44 Acoustic Trainer is a duplication of the onboard acoustic equipment which is found in a P-3C aircraft. This equipment includes the AQA-7 Lofargram Equipment, AQH-4 Tape

Recorder, ICS control box and various other control panels and boxes that are required as a part of the acoustic suite.

Sample mean, together with standard deviation will be calculated for the criterian-referenced test which is to be administered to the eight students completing the FRS training pipeline. In addition, item analysis will be performed from a qualitative perspective.

D. ORGANIZATION OF STUDY

This study is organized in 6 chapters. Chapter I is provided as an introduction and a broad overview with specifics being considered in the following chapters. Chapter II presents a review of literature dealing with the topic of this study and other related topics either currently under consideration or studies that are related and have been done in the past. Chapter III deals specifically with the methodology and organization of this study. It deals in detail with the unclassified specifics of this study including what assumptions were made and why, selection of subjects, development of the scenario and scoring procedures. Chapter IV presents the data resulting from the administered scenario. Chapter V provides an analysis of this data. Chapter VI discusses the results of the study and lists the conclusions drawn by the author. This chapter also provides recommendations for future research and recommends possible changes to the training currently being provided. The appendix provides a list of acronyms used throughout this study.

II. REVIEW OF LITERATURE

A. INTRODUCTION

The U.S. Navy has long insisted on the proper training of personnel. At the same time, the Navy has endeavored to ensure the highest standards of instruction are available to trainees. This chapter reviews some of the research done by the Navy in an attempt to find areas of instruction relating to aviation acoustic operators that could be improved.

B. STUDIES BY NPRDC

The Navy Personnel Research and Development Center (NPRDC) San Diego has conducted numerous studies of acoustic operators and the instruction they receive.

In a study reported in March 1983 (NPRDC SR 83-18), the authors (Wetzel and Montague) did a comparative analysis of three Navy communities - aviation, subsurface and surface. The purpose of this study was to identify conditions leading to skill loss in the Navy's three sonar communities, compare conditions across the three communities and, based on the results, predict whether or not skill deterioration was likely to occur. This study concluded that aviation antisubmarine warfare operators on S-3A and P-3 platforms maintain their required knowledge and skills at relatively high levels because of:

> High levels of initial training, frequent practice with individual feedback, and low periods of task nonutilization. (Ref.4: p. vii)

The study concluded that the aviation community faired better in these areas than both the submarine and surface communities.

In a study reported in Sept 1983 (NPRDC SR 83-53), the authors (Wetzel, Konoske and Montague) evaluated the instructional methods used in the training syllabus for the S-3 AW's which focused on the AW Common Core Acoustic Analysis Course that is taught by Fleet Aviation Specialized Operational Training Group, Pacific (FASOTRAGRUPAC), Naval Air Station, North Island, San Diego. It is in this course that the AW's acquire the knowledge and training necessary to perform duties as Acoustic Operators in the S-3 aircraft. Even though this study focus' on the VS vice VP community, a related course is being taught by a detachment of FASOTRAGRUPAC at NAS Moffett Field, CA for the AW's of the VP community. Identical standards and requirements are used as guidance for instruction by both the detachment and the home unit. (Ref. 2)

This study noted a number of deficiencies in course organization, diagnostic feedback and testing methods. Of specific interest, the course did not explicitly provide the student with a thorough understanding of the relationship between sound that was detected and its appearance on a lofargram. A lack of conceptual understanding was noted. Finally, testing methods being used did not require the student to demonstrate conceptual understanding of the material. Instead, the use of rote memorization was being used by students. (Ref. 5: p. 12)

In a study reported in November 1983 (NPRDC SR 84-7), the authors (Wetzel, Konoske and Montague) investigated the result of critical rating skills being taught early in the training pipeline with little, or inadequate opportunity for, practice during the follow-on schools. This study pointed specifically at the training pipeline for AW's destined for the VS community, but clear similarities exist for the VP Acoustic AW Pipeline. (Ref. 2)

The authors identified time segments where practice was not being received for skills already learned. A reorganization in the sequence of subject matter was then recommended. This reorganization would provide for a shorter time duration between skill acquisition and skill useage. However, it was noted that in some cases a reorganization was not possible. Those cases include the time segments where the students are transferred between schools and from school to the operational squadron.

An additional recommendation was that skills acquired early in the pipeline be adequately maintained with continued practice. The authors went on to say that proper skill maintenance could be acquired by reviewing the amount and quality of practice the students receive, reinforced with proper feedback and review after the practice sessions. (Ref. 6: p. viii)

Two additional studies carried the subject of skill degradation further by assessing the loss of skills related to job and training variables and the loss of skills related to the amount of time which had elapsed since training. These are discussed separately.

In the first of these two studies (NPRDC SR 83-28), the authors (Konoske, Wetzel and Montague) identify job conditions that are associated with skill and knowledge degradation in AW's. This was done using a questionnaire they developed.

The results of this study indicated the developed questionaire could be used to accurately predict good performance as well as bad. In addition, it showed that the AW community is characterized by "mastery level initial training, frequent task practice, individual feedback, and short periods of task nonutilization." (Ref. 7: p. vii) The authors further concluded that results of the questionnaire may be used to suggest corrective action.

In the second of the two studies (NPRDC SR 83-31), the authors (Konoske, Wetzel and Montague) wanted to determine if AW's can retain the skills and knowledge learned during one phase of training over a 25 day nonutilization period while waiting for a second phase. Again this study was done with the S-3 community AW. Their approach was to administer the final exam from the course just prior to a 25 day nonutilization period, to the same students after the 25 day period with no practice or use of learned skills. The conclusion was that:

> Knowledge factors, computational skills, and gram analysis procedures of students in the S-3A acoustic analyst training pipeline degraded significantly. (Ref. 8: p. vii)

This substantiates the importance for members of this rating to obtain ongoing sequential training throughout their entire training pipeline. It can also be seen that adequate review and refresher training should be provided after long periods where skills that were previously learned were not being practiced or used.

Another study done by NPRDC (NPRDC SR 85-16), the authors (Wetzel, Smith and Konoke) look at the differences between training and actual onstation requirements. More specifically, this study points to the acoustic training being received is for single contacts presented on lofargrams and the existing requirement of multicontact environments using more complex multiple display modes. The purpose of this study was to:

1. identify the need for an advanced course of instruction in acoustic analysis, and
2. develop a common-core course to train AW's to operate in multicontact acoustic environments. (Ref. 9: p. vii)

C. SUMMATION

There have been numerous studies done by the Naval Personnel Research and Development Center relating to AW's and the training they receive. However, most of these studies address AW's who will be assigned to operational squadrons in the VS community. As already mentioned above, there are strong similarities in the training and the operational requirements of AW's in the VS and VP communities. The dissimilarities that do exist consist of the aircraft being flown and the lack of two acoustic operators in the VS community Much of the acoustic analysis equipment used in the VS community is similar (and in many cases identical) to that used in the VP community. Therefore the results obtained in these studies can also be relative when doing research with AW's of the VP community.

III. RESEARCH METHODOLOGY

A. EQUIPMENT

The equipment used in this study is the 14B44 Acoustic Trainer. These particular trainers are located in Hanger 1 at NAS Moffett Field and are used by both FRS students and fleet personnel. The 14B44 Acoustic Trainer is nearly identical in layout and design to the acoustic operator station onboard the P3C aircraft. In addition, the 14B44 trainer contains nearly all of the equipment found aboard the P3C. This equipment includes the AQA-7 Lofargram Equipment, AQH-4 Tape Recorder, ICS control box and various other control panels and boxes that are required as a part of the acoustic suite.

B. RESEARCH SUBJECTS

The participants in this study were selected on the basis of being students in the latter days of their final week of their training in the FRS environment. In addition, they will be assigned to squadrons having aircraft fitted with the same type and model of analysis equipment used in this study. It was originally intended that two classes of graduating acoustic AW's would be included in this study.

The demographic data for the 8 participants is similar and is shown in Table 3-1. Of note, the Armed Services

Vocational Aptitude Battery (ASVAB) scores were not considered. A study done by Lt Debra Gonzales (Ref. 10) showed that there is no significant correlation between ASVAB scores and student success in the AW training pipeline.

C. PROCEDURE

This study entails a specially designed scenario that is administered to students on the 14B44 Acoustic Trainer. This scenario is specifically designed to test for all the skills and knowledge required by the acoustic operator in the performance of his duties.

In addition to the development and standardization of an acceptable testing scenario, the specific definitions of Operator Capability and Equipment Cability needed to be considered. The following definitions were formulated:

- Equipment Capability - The capability of the equipment to display frequencies at their respective minimal discernible levels given optimal mode selection as defined by the manufacturer.

- Operator Capability - The capability of the operator to both 1) select the proper mode of operation for the equipment to display the frequency/frequencies of interest at their minimum discernible levels and 2) to properly classify the source of the information being presented by the equipment.

Equipment capability can be readily and specifically identified by means of equipment specifications which are

TABLE 3.1

DEMOGRAPHIC DATA

student	1	2	3	4	5	6	7	8
Age:	19	19	20	22	24	21	20	19
Marital Status:	S	S	M	M	S	S	S	M
Rate:	AR	AA	AN	AN	AA	AN	AR	AA
Years of Civ. Educ:	12	10	13	12	12	12	12	12

S = Single

M = Married

AR = Airman Recruit (E-1)

AA = Airman Apprentice (E-2)

AN = Airman (E-3)

published in the operations manual for each of the respective pieces of equipment.

The problem of accurately measuring operator capability was not easy. Certain assumptions were required in order to arrive at a viable and acceptable measure of Maximum Operator Capability. It was determined that the use of experienced fleet operators would be necessary in order to determine actual Maximum Operator Capability. Debrief personnel, those individuals who provide postflight analysis and mission debrief, were polled to determine who were the best, most capable, experienced and imaginative acoustic operators at the Naval Air Station Moffett Field. The result of the poll resulted in the selection of four personnel. These four personnel were administered the scenario and the best of their scores was assumed to be the absolute maximum that can be expected of experienced, fully qualified fleet acoustic operators. That top score was then used as the basis for the scoring of scenarios that were administered to the test group.

Once the above terms were defined and accepted and the methods of determining the scoring base were defined, every effort was then made to insure that every variable was removed from the actual test scenario with the exception of the individual operator capability.

In an effort to ensure standardization was maintained throughout each event, the following guidelines were followed:

- The same instructor administered each of the scenario events.
- An identical brief was administered to each of the subjects prior to the event. Questions were answered but no information was provided to any subject that would have provided an advantage.
- Subjects were disqualified or rescheduled if they were found to be tired, sick or not considered to be physically prepared in any way.
- The scenario was started in an identical manner in each experiment event. The scenario did not commence until all subjects declared they were ready to begin.
- The scenario was predetermined and preprogrammed into the training device. Once started, all sonobuoy drops, all sonobuoy types, sonobuoy channels and movements by all contacts were identical.
- Identical voice cues were given by the instructor at specific, predetermined times in an effort to duplicate Tactical Coordinator (TACCO) cues. These are normally given throughout an ASW event and consist of notification of what additional sonobuoys the operator can monitor to track the TOI.
- The same instructor graded each of the scenario events. After completion, scenarios were then regraded to ensure there were no deviations from the published grading standards.

The actual specifics of the scenario will not be discussed as their classification goes beyond that of this document. However, all required knowledge of the scenario results can be provided at this UNCLASSIFIED level.

IV. DATA

A. OVERVIEW

As previously mentioned, the data in this study consists of the results of an administered test scenario. This test scenario was specifically designed to test actual operator capability and utilization of the installed acoustic sensor station equipment aboard a P3C aircraft.

There were eight test subjects participating in this study. These participants were selected on the basis of being students in the latter days of their final week of training in the FRS environment. This is also the final formal schooling that the AW's will receive prior to being assigned to an operational VP squadron.

B. SCENARIO GRADING

The scenario grading was based upon actual operator requirements to properly utilize the acoustic analysis equipment and to recognize and provide target information based solely on their utilization of that equipment. These requirements include the proper use of certain equipment modes, submodes and features of the installed equipment, the ability to recognize target information versus non-target information, the ability to classify this information as Target of Interest (TOI) in a timely manner and the ability to obtain information needed for the tactical prosecution once they have recognized the target. Information needed for tactical prosecution of the target includes the recognization of target to sonobuoy Closest Point of Approach (CPA), obtaining the base frequency (Fo), used for tracking the target, and target course, speed and depth calculations at various times throughout the entire testing event.

Scoring of the event was based an existing scoring schedule that is currently in use for events on the 14B44 trainer. The maximum points that can be attained using this grading schedule is 295.

However, this grading schedule had to be adjusted. The reason for the adjustment is to determine the actual maximum operator capability. The method used for this was to test highly qualified fleet operators. The best of their scores was then assumed to be the maximum that can be expected from the operator when utilizing the acoustic analysis equipment in the performance of his duties as an acoustic operator. The four experienced fleet operators had scores of 295, 295, 290 and 285. The best of their scores is 295.

A final score percentage can now be determined using the best of the fleet operators as the new scoringbase. As an example, suppose the students score of 185 pts would result in a final score percentage of 185 / 295 = .62712 which equals 62.925%. This method of scoring was used in the adjustment of all student scores.

C. GRADING CRITERIA

Total operator requirements/responsibilities were broken down into 4 areas. These areas are:

1. Sonobuoy Management - selection and/or selection timing of available sonobuoys used for the tracking of the target of interest (TOI).

2. System/Equipment Utilization - proper selection and use of equipment modes, submodes and features so as to provide the operator with the ability to acquire the proper tactical data for the then current tactical situation.

3. Analyzation of Available Information - proper analyzation of all available data to properly classify the contact as TOI, derive tactical information such as target speed, target course, target depth, CPA's and Fo.

4. Timeliness - timely extraction of tactical information and data so as to provide the tactical crew with current, vice time late, information.

Score reductions in each of the above areas were made at the discretion of the grader but are consistent with current scoring procedures in use for events on the 14B44 trainer.

Extensive discussions (Ref. 11) pursued a valid or acceptable final scenario grade for those graduating out of the FRS environment. It is the goal of VP-31/FASO to graduate "Lower Level Intermediate Analysts. Typically a fleet experienced analyst will score in the 80% range on this type of scenario. Conditional qualification requires a score of 2.5 on a 4.0 scale. This equates to a score of 50 on this type of scenario. Therefore a score of 50% was accepted as a valid passing score for the purposes of this study. Mastery level analyst capabilities are then developed in the operational squadron.

D. GRADING RESULTS

Tables 4.1 through 4.8 contain the results of the scenario grading for participants 1 through 8 respectively. Of note, it was felt by the scenario administrator/grader that all 8 students were significantly behind during the entire event. So far behind, in fact, that he felt it would seriously impair proper tactical crew coordination and tactical prosecution of the TOI. He therefore reduced the scores of all these participants by an initial 20%. Further deductions due to additional errors are reflected in the following figures.

Further data of a historical nature can be found in Tables 4.9 and 4.10. Table 4.9 contains the grades earned by the students during their training in "A" School. These grades are broken down by subject matter. Table 4.10 contains the grades earned by the students during the analyzation phase of the FRS training. This analyzation phase also includes equipment utilization.

TABLE 4.1

OPERATOR 1 RESULTS

Total Deductions	Area
-7	Sonobuoy Management
	-2 Failed to monitor all sonobuoys
	-5 Tuned out sonobuoys prior to target passage
-22	System Equipment Utilization
	-10 Failed to properly select frequency band width
	-7 Failed to select proper modes/submodes
	-5 Inappropriate selection of frequencies and sonobuoys
-18	Analyzation of Available Data
	-15 Failed to recognize 3 CPA's
	-2 Failed to calculate Target Data
	-1 Failed to consider aural cues
-0	Timeliness

Total Deductions = 47

Grade = 64.067 %

TABLE 4.2

OPERATOR 2 RESULTS

Total Deductions	Area
-0	Sonobuoy Management
-27	System Equipment Utilization
	-10 Failed to properly select frequency bandwidth
	-7 Failed to select proper modes/submodes
	-5 Inappropriate initial search mode
	-5 Tracked wrong target for 3 minutes
-40	Analyzation of Available Data
	-5 Initial misclassification of TOI
	-15 Failed to recognize 5 CPA's
	-20 Failed to calculate Fo
-20	Timliness
	-20 Failed to classify as TOI within time specified IAW grading criteria

Total Deductions = 87

Grade = 50.508 %

TABLE 4.3

OPERATOR 3 RESULTS

Total Deductions	Area
-2	Sonobuoy Management
	-2 Failed to monitor all sonobuoys
-19	System Equipment Utilization
	-10 Failed to properly select frequency bandwidth
	-7 Failed to select proper modes/submodes
	-2 Inappropriate initial search mode
-40	Analyzation of Available Data
	-15 Failed to recognize 5 CPA's
	-4 Failed to calculate target data
	-20 Failed to calculate Fo
	-1 Failed to consider aural cues
-20	Timeliness
	-20 Failed to classify as TOI within time specified IAW grading criteria

Total Deductions = 81

Grade = 52.542 %

TABLE 4.4

OPERATOR 4 RESULTS

Total Deductions	Area
-0	Sonobuoy Management
-22	System Equipment Utilization
	-10 Failed to properly select frequency bandwidth
	-12 Failed to select proper modes/submodes
-93	Analyzation of Available Data
	-25 Failed to recognize 8 CPA's
	-25 Failed to track correct target for initial 15 minutes of event
	-20 Failed to calculate Fo
	-22 Failed to calculate target data
	-1 Failed to consider aural cues
-15	Timeliness
	-15 Failed to classify as TOI within time specified IAW grading criteria

Total Deductions = 130

Grade = 35.932 %

TABLE 4.5

OPERATOR 5 RESULTS

Total Deductions	Area
-2	Sonobuoy Management
	-2 Failed to monitor all sonobuoys
-17	System Equipment Utilization
	-10 Failed to properly select frequency bandwidth
	-7 Failed to select proper modes/submodes
-21	Analyzation of Available Data
	-20 Failed to calculate Fo
	-1 Failed to consider aural cues
-0	Timeliness

Total Deductions = 40

Grade = 66.441 %

TABLE 4.6

OPERATOR 6 RESULTS

Total Deductiona	Area
-2	Sonobuoy Management
	-2 Failed to monitor all sonobuoys
-32	System Equipment Utilization
	-10 Failed to properly select frequency bandwidth
	-22 Failed to select proper modes/submodes
-42	Analyzation of Available Data
	-15 Failed to recognize 4 CPA's
	-20 Failed to calculate Fo
	-6 Incorrect calculations of target data
	-1 Failed to consider aural cues
-0	Timeliness

Total Deductions = 76

Grade = 54.237 %

TABLE 4.7

OPERATOR 7 RESULTS

Total Deductions	Area
-2	Sonobuoy Management
	-2 Failed to monitor all sonobuoys
-42	System Equipment Utilization
	-10 Failed to properly select frequency bandwidth
	-22 Failed to select proper modes/submodes
	-10 Inappropriate initial search mode
-1	Analyzation of Available Data
	-1 Failed to consider aural cues
-20	Timeliness
	-20 Failed to classify as TOI within time specified IAW grading criteria

Total Deductions = 65

Grade = 57.966 %

TABLE 4.8

OPERATOR 8 RESULTS

Total Deductions	Area
-2	Sonobuoy Management
	-2 Failed to monitor all sonobuoys
-17	System Equipment Utilization
	-10 Failed to properly select frequency bandwidth
	-7 Failed to select proper modes/submodes
-48	Analyzation of Available Data
	-15 Failed to recognize 5 CPA's
	-10 Classified a nonexistant target
	-22 Failed to calculate target data
	-1 Failed to consider aural cues
-20	Timeliness
	-20 Failed to classify as TOI within time specified IAW grading criteria

Total Deductions = 87

Grade = 50.508 %

TABLE 4.9

"A" SCHOOL GRADE DATA

student	1	2	3	4	5	6	7	8
Subj:								
Math	63	81	90	63	90	67	87	90
General AW Knowledge	75	86	93	73	93	77	85	93
Navigation	80	82	89	79	87	71	86	85
Radar	86	86	92	84	87	77	86	86
ESM	86	88	92	85	89	77	87	87
MAD	88	89	92	86	91	80	88	89
Oceanography	87	87	93	84	89	82	84	86
Analysis-1	87	87	94	84	87	82	84	87
Analysis-2	88	87	94	84	88	82	82	86
Analysis-3	90	88	94	80	89	83	83	87
Analysis-4	81	87	93	85	90	82	84	89
Sonar Principles	82	88	93	85	90	82	84	89
Tactics	82	88	93	85	91	82	85	90
Final Comp	82	88	91	86	90	82	85	89

TABLE 4.10

ANALYSIS PHASE GRADES

student	1	2	3	4	5	6	7	8
Subj:								
Equipment Operation	83	92	88	80	100	83	92	85
Principles Of Lofar	86	92	90	80	92	84	90	88
Diesel Submarine Signatures	98	88	100	92	98	90	100	82
Nuclear Submarine Signatures	88	86	94	88	98	78	96	94
Mixed (Diesel & Nuclear)	97	89	84	82	69	81	89	79
Tactics	97	82	87	89	85	80	100	95
Final Comp	84	94	89	84	97	80	93	85

V. DATA ANALYSIS

A. OVERVIEW

The primary purpose of this thesis is to determine if the requirements for operation of the acoustic analysis equipment now installed aboard P-3C aircraft is too complex for the acoustic operators given their current amount of training.

To attain this objective, this study focused on the training received by the acoustic operators throughout the entire training pipeline. It could then be established whether the students graduating from the acoustic operator course at VP-31/FASO are acquiring an acceptable level of operator capability as determined by the criteria previously described in Chapter IV.

To test every graduating student from this course for the purpose of this thesis would have been impossible. Eight graduating students were selected and were administered the previously described test scenario. The data to be analyzed consists of the graded results of this testing procedure.

B. ASSUMPTIONS

In order to properly analyze this data the assumption was made that the population from which the sample was taken conforms to a Normal Distribution. However, recommended future longitudinal studies will determine the accuracy of this assumption.

C. ANALYSIS

The Sample Mean and Sample Standard Deviation were calculated. With all values considered, the Sample Mean equals 54.025 and the Sample Standard Deviation equals 9.448.

An assumption of a population with a Normal Distribution was made.

Since the passing criteria for operator capability was set at 50%, we can see that seven of the eight tested met or exceeded that requirement, leaving one of the eight as having not met the minimum acceptable score.

In two cases, the scores were between 1.5 and 2 standard deviations above the minimum acceptable score, with the highest score being 1.3 standard deviations above the sample mean. At the same time, the lowest score was 1.9 standard deviations below the sample mean. This raises questions as to the possibility of that score being an outliner.

The exclusion of the possible outliner would raise the Sample Mean from 54.025 to 56.61 and reduce the Sample Standard Deviation from 9.448 to 7.042. Although these differences in values are noteworthy, the author accepts that score as being valid after plotting all scores on a histogram (Figure 5.1) further suggesting this sample as having direct tendencies toward a Normal Distribution.

There will be, as in the case of this sample, certain individuals who successfully completed the prescribed course of instruction but who failed to achieve an acceptable score on the administered test scenario. This can be the result of numerous conditions. The student may not have been physically or emotionally prepared for the scenario. The student could have been expecting something other than what he actually received. Or, as in this case, based on an initial mistake, the student misclassified the primary target resulting in numerous additional errors, compounding his difficulties, and lowering of his score. In any case, these occurrences are to be expected just as it can be expected that some students will do remarkably well when administered the test scenario.

Given the above analysis with a population mean of between 46.25 and 61.925 and an obtained sample mean of 54.025, the data seemed to suggest that students graduating from the acoustic operator course at VP-31/FASO are acquiring an acceptable level of operator capability based on the previously defined criteria.

In addition to the above statistical analysis, the grading of the individual scenarios resulted in several errors common to many of those tested. These errors can be broken down into two areas; equipment utilization and lofargram interpretation.

The equipment utilization errors that were made by the students include:

1) Failure to monitor all sonobuoys (7 of 8)

2) Failure to properly select frequency bandwidth (8 of 8)

3) Failure to select proper equipment modes/submodes (8 of 8)

The equipment utilization errors that were made by the students include:

1) Failure to recognize CPA's (6 of 8)

2) Failure to calculate Target Data (5 of 8)

3) Failure to consider aural cues (6 of 8)

The instructor that administered the test scenarios conducted an oral interview with each student after the examination. The instructor determined that the errors were the result of not knowing when to apply acquired skills or knowledge rather than a knowledge and skills deficiency. These types of errors are a direct result of a lack of experience and will reduce in frequency with an increase in experience levels for these FRS students.

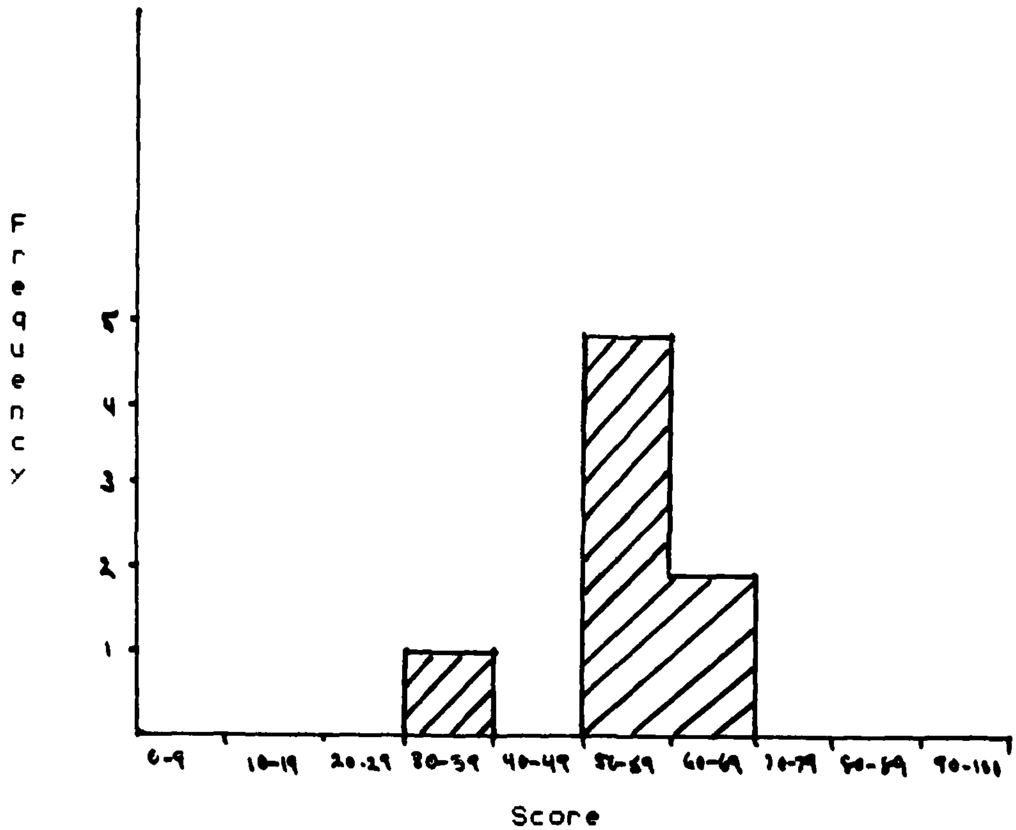


Figure 5.1 Test Scenario Results

VI. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

As previously stated, the goal of this thesis was to determine if the requirements for operation of the acoustic analysis equipment now installed aboard P-3C aircraft is too complex for the acoustic operators given their current amount of training.

The problem of whether the equipment is too complex for operators to operate was divided into two segments. The first segment, and within the scope of this study, was the problem which involves the education received by the AW's in their training pipeline. The final portion of this classroom education is received while attending the acoustic operator course at VP-31/FASO. In this thesis, the statistical analysis seems to suggest that the students graduating from the acoustic operator course at VP-31/FASO are acquiring an acceptable level of operator capability based on previously defined criteria in Chapter IV.

The second segment of this problem deals with the training received by the AW's after their assignment to an operational VP squadron. This study has developed information about operator capability throughout the training pipeline and operator capability for those who are recognized in fleet squadrons as master journeyman. The results of this study suggests that operators in these two extreme groups appear to be operating their ASW acoustic processing equipment to its fullest capability and without apparent operator deficiences. However, there is little or no information on those operators who fall between these two extremes. The defined scope of this study, by design, did not include this middle experience area of acoustic operators. Therefore, it is important that additional study concerning operator capability versus equipment capability address the middle experience group.

B. RECOMMENDATIONS FOR FUTURE RESEARCH

In addition to the recommended research in training received by the AW's in their operational squadron, there are additional areas of research that are recommended.

As previously mentioned, the test scenario used in this study was administered to only eight students. To provide a more accurate and concrete database, it is recommended that this scenario be administered to members of future groups of acoustic operators graduating from the acoustic operator course at VP-31/FASO. This will provide a more thorough longitudinal study not available through research with a limited time constraint as in this thesis.

An additional area of possible research is the validity of an acceptable score of 50% on the test scenario. Although this score was reached after extensive discussions with senior acoustic instructors, additional research may provide data which would add to the credibility of this established benchmark.

A third area of possible research involves the validity of any test scenario used to determine actual maximum operator capability. While the test scenario used in this thesis tested the operator for his ability to manipulate the equipment correctly for every passive function for which the equipment was designed. additional research is recommended to determine if the operator is more capable than the equipment.

A final area of suggested research involves the active functional capabilities of the equipment. The test scenario used in this study tested only the passive capabilities of the equipment. As previously mentioned, this was done intentionally due to the teamwork required by both acoustic operators during the active phases of a tactical scenario. Since this could not be accommodated in this study, it is recommended that additional research involving teams of acoustic operators be conducted to determine whether the active portions of the equipment are too complex for the operators given their current amount of training.

APPENDIX

GLOSSARY

AA	Airman Apprentice (E-2)
AN	Airman (E-3)
AR	Airman Recruit (E-1)
"A" School	The initial technical training school in a Navy Rating.
ASW	Antisubmarine Warfare
AW	The "Antisubmarine Warfare Operator" rating
CPA	Closest Point of Approach
ESM	Electronic Sensor Measures
FASOTRAGRUPAC (FASO)	Fleet Aviation Specialized Operational Training Group Pacific
FRS	Fleet Readiness Squadron
MAD	Magnetic Anomaly Detection
NPRDC	Navy Personnel Research and Development Center, San Diego, California
SERE	Search, Evasion, Rescue and Escape
SONAR	Sound Navigation And Ranging
VP	Patrol squadron (PATRON)
VS	Fixed-wing antisubmarine aircraft squadron

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