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DEMONSTRATION OF A METHODOLOGY FOR CLASSIFYING NAVAL TRAINING C--ETC(U)
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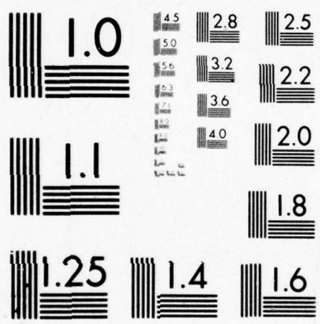

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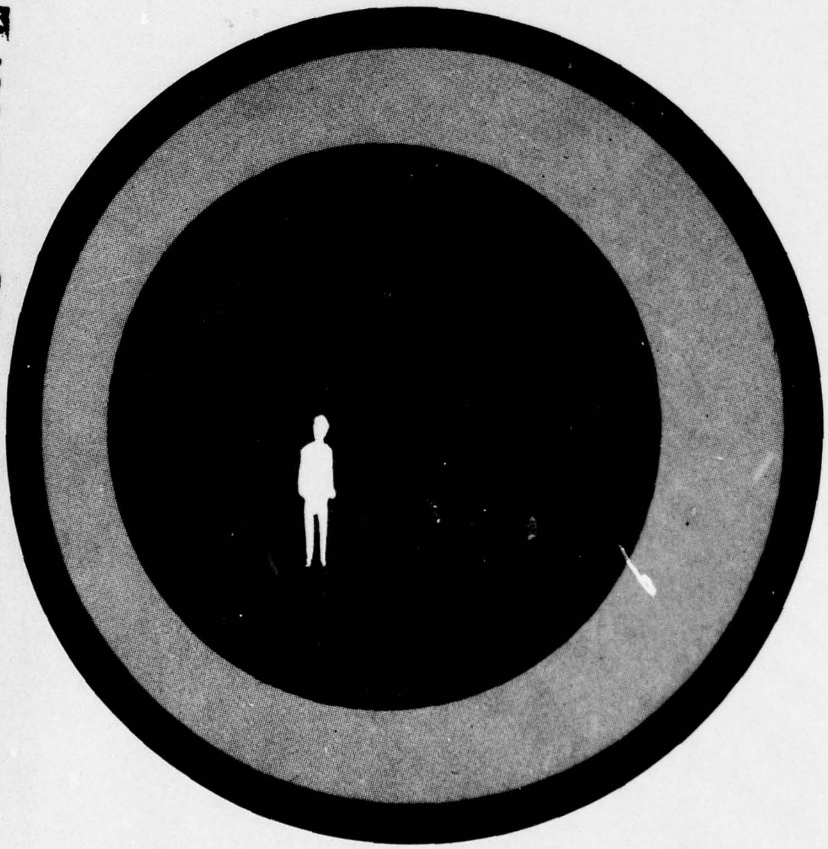

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(6) # DEMONSTRATION OF A METHODOLOGY FOR CLASSIFYING NAVAL TRAINING COURSES,

(10) William C./Rankin
Eugene R./Hall

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ALFRED F. SMODE, Ph.D., Director,
Training Analysis and Evaluation Group

F. WORTH SCANLAND, Ph.D.
Assistant Chief of Staff for
Research and Program Development,
Chief of Naval Education and Training

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Navy enlisted technical training courses (numbering in the thousands) are grouped into two broad categories--"A" and "C" courses. The apparent basis for these categories lies in the purpose for which the courses are conducted: "A" courses typically are designed to teach occupationally oriented, entry level skills and knowledge to first-term enlistees; "C" courses are designed to teach advanced or system-specific knowledge and skills. The courses within the "A" and "C" categories vary on many each → over

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered) dimensions; e.g., length, cost, kinds of skills trained, annual input of trainees. These differences preclude any but the broadest of generalizations about the training courses within these categories.

The problem addressed in this study concerned ways of determining homogeneous subgroups of courses within the "A" and "C" distinction. Groups of courses that are homogeneous in terms of a common set of variables permit more specific generalizations or inferences to be made about them. An obvious example would be a group of courses that had similar profiles of resource consumption over a common set of resource variables. This type of course grouping would provide a sound basis for inferences about group members and also about new courses that were similar to the group.

This study demonstrates a method for finding homogeneous groups of courses within the broader categories of "A" and "C." A computer based clustering algorithm was employed on data from a sample of over 400 Navy enlisted technical training "A" and "C" courses. Data on courses were acquired from both existing training management information data bases and from a course description survey developed for the study.

The clustering program demonstrated its utility by sorting technical training courses into several groups on the basis of "common" course characteristics. Several possible applications and benefits of the clustering methodology are discussed. The general conclusion is that this methodology is a viable and valid analytical tool for studying Naval training courses.

Data used in the study were gathered during the period December 1975 to February 1976.

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SECTION I

INTRODUCTION

The Chief of Naval Education and Training (CNET) is administratively responsible for several thousand technical training courses. Currently, the majority of these courses are classified into two broad, administrative categories: "A" and "C." "A" courses typically are designed to teach occupationally oriented, entry level skills and knowledge to first term enlistees. "C" courses are designed to teach advanced or system-specific knowledge and skills. The courses within these categories have many different characteristics, and because of this it is difficult to make fair, meaningful or defensible generalizations about them. Consequently, for planning or analytical purposes, it is usually necessary to deal with these courses on a case-by-case basis.

Within the "A" and "C" categories, however, there are similarities among courses that conceivably could be used as a basis for classifying them into smaller subgroups about which meaningful generalizations can be made. For example, there are similarities in economic aspects such as the amount or type of resources required by a course. There are also similarities in training variables, such as the kind of skills trained, course lengths, management and evaluation of the instructional process. Descriptive variables such as these may provide a basis for the classification of courses into homogeneous subgroups or "types."

More precise classification, based on common sets of characteristics of courses can be useful in a number of ways. Given that training courses can be classified into definable subgroups possessing high within-group similarity, training management can be provided with an information structure to support decisions about:

- Distribution of training resources, such as:

1. <u>Instructor requirements</u>. Some groups of courses may require higher or lower instructor student ratios.

2. <u>Training media and equipment</u>. Some groups of courses may require greater or lesser amounts of these resources, indicating, perhaps, greater or lesser capital versus labor intensity, the potential mobility of such courses, and the potential for consolidating courses so as to better utilize training media and equipment.

3. <u>Training facilities</u>. Some courses may require housing in special facilities; this resource implication is similar to the training media and equipment considerations cited above.

- Management of the training process through analyses of:

1. <u>Kinds of skills trained</u>. Courses that teach common or similar skills imply a potential for organizational efficiencies. Noteworthy is the Basic Electricity and Electronics (BE&E) course which was designed to be a

prerequisite for several subsequent courses involving aspects of electronic maintenance. Similarly, other groups of courses might be discovered that would benefit from a common prerequisite course.

2. Strategies for training and evaluation. Courses that have many common elements may benefit from similar teaching approaches. And, groups of similar courses may be evaluated for training effectiveness as a group, or individual courses more fairly compared to group averages.

The potential benefits accruing from the identification of homogeneous groups is highly dependent upon the skills, needs, and ingenuity of the classifier. It is incumbent on the reader to recognize occasions or specific problems where the identification of homogeneous groups of courses is desirable or necessary for further analysis. The issue addressed in this report is the methodology for finding the groupings--not what use to make of the groupings.

PURPOSE OF THE STUDY

The purpose of this study was to determine the feasibility of developing data based classification categories of technical training courses. To meet this objective it was necessary to identify (or select), demonstrate, and document a procedure for classifying training courses on various descriptive bases. Since it is doubtful that a single "general purpose" classification is either feasible (or desirable), an important consideration in this development process was to insure that the classification procedure has sufficient flexibility for classifying courses on whatever set of variables may be relevant to some particular application.

BACKGROUND

Classification refers to both a process and a product. As a process, classification is the technique or procedure employed to find categories. As a product, a classification is simply a listing of categories and their members. Classifications permit decision makers to make generalizations about the members within a category. A commonplace example would be the Navy enlisted personnel classification system. Personnel requirements are usually stated in terms of categories described by such variables as pay grade and Navy Enlisted Classification (NEC) code. Despite obvious individual differences, personnel in a particular pay grade and NEC are considered (inferred) to be "the same" for assignment purposes.

The focus of this report is on classification as a process or procedure. In this vein, classification should be viewed as a tool for generating information to assist training management in policy and decision making. The need for such a tool was recently highlighted in a questioning assessment of the propriety of imposing the Navy Resource Model (NARM)[1] results on estimating specialized training resource requirements. In particular, it was stated:

[1] This model is designed to estimate resources required by major Navy organizations.

> Very little attention is given to the methodology by which resource types and mix will be considered and costed. The suggestion is that specialized training be subdivided into several groups and a cost per student be provided by CNET. The number of groups suggested (by the Center for Naval Analyses (CNA)) appears too small, and no rationale is provided as to why these make sense from a resource and cost viewpoint. What is required is a definition of CNET functions into homogeneous groups where the determinate of a group is based upon like (similar) resource requirements. It is well understood that the NARM cannot model all 5,000 courses conducted by CNET, but the need for simplicity in programming and budgeting is not an excuse for using tenuous relationships. More attention should be given to the degree of aggregation used, definition of groups, and more detailed cost analyses than provided (in the CNA memorandum). In conclusion, it is agreed that the current NARM algorithm should be improved. It is recommended that an alternative approach which identifies Navy requirements and costs in a meaningful way be developed.[2]

CURRENT TRAINING CLASSIFICATION SYSTEMS. Before discussing the rationale for the approach to classification taken in the present study, two existing classifications of Navy training are briefly described. One is the program elements designation used by the Center for Naval Analyses (CNA) and other organizations for budget analyses. The other is that currently found in NAVEDTRA 10500, Catalog of Navy Training Courses (CANTRAC). Both systems are comprehensive in that they include all Navy training and education for both officer and enlisted personnel.

Budget Program Element Training Categories. Table 1 is a listing of the program element classification categories. No rationale was offered by the originator for these categories. However, the budget program elements; for example, PE81112N, are detailed in the Navy Comptroller Manual (NAVSO P-1000), volume 2, chapter IV, paragraph 6. The variables that underlie the categories shown in table 1 are not explicit, but some of the bases of such a classification can be inferred. A partial listing might include:

1. skill level of the trainee

2. special training areas of interest: Flight, Medicine, Construction, Aviation Maintenance, Nuclear Power, Fleet Ballistic Missiles, etc.

[2] R. M. Lloyd, Professor of Management, Naval War College, in Memorandum for Chief of Naval Education and Training, Subj: Evaluation of "A proposed revision of the NARM specialized training algorithm," CNA memorandum 902-75.10 of August 1975; dated 29 December 1975.

3. organizational control: Fleet, Reserve, CNET

4. education programs versus specialized training.

Obviously, these "dimensions" overlap considerably, but the system clearly has budget-oriented utility. In fact, it could be used when seeking answers to such questions as "How much does medical training cost?" or "How much does recruit training cost?" or "What is the average number of trainees in aviation maintenance training courses?" Gross questions typically are followed by gross answers which while adequate for some purposes are insufficient for more detailed description within a program element; e.g., "A" and "C" courses within PE81112N.

TABLE 1. PROGRAM ELEMENT TRAINING CATEGORIES

DEFINITION OF TRAINING CATEGORIES

1. Recruit Training -- PE81111N

2. Fleet Training -- part of PE81112N
   includes all activities under COMTRALANT and COMTRAPAC plus amphibious schools

3. Officer Training -- part of PE81112N
   SC School, TRANSMGMT School, CEC School, DE School, NETC Newport, Justice School

4. Air Training -- part of PE81112N
   NATTCs in Memphis, Glynco, Lakehurst; NTTC, Pensacola, Navy Unit Lowry, Air Maintenance Training Group

5. Nuclear Power/FBM Training -- part of PE81112N
   Nuclear Power Schools, Nuclear Power Training Units, Guided Missile School, Fleet Ballistic Missile Training in Charleston

6. Construction Training -- part of PE81112N
   Navy Construction Schools in Gulfport, Pt. Hueneme, Davisville

7. Medical Training -- part of PE81112N
   HM Schools at Great Lakes and San Diego, miscellaneous medical training

8. All other "A" and "C" school training -- part of PE81112N
   Service School Commands, Navy Scol Com, T. I.; Combat Systems Technical School, BT School, Communication Systems Technical School, DC School, Diving and Salvage School, EOD School, SUB School

TABLE 1. PROGRAM ELEMENT TRAINING CATEGORIES (continued)

9. Unfunded Training Plans in Specialized Training

10. Professional Training -- PE81113N

11. Service Academy -- PE81115N

12. Flight Training -- PE81114N

13. Reserve Training -- PEs: 81122N, 81123N, 81124N, 81125N, 52413N, 58112N, 58114N, 58170N, 58164N
    Aviation ROCs, ROCs, ROTC, JROTC, Fleet Support Training (RESERVE), Specialized Training (RESERVE) Flight Training (RESERVE), all other reserve training

14. Program 2 Training -- PEs: 24632N, 24633N, 28011N
    Sea Control Training, Fleet Support Training, JCS directed and coordinated exercises

15. Training R&D -- PEs: 63702N, 64703N
    Training Devices Prototype Development; Education and Training

16. Other Training Support -- PEs: 35897N, 81117N, 82833N, 88097N, 91513N, part of PE81112N
    Audio Visual Activities, Training Equipment Centers, Training and Education Support Centers, Other Education Programs, Administrative Commands

<u>CANTRAC Training Categories</u>. Volume I of the CANTRAC contains another training classification system but with a larger number of categories. The CANTRAC categories are presented in table 2. These classification categories appear to be based upon: level of skill, type of education program, fleet versus shore establishment control, and the special category for flight training.

While there are a large number of categories, membership appears to be determined by one or, at most, three variables. Examples of this are R1, Recruit Training; or A6, Initial Skill Training, Officer, Medical. The "A" and "C" courses of interest are lumped together under the CANTRAC categories A1, A3 and C1, C3. In essence the CANTRAC categories would provide more structure to the information required to answer questions concerning who (personnel categories) receives training and possibly the cost of a training category. For this limited purpose the CANTRAC appears useful and more analytically informative than the Program Element categories. But again, very little could be learned about the kinds of skills trained or the commonality of resources consumed or even the way the process of training is managed.

TABLE 2. CANTRAC TRAINING CLASSIFICATION

Class "A" - Provide the basic technical knowledge and skills required to prepare for job entry level performance and further specialized training. Includes apprenticeship training. An NEC, NOBC, MOS or AFSC may be awarded to identify the skill achieved. Also, includes some officer courses such as communication officer, ASW officer, etc.

AA	Apprenticeship Training
A0	Officer Preparatory Schools not associated with professional development programs
AP	Enlisted Preparatory Schools
A1	Initial Skill Training - Enlisted
A2	Initial Skill Training - Officer
A3	Initial Skill Training - Enlisted Communications Program 3
A4	Initial skill Training - Officer Communications Program 3
A5	Initial Skill Training - Enlisted Medical
A6	Initial Skill Training - Officer Medical.

Class "C" - Provide the advanced knowledge, skills, and techniques to perform a particular job in a billet and/or any course which awards or is a prerequisite to a skill awarding course; i.e., NEC, NOBC, MOS or AFSC, or is 13 calendar days or longer and does not conform to the definition of a Class "A" course.

C1	Skill Progression Training - Enlisted
C2	Skill Progression Training - Officer
C3	Skill Progression Training - Enlisted Communications Program 3
C4	Skill Progression Training - Officer Communications Program 3
C5	Skill Progression Training - Enlisted Medical
C6	Skill Progression Training - Officer Medical
C7	Specialized Progression Training for advanced pay grades: Enlisted personnel normally pay grade E-5 and above.

Class "E" - Programs designed to provide formal professional educational instruction in a general or particular field of study which may lead to an academic degree.

E1	Professional Development Education - Senior Service College
E2	Professional Development Education - Intermediate Service School
E3	Graduate Education for Subspecialty, full time, funded - Degree Program
E4	Undergraduate Education - Degree Program
E5	Postgraduate Education (not fully funded) - Degree Program
E6	Non-degree Educational Programs
E7	Health Education Programs
E8	Other Education Programs.

TABLE 2. CONTRAC TRAINING CLASSIFICATION (continued)

Class "F" - Provide team training to fleet personnel, officers and enlisted, who normally are, or are en route to duty as, members of ship's companies, and/or individual training such as refresher, operator, maintenance and technical training of less than 13 calendar days established to meet the needs of the fleet or type commanders. A NEC, NOBC, MOS or AFSC will not be awarded.

F1 Functional Training - Enlisted
F2 Functional Training - Officer.

Class "P" - Officer acquisition programs designed to provide undergraduate education and/or indoctrination and basic training in fundamentals, preliminaries, or principles to midshipmen, officer candidates, and other newly commissioned officers (except those acquired through Class "V" programs).

PA NESEP
PB Health Profession Acquisition Military Programs
PC Other Programs
PD Preparatory School
P1 Officer Acquisition Training (Academy)
P2 NROTC
P3 NJROTC
P4 AVROC II
P5 ROC
P6 OCS
P7 AOC (Precommissioning)
P9 NUPOC-S.

Class "R" - Training upon initial enlistment or induction which provides the general indoctrination and prepares the recruit for early adjustment to military life by providing skill and knowledge in basic military subjects. Note: Does not include Apprenticeship Training.

R1 Recruit Training.

Class "V" - Provide the skills which lead to the designation of Naval Aviator or Naval Flight Officer.

V1 Undergraduate NASC/PRIM Flight Training
V2 Undergraduate Flight Training - PROP
V3 Undergraduate Flight Training - JET
V4 Undergraduate Flight Training - HELO
V5 Undergraduate NFO Training.

NUMERICAL TAXONOMIST'S APPROACH. The approach to classifying training courses that was followed in this study differs from the previous two examples in that categories are based upon quantifiable aspects of training. The logic of the approach, stated simply, is that the things for which a classification system is sought; i.e., training courses, possess observable, quantifiable attributes, and "courses" that are "similar" in terms of the attributes should be regarded as members of the same category. This approach is typified by the numerical taxonomist Sokal (1965):

> In the early days of modern science, and for special purposes even today, classifications were based on a single property or characteristic, the choice of which might be quite arbitrary. Metals are divided into conductors and nonconductors, other substances into those that are soluble in water and those that are not; organisms are divided into unicellular ones and multicellular ones. Some of these classifications are arbitrary in the sense that there is a continuum of properties -- as in the case of solubility, for which the line between soluble substances and insoluble ones is not distinct. In contrast one can almost always say whether an organism is unicellular or multicellular, so that with properties such as these the decisions can be quite clear-cut. Classifications based on one or only a few characters are generally called "monothetic," which means that all the objects allocated to one class must share the character or characters under consideration. Thus the members of the class of "soluble substances" must in fact be soluble.
>
> Classifications based on many characters, on the other hand, are called "polythetic." They do not require any one character or property to be universal for a class. Thus there are birds that lack wings, vertebrates that lack red blood and mammals that do not bear their young. In such cases a given "taxon," or class, is established because it contains a substantial portion of the characters employed in the classification. Assignment to the taxon is not on the basis of a single property but on the aggregate of properties, and any pair of members of the class will not necessarily share every character.
>
> It is obviously much more complicated to establish classifications based on many characters than it is to establish classifications based on only one character. The human mind finds it difficult to tabulate and process large numbers of characters without favoring one aspect or another. The comparative subjectivity of traditional approaches and the inability of taxonomists to communicate to one another the nature of their procedures have contributed to making taxonomy more of an art than a science.

> The arrival of the computer has reversed this trend, and a new field with many possibilities for objective and explicit classification has opened up. Computer techniques have indeed been a principal force behind the gradual adoption of an operational approach in taxonomy; in order to use such techniques, classificatory procedures must be outlined in such a form that any scientist or a properly programmed computer can carry out the indicated operations, and given the same input data, arrive at the same results. This would preclude the often arbitrary decisions of conventional taxonomists, epitomized by the statement that "a species is whatever a competent taxonomist decides to call a species."

The principal virtues of this approach to developing classification categories are that it is objective (reproducible by anyone who employs the procedure), based on descriptive data, and proceeds with no preconceived notions about what the categories are. This approach permits natural categories to emerge from the data.

The numerical taxonomist's approach was employed in the present study. In employing the approach, a large number of variables were considered for use. These variables are of the following kinds:

1. outcome of training--where the graduates go in terms of assignments following graduation from the course

2. kinds of skills trained--an array of skills across common Navy tasks

3. management of the instruction process--the teaching strategies employed

4. measurement and evaluation--how the process and product of training are assessed

5. training resources--resources consumed by training courses

6. organizational properties--course lengths, whether an NEC is awarded.

It can be noted that variables under such headings offer much richer training course information. The key issue in using this approach rests with the choice of variables upon which the classification is to be developed. Several different classifications of interest may be possible depending on the data set used; e.g., the kinds of skills trained variables would presumably produce a different classification than training resource consumption variables.

ORGANIZATION OF THE REPORT

The remainder of this report is divided into sections concerning methodology, results, conclusions and recommendations. The methodology section documents a demonstration of the numerical taxonomic approach applied to "A" and "C" courses with course data on a variety of variables. The results section presents the results of applying the approach on three data sets. The final section of the report contains conclusions and recommendations for areas of possible application within Navy training organizations.

SECTION II

METHODOLOGY

This section describes a procedure for developing categories of courses on the basis of a common set of descriptive variables or attributes. Several discrete but interdependent operations are involved. A brief overview of the general approach is presented first. A case study of its application on Navy courses and data follows the overview.

GENERAL APPROACH

The steps in the general approach are described briefly below. They are:

1. Hypothesize or Identify Variables Appropriate to Some Problem
2. Develop a Sampling Plan
3. Gather Data on the Variables for the Things to be Classified
4. Develop Classification Categories
5. Use Category Data in Decision Making

In some instances where this approach is applied, certain of the early steps may already have been completed. For example, the variables may be given; sampling may not be necessary because the set of courses to be classified is given; the data may have been reported previously. Even step 5 may not result in final decision making but, rather, point toward more intensive analysis. However, for most applications, it is assumed that all of the steps will be completed in a fashion which incorporates the necessary variation to meet specific needs.

1. <u>Hypothesize or Identify Variables Appropriate to Some Problem</u>. The purpose for developing categories of courses is to permit generalizations to be made about the categories with respect to some common set of characteristics. The classification task is to determine which courses have similar attributes. Courses that are similar may have several attributes or variables in common, or high values or low values on the same variables.

In cases where not much is known about which variables to use to develop classification categories, it may be necessary to hypothesize a large number. After taking data on the variables, it is possible to refine them by eliminating those that are highly redundant (correlated with other variables) or those that do not vary much across the courses to be classified. Or, it may be discovered that it is impossible to get complete or accurate data on some variables. In other cases the appropriate variables may be so obvious as to render their identification almost trivial. The important point to be recognized is that the set of variables used determines the classification basis. Consequently, a classification based on variables X, Y, Z will not be the same as a classification based on variables A, B, C.

2. Develop a Sampling Plan. If the number of "things" to be classified is relatively small, or if resources are sufficient to permit gathering data on all potential classification variables for all the "things" to be classified, sampling is not necessary. In the general case, however, it will be necessary to constitute a sample to represent the larger population. A sampling plan should be devised. This will include identification of the number of courses on which data will be collected, details of how the data will be collected, and provisions for insuring that the sample is representative of the larger population. For example, if 50 percent of the "A" and "C" courses were west of the Mississippi River, then 50 percent of the "A" and "C" course sample should be located west of the Mississippi. Guidelines to follow in preparation for sampling may be found in most elementary statistics and survey texts; e.g., Wessel and Willett (1959), as well as in the procedures followed in the demonstration described later in this section.

3. Gather Data on the Variables for the Things to be Classified. There are a variety of procedural options for collecting data. What is appropriate will depend on the particular problem at hand. In some cases data may be readily available. In other cases, data may have to be acquired via experimentation or field survey methods. It may not be practicable to obtain data on all of the variables for all of the sample; i.e., there may be too much missing data on some variables or too much missing data for portions of the sample. Effort should be made to avoid data collection when it is not likely that complete or fairly accurate data will be forthcoming. Secondary data; i.e., data from data base reporting systems or data collected by others, may be adequate and should be sought whenever possible. But, careful examination of data sources and careful sampling from these sources should be practiced.

4. Develop Classification Categories. When descriptive data have been acquired and prior to performing the classification analysis, it is desirable to perform some preliminary statistical examination of the data. This is intended to identify the extent of missing data, eliminate variables that are redundant, and make decisions about what data set to use. This operation should be performed regardless of the clustering or classification procedure to be used.

To perform the classification analyses, an algorithm should be used which clusters (forms groupings of) the things to be classified on the basis of their similarity across the set of variables selected. The algorithm should form clusters (or categories) such that the members of one cluster are more similar to each other than to those of any other cluster. In the hypothetical example shown in figure 1, the clustering algorithm should be able to form two major clusters. Each point in figure 1 represents a course plotted in terms of its length and annual throughput. The three courses with question marks do not fit neatly into clusters A or B. In this hypothetical instance the algorithm should form a third cluster for the two courses with relatively low throughput and relatively high course length. The course between clusters A and B would be forced to be included in one or the other, depending on which was closer. Since clustering algorithms may produce more than one solution, it may be necessary to further examine the outputs of the algorithm to select the most desirable clustering solution. The general concern is that the clusters should be fairly distinguishable.

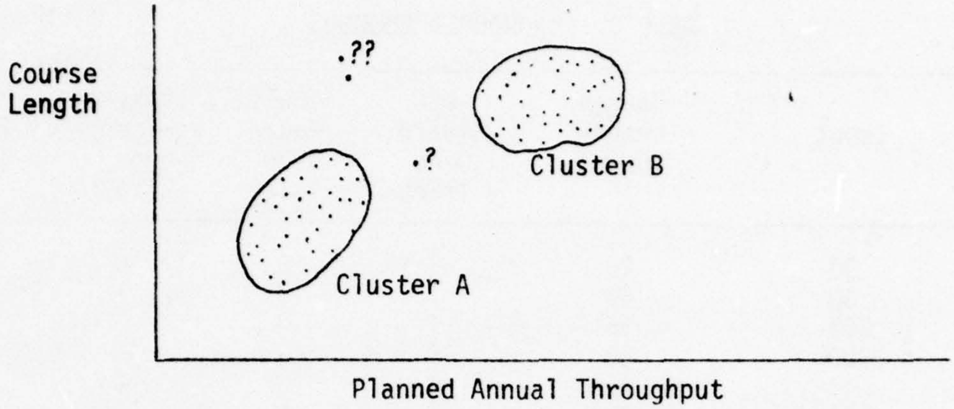

Figure 1. Two Hypothetical Clusters of Courses Based on the Variables of Course Length and Planned Throughput

A number of clustering algorithms, developed over the past 25 years, could be used to develop classification categories. Several of these clustering algorithms may be found in Hartigan (1975), and Rice and Lorr (1969). Most of these would be expected to yield similar results in terms of the clusters that would be formed. However, it was not the intent of this study to compare and contrast various clustering algorithms nor to allege the superiority of one over the others. For the case study of an application on Navy courses which is reported following this overview, the computer program chosen to perform the clustering was selected because of its ready availability within TAEG and its adaptability to available computational equipment.

5. Use Category Data in Decision Making. The output of the previous step is a set of grouped (courses) and related data such as the means of each group on the values of the classification variables used. By examining these category or group means it becomes possible to recognize and better interpret the distinguishing features of each category. A statistical methodology called multiple discriminant analysis (Anderson, 1958) may be used to determine which variables are most influential in discriminating one category from another.

Numerous decisions may be influenced by knowledge of the characteristics of the groupings. However, these can only be addressed in general terms; specific decision making situations depend on particular classification applications. An artificial example is presented to amplify this phase of the general approach. Table 3 shows 13 courses to be clustered and their respective data on six variables: student input, course length, whether an NEC is awarded, whether the course is self paced, whether equipment operation or equipment maintenance is taught. Table 4 shows a possible clustering algorithm grouping of these courses.

TABLE 3. UNGROUPED COURSES

Course	Input	Course Length (Days)	NEC Award 0=No 1=Yes	Self Paced 0=No 1=Yes	Operate Equipment 0=No 1=Yes	Maintain Equipment 0=No 1=Yes
1	90	20	1	0	0	1
2	50	42	1	0	1	1
3	200	16	1	0	1	1
4	1900	80	0	1	0	1
5	42	12	1	0	0	1
6	150	32	1	0	1	1
7	75	16	1	0	0	1
8	1500	215	1	1	1	1
9	2000	60	0	0	0	1
10	188	16	1	0	0	1
11	800	120	0	1	1	0
12	16	30	1	0	0	1
13	1200	75	0	1	0	1

TABLE 4. GROUPED COURSES

Group	Course	Input	Course Length (Days)	NEC Award 0=No 1=Yes	Self Paced 0=No 1=Yes	Operate Equipment 0=No 1=Yes	Maintain Equipment 0=No 1=Yes
	9	2000	60	0	0	0	1
	8	1500	215	1	1	1	1
I	13	1200	75	0	1	0	1
	11	800	120	0	1	1	0
	4	1900	80	0	1	0	1
	2	50	42	1	0	1	1
II	6	150	32	1	0	1	1
	3	200	16	1	0	1	1
	7	75	16	1	0	0	1
	12	16	30	1	0	0	1
III	10	188	16	1	0	0	1
	5	42	12	1	0	0	1
	1	90	20	1	0	0	1

Table 5 shows descriptive statistical properties of the three groups on each variable. This table, in part, shows the salient features of the categories in terms of the average member of each group.

TABLE 5. MEANS AND STANDARD DEVIATIONS FOR GROUPS OF COURSES ON EACH VARIABLE

GROUP		INPUT	COURSE LENGTH (DAYS)	NEC AWARD	SELF PACED	OPERATE EQUIPMENT	MAINTAIN EQUIPMENT
I							
	$\bar{X}$	1480	110	.200	.800	.400	.800
(n=5)	s.d.	497	63	.447	.447	.547	.447
II							
	$\bar{X}$	133	30	1.000	.000	1.000	1.000
(n=5)	s.d.	76	13	.000	.000	.000	.000
III							
	$\bar{X}$	82	19	1.000	.000	.000	1.000
(n=5)	s.d.	66	7	.000	.000	.000	.000

Group I courses have the highest average input of students and the longest course durations. Most Group I courses are self paced and do not award an NEC. Group II courses, although having a much lower input and course duration than Group I courses, still have a higher average input and duration than the Group III courses. And, while Group II and Group III courses do not differ in terms of the NEC and self paced variables, Group II courses appear to emphasize operator <u>and</u> maintenance skills in the same course. Group III courses have the lowest average inputs and duration. They appear to be strictly maintenance courses.

Data, such as the above, describing these three categories would support several broad decisions. For example:

1. Improvements in instructional technology would have a high potential for improving instructional efficiency and lowering training costs in Group I courses because of their larger number of man-hours of training (Input X Course Length).

2. Consonant with 1 above, Group I courses should be examined further to evaluate their training effectiveness and operational efficiency.

3. Across all three groups, courses that teach both equipment operation <u>and</u> maintenance have longer durations (courses in Group I and all courses in Group II). Further study should be initiated to determine the implications of converting these courses to strictly operation <u>or</u> maintenance. This would have

one possible effect of creating more but shorter courses. Obviously more information is required, but the groupings of existing courses suggest these kinds of generalizations.

CLASSIFICATION STUDY OF TRAINING COURSES

The general scheme outlined above was followed to explore the feasibility of applying classification methodology to Navy technical training "A" and "C" courses. Details of this study are presented next. It should be noted that the main departure of this study from the general approach is that no specific problem area was addressed. That is, the study was not initiated to develop supporting information for specific decision making. However, for a specific application to a training course classification problem, many of the same variables would be used.

IDENTIFICATION OF POTENTIAL CLASSIFICATION VARIABLES. For this study, a large number of potential classification variables were identified. This was accomplished through a rational process. Some general criteria for selecting the variables were applied. These were:

- management interest in particular classification bases; e.g., variables describing resource consumption
- accessibility of data; i.e., whether it was possible to acquire data on the variables
- face validity; i.e., whether the variables appear to be descriptive of nontrivial aspects of training courses. (This lends additional credibility to the emergent classification groups.)

Variables were generated from six topical areas considered to be descriptive of training courses. The variables were subsumed under the following categories:

- Outcome of Training, in terms of graduate assignments following completion of the course
- Kinds of Skills Trained; e.g., operator, maintenance, communication, welding, etc.
- Management of the Instruction Process; e.g., teaching strategies employed, classroom and laboratory practices, use of media
- Measurement and Evaluation; i.e., how the process and product of training are assessed
- Training Resources Consumed by the Course
- Organizational Properties.

These headings appear to subsume most of the characteristics by which courses can be described. Very specific classifications of courses could be performed based on variables from any or all of the above descriptive areas.

Altogether, 150 variables were identified, initially, in this study. It was anticipated that not all of the variables would be utilized in the classification analysis. However, a large number of variables were deemed necessary so that one or more subsets could be selected to try out for classification bases. The variables are discussed further, below, in the context of the data sources and data collection.

SAMPLING STRATEGY. Resource limitations precluded the acquisition of data on all of the courses in the target population of "A" and "C" courses. Thus, a sample of courses was selected. These were courses predominantly under CNET control. A sampling strategy was developed for assuring the representativeness of the sample and for determining the relative proportions of "A" and "C" courses to be included. A May 1975 computer run of the Master Course Reference File (MCRF) of the CNET Navy Integrated Training Resource Administration System (NITRAS) was searched to determine the approximate numbers of "A" and "C" courses in the target population. Target population data were also extracted from the MCRF on variables concerning whether the course awarded an NEC, course locations, the producing or curriculum controlling command. These data were used to compare the same characteristics with the sample to insure that the sampling was representative.

It was determined that on the basis of sheer numbers of "A" and "C" courses the sample should contain roughly 10 percent "A" courses and 90 percent "C" courses. The actual proportions noted were:

		NUMBER	PERCENT
A1 Courses	136		
A3 Courses	26		
TOTAL "A"		162	7%
C1 Courses	1983		
C3 Courses	42		
TOTAL "C"		2025	93%
TOTAL "A" and "C"		2187	100%

These proportions, however, are based only on numbers of courses; they do not take into account the man-hours of training associated with "A" and "C" courses. Since "A" courses typically involve many more man-hours than "C" courses, a decision was made to "weight" the sample proportions of "A" and "C" courses. Weights were estimated from the data below which were provided by the Chief of Naval Technical Training (CNTECHTRA) for a previous TAEG effort; i.e., NEOCS. "A" courses accounted for approximately 78 percent of the total man-hours trained while "C" courses accounted for the remaining 22 percent. The obtained

	Man-Hours Trained[3]	Percent
"A" Courses	19,996,909	78
"C" Courses	5,477,121	22
	25,474,030	

proportions (.78 and .22) were then multiplied by the respective numbers of "A" and "C" courses to produce a "weighting index" for determining relative proportions of "A" and "C" courses to sample. These simple calculations are shown below:

	(1) Numbers of Courses	(2) Training Man-Hours Weight	(1) X (2) Weighted Product Index	Weighted Proportions
"A" Courses	162	.78	126	126/572 = .22
"C" Courses	2025	.22	446	446/572 = .78
			572	

The apparent reversal of the obtained weighted proportions and the man-hour proportions was purely coincidental.

Since there were relatively few "A" courses (n=162) and they represent such a significant proportion of man-hours trained, it was decided to "sample" all of them and to make the number of "C" courses to sample equivalent to the weighted proportion. Thus, if the sample size was adjusted such that the 162 "A" courses would comprise 22 percent of the sample, the number of "C" courses needed to comprise 78 percent of the sample was approximately 575, solving (X/78=162/22). The actual sampling plan used, for reasons of expediting drawing the sample manually from the MCRF, differed slightly. However, in checking the sample characteristics against the target population characteristics (such as NEC awarding, geographic location), there were virtually no differences. Therefore, the sample was considered both representative and large enough to tolerate shrinkage for a variety of reasons (e.g., for error or missing data).

GATHERING THE COURSE DATA. This subsection describes how the data on the 150 variables for the sampled "A" and "C" courses were acquired. Data which are originally collected for a study are known as primary data, while those data collected by others are called secondary data (Wessel and Willett, 1959). In this study both primary and secondary data sources were used. Primary data sources were individuals who were knowledgeable about the sampled courses; i.e., instructors of the courses or training program coordinators. Secondary data sources were reports in the form of computer print-outs from training management information data bases; i.e., Master Course Reference File (MCRF)

[3] Based on FY 1973 data.

and Resources Management System (RMS) accounting data. The specific data sources used and the kinds of variables upon which data were gathered are discussed below. It can be noted that the data came from slightly different time periods. In applying the classification approach to a specific problem, it is desirable that data come from the same time period. However, for purposes of this demonstration study, it was felt that the use of slightly differing time periods was tolerable.

Master Course Reference File (MCRF). The MCRF is one of the principal management information components of the NITRAS. Data for over 4,000 courses are fed via a field reporting system to the MCRF data base. Data in report format 1500.1003 were sent to TAEG on microfiche for the extraction of information on the sampled courses for the variables described below. The way the variables were coded for analysis is also given.

- Service Support. Which uniformed service is responsible for the resources that support the course? 1 = Navy; 0 = Non-Navy.
- Navy Enlisted Code (NEC). Does the course award an NEC? 1 = Yes; 0 = No.
- Number of Enlisted Ratings Served by the Course. Single digit number of ratings up to the MCRF limit of six.
- Number of Enlisted Ratings Served by the Course. 1 = General; i.e., six or more enlisted ratings. 0 = Not General; i.e., less than six enlisted ratings.

(The previous two variables are redundant, but data on both were acquired pending a decision to drop one.)

- Course Length. Number of calendar days elapsed from the convening date to the graduation date. In the instances of a self-paced course, the estimated mean number of days to complete the course was used.
- Frequency of Convening. The estimated number of times the course would be taught in FY 75.
- Total Students. An estimate of the planned number of students going through the course in FY 75.

The above list does not exhaust all the possible or potential classification variables on which data might have been taken from the MCRF. However, conversations with NITRAS staff indicated that the above variables were the "best" ones which could be used for classification with any comfortable degree of confidence in their accuracy. Perhaps as the MCRF matures; i.e., becomes more consistently accurate over time, it will become even more useful as a data source for a variety of management analyses.

Resources Management System (RMS). Accounting data on several course cost elements are available from the RMS for many of the courses in the population of interest. However, a key feature of any RMS is the definition of a cost center. A cost center is the smallest unit of accounting against which costs are charged. In maintaining training cost accounting data, the ideal definition of a cost center would be the individual course. This would enable the accounting system to capture the cost of resources used specifically by each course. Unfortunately, not all courses have their respective costs accounted for individually; rather, training resource costs for a group of courses may be aggregated at the "schoolhouse" or training activity level as cost centers. This creates a problem for a study such as the present one since the costs of resource variables for aggregated groups of courses have to be prorated on bases such as the average number of students on board (AOB) or numbers of students trained per year.

Therefore, in some cases, the data for some courses (usually "A" courses) result from direct cost accounting, and data for other courses (usually "C" courses) are prorated estimates. The CNTECHTRA RMS FY 74 data were used to arrive at values of resource variables for the sampled courses. In some cases, it was not possible to get complete resource accounting data for a particular course.

Only variables of "direct" resource consumption by a course were used. The definition for "direct resource" includes labor and capital usage directly attributable to a course; i.e., if the course were cancelled, consumption of those resources would cease (Swope and Cordell, 1975). Indirect costs; i.e., overhead, were available in the RMS (at the training activity level) but it was not practical to determine an acceptable rationale for allocating joint indirect costs to individual courses. Therefore, indirect costs were not used.

Below is a list of the available RMS variables considered for use as a basis for developing classifications of courses.

1. Military Hours--direct military labor associated with a course; calculated in man-hours per fiscal year (FY), assuming 5 days per week and 8 hours per day.

2. Military Cost--pay and allowances of military labor; calculated in dollars/FY, assuming 5 days per week and 8 hours per day.

3. Civilian Costs--civilian labor costs chargeable to a specific course in dollars/FY.

4. Equipment Depreciation--the depreciation cost of nonconsumable equipment (on equipment originally costing $1,000 or more) used by a particular course in dollars/FY.

5. Equipment Maintenance--the maintenance, repair, or other overhead costs for equipment used by a particular course in dollars/FY.

6. Supplies--the cost of supplies (consumable materials and equipment) charged to a specific course in dollars/FY.

7. Student Salaries--pay, allowances, and subsistence costs for all students in a particular course in dollars/FY.

These definitions are consonant with CNET Instructions 7310.2 and 7300.1. Of the three broad economic categories of resource consumption (land, labor, and capital), land is assumed to be given; direct labor is measured in terms of military, civilian, and student costs. The flow of capital services from capital stock can be ascertained by equipment depreciation and maintenance and the cost of supplies.

Course Description Survey. In addition to the information extracted from MCRF and RMS files, data on other characteristics of courses were gathered via a course description survey. A number of variables were hypothesized to have potential classification utility. These variables were developed under the general headings of:

- management of the instructional process
- kinds of skills trained
- where graduates go after training
- measurement and evaluation of the course.

Variables under these headings are relevant to some of the kinds of decisions discussed in section I.

The variables under the above headings were cast in the form of a checklist/questionnaire for administration to personnel who were knowledgeable about the courses. A copy of this Course Description Form (CDF) is in appendix A. A prototype of the CDF was administered to instructors at the Service School Command in Orlando and to Training Program Coordinators (TPCs) at CNTECHTRA in Memphis. This preliminary administration was to determine the feasibility of the form as a data collection instrument and to determine its suitability for subsequent unsupervised administration. The tryouts were conducted in the form of interviews with the instructors and TPCs. Information and comments obtained were used to revise the instrument to its final form (as it appears in appendix A).

Also, during the tryouts at Memphis, administrative procedures were established for collecting the CDF information for courses under CNTECHTRA control. By agreement, the coordination of form distribution and collection was performed by the CNTECHTRA Code 016, Training Methods, Research, and Evaluation. The CDF forms were disseminated to the TPCs for the sampled courses. The TPCs either filled out the forms or forwarded them to the instructors of the courses. A similar procedure was followed for courses under Commander Training Command, U.S. Atlantic Fleet (COMTRALANT) and Commander Training Command, U.S. Pacific Fleet (COMTRAPAC). The course description data from the participating Commands were collected betweeen December 1975 and February 1976. These data were coded and keypunched together with the MCRF and RMS data for automatic data processing.

DEVELOPING CLASSIFICATION CATEGORIES. Collating the data from the three sources cited above into a single data record for each sampled course was complicated by the problems of missing data on all or some variables. Figure 2 is a schematic representation of a data matrix. It is provided to help the reader visualize the raw data set from which variables could be selected for various classification analyses. For example, there might be complete RMS data on a course but no MCRF or CDF information; or, there might be (and were) permutations of that problem.

After matching up data records, basic statistical analyses were run on the data to determine means, variances, and intercorrelations of the variables. These were obtained as outputs of the Biomedical Computer Program 8M: Factor Analysis (Dixon, 1973). The basic statistics on the variables were helpful in determining which variables to employ in the classification analyses. Since most of the RMS and MCRF variables were used, the data reduction effort was aimed chiefly at weeding out redundant CDF variables. This was accomplished, arbitrarily, by examining the multiple correlation between each CDF variable and all other CDF variables. The CDF variables were rank ordered from highest to lowest in terms of their correlations with all other CDF variables. Then, the 20 variables with the lowest correlations; i.e., least redundant, were selected. This step was necessary because of the "shotgun" approach taken when hypothesizing potential classification variables. It was anticipated, a priori, that not all of the CDF variables would be used because of (1) sheer number of variables, (2) possible redundancy among the variables, and (3) possible inappropriateness of the variables as descriptors. In an application of the methodology to a specific classification problem, the number of variables chosen would probably be considerably fewer; however, it is still recommended that the basic statistical properties of the variables be examined.

Cluster Analysis Program. The computer program for cluster analysis used in the present study was developed at the University of Pennsylvania in the late 1960s.[4] The program is available for inspection within TAEG. The technique involved is directly analogous to one employed by Howard (1966) in classifying 5,000 tax districts in the city of London on the basis of approximately 40 socioeconomic variables. Interested readers are referred to Hartigan (1975) for a technical discussion of clustering programs and algorithms similar to the one used here.

Again, referring to figure 1 (see page 17), the objective of the cluster analysis program is to group together courses (rows) that are most similar to each other in terms of the selected set of classification variables (columns). This is accomplished by iteratively forming groups of courses (clusters) such that the members of any one cluster are closer to the midpoint of their cluster than to the midpoint of any other cluster. When forming a cluster, regardless of the number of clusters in a solution, the program minimizes within group variance. Within group variance is similar to the variability of a group of courses around the mean of one variable. However, in this case within group variance refers to the variability of a group of courses around the centroid or means of the classification variables used.

[4] Dr. W. M. Swope, a TAEG economist, acquired the clustering program for use in this study.

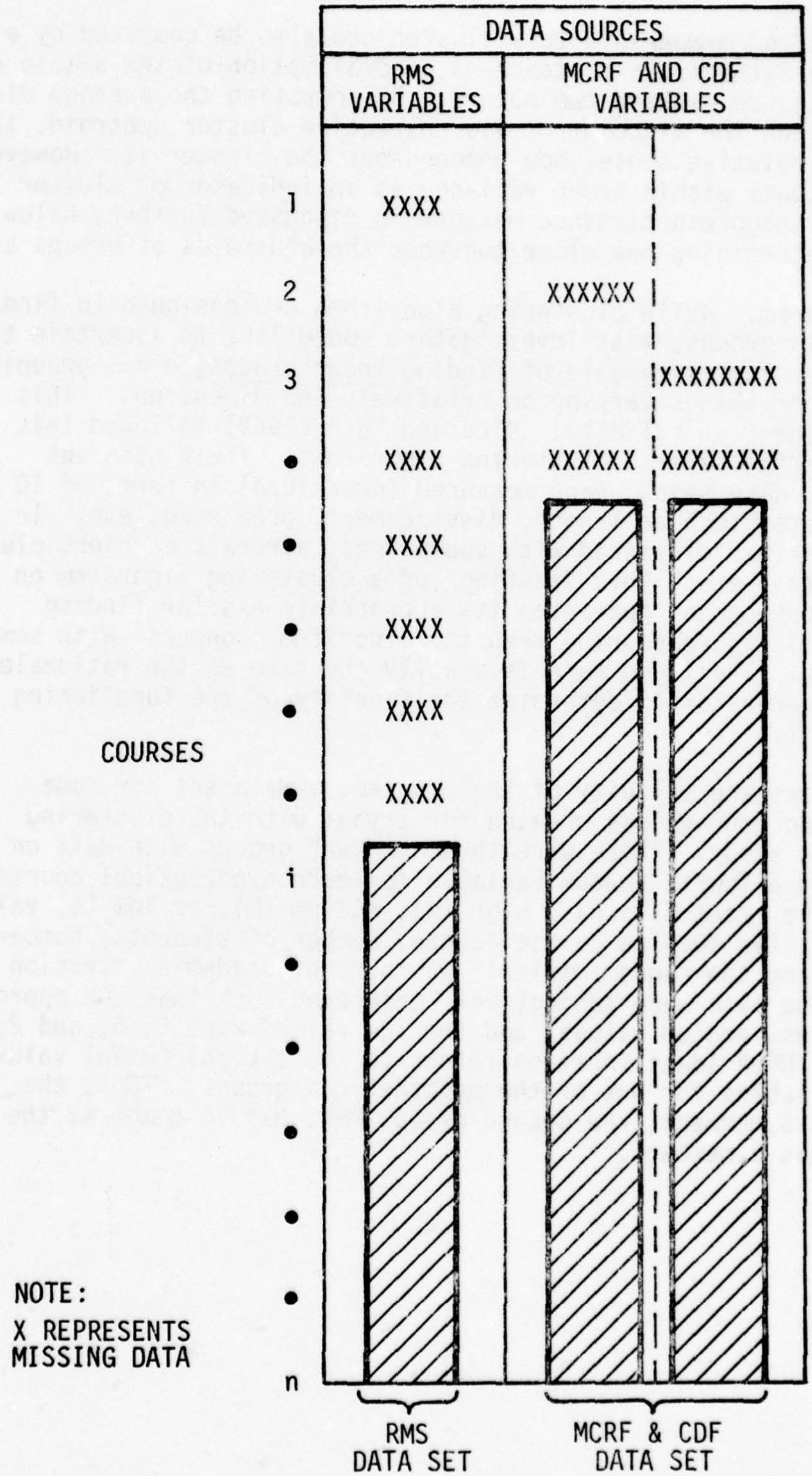

Figure 1. Schematic of the Course Data Matrix Showing Possible Missing Data by Source and Some Possible Data Sets for Analysis.

This "closeness" of membership to a cluster can also be computed by a measure analogous to Pythagorean distance--a generalization of the simple case of computing the distance between two points. By computing the average distances between each course and the midpoint of its respective cluster centroid, it can be determined, in a relative sense, how homogeneous the cluster is. However, the program used outputs within group variance as an indicator of cluster homogeneity. The Pythagorean distance measure is discussed further, below, in the context of determining how close together the centroids of groups are.

Validity of the Program. While clustering algorithms are designed to find or form hitherto unknown groups, most investigators would like to ascertain that the technique they employ is capable of finding known groups; e.g., groupings of physical objects or things varying on relatively few dimensions. This provides a partial check on validity. Rice and Lorr (1969) followed this practice while comparing several clustering algorithms. Their data set consisted of 33 U.S. Navy ships, each measured (described) in terms of 10 variables or attributes such as length, displacement, crew size, etc. In their results, submarines clustered with submarines, aircraft carriers clustered with aircraft carriers, etc. This "testing" of a clustering algorithm on data from known groups cannot guarantee its appropriateness for finding unknown groups, but it is reassuring when the algorithm "concurs" with some meaningful groupings. The logic here is exactly the same as the rationale for using a signal generator to determine the fidelity of the functioning of an electronic circuit.

To further assess the validity of the program, a data set for some hypothetical training courses was created for tryout with the clustering program used in this study. There were three "known" groups with data on three variables plus a fourth random variable for each hypothetical course. The known groups were created to have high (H), medium (M), or low (L) values on descriptive variables such as course length, number of students, number of annual convenings; and the random variable was percent academic attrition (see table 6). These data were subjectively generated such that the approximate means for high values, medium values, and the low values were 8, 5, and 2, respectively. The "HML" identification refers to the typical (mean) value of the first three variables for one of the hypothetical groups. Thus, the first group HML has 5 members; the second group, MHL, has 10 members; the third group, LMH, has 5 members.

TABLE 6. HYPOTHETICAL COURSE DATA SET

		VARIABLES			
	Course No.	(1) Course Length (In Weeks)	(2) Number of Students (In 100's)	(3) Number of Convenings Per Year	(4) Percent Academic Attrition
Group 1	HMLØ1	7	5	2	1
	HMLØ2	8	6	1	5
	HMLØ3	8	5	3	2
	HMLØ4	9	4	2	7
	HMLØ5	7	6	1	3
Group 2	MHLØ1	6	8	2	5
	MHLØ2	4	8	2	3
	MHLØ3	5	8	3	6
	MHLØ4	4	9	3	5
	MHLØ5	5	9	2	9
	MHLØ6	5	7	1	2
	MHLØ7	6	7	2	3
	MHLØ8	5	9	1	4
	MHLØ9	6	8	1	7
	MHL1Ø	4	8	3	8
Group 3	LMHØ1	3	5	7	9
	LMHØ2	1	6	8	8
	LMHØ3	2	4	9	6
	LMHØ4	1	4	8	4
	LMHØ5	2	6	9	1

The data from table 6 were entered together with the clustering program into a computer and on the second iteration (the program finds two clusters on the first iteration, three clusters on the second iteration, etc.) three clusters were formed as follows:

Group 1	HMLØ1	Group 2	MHLØ1	Group 3	LMHØ1
	HMLØ2		MHLØ2		LMHØ2
	HMLØ3		MHLØ3		LMHØ3
	HMLØ4		MHLØ4		LMHØ4
	HMLØ5		MHLØ5		LMHØ5
	MHLØ6		MHLØ8		
	MHLØ7		MHLØ9		
			MHL1Ø		

It can be readily observed that the clustering program did well in classifying the groups of hypothetical courses. It can also be seen that courses MHLØ6 and MHLØ7 were clustered with the first group. This was a defensible outcome in view of the fact that the data were subjectively generated and those two courses actually were more similar to the HML group. The means for each of the four descriptor variables for each of the three groups formed by the program are shown below.

Variable	Group 1	Group 2	Group 3
1	7.14	4.88	1.80
2	5.71	8.38	5.00
3	1.71	2.13	8.20
4	3.29	5.88	5.60

With the exception of the fourth variable, the clustered groups' means come close (by rounding) to the values of 8, 5, and 2 for the original "known" values for H, M, and L.

Clustering Strategies. Before actually clustering the sampled courses with complete data, two final considerations were addressed. The first was to determine on which data sets to apply the clustering program; the second concerned the selection of the "best" clustering solutions. As stated earlier, in most specific problem oriented applications the number of variables would be smaller, but since this study was aimed at showing the broader possibilities of applying the approach, it was necessary to choose data sets for clustering. The second consideration; i.e., choosing the "best" clustering solution(s) would have to be faced in any application.

Reexamination of figure 2 (page 27) reveals numerous possible data sets; e.g., any subset of "A" courses (rows), any subset of descriptor RMS and MCRF variables (columns), could be selected as the basis for clustering. However, not all of the data were appropriate for analysis. For example, there were not sufficient RMS data on the "C" courses; this precluded a cluster analysis to develop a classification of "A" and "C" courses on the basis of resource utilization descriptor variables. Consequently, the classification analysis based on economic (RMS) variables was limited to the "A" courses in the sample.

Combining RMS variables with MCRF variables was also not attempted for the above reason as well as the rationale that RMS variables constituted a different basis for classifying than MCRF variables, and the two bases should probably not be confused. A limited subset of CDF variables (20 of the least redundant) was used as a partial basis for the classification analysis. These were combined with the MCRF variables because they were complementary descriptors. A third subset of data for classification analysis was the MCRF variables, alone. This analysis was of greatest interest since the MCRF variables, like the RMS variables to some extent, represent data that are collected on all courses via a routine data reporting system to NITRAS. One of the main virtues to be derived from classification on the basis of the RMS and MCRF variables is that they require no primary data collection effort. In summary, the data sets selected for separate cluster analysis runs were:

1. RMS variables for "A" courses

2. MCRF and selected CDF variables for all courses

3. MCRF variables for all courses.

When to stop clustering, regardless of the data set, is a problem. The computer program used in the present analyses will successively form clusters of courses by finding the best fitting groupings for each iteration. That is, on the first iteration, on the basis of computed similarity between courses, the program will find a solution for two groups. On the second iteration, three groups are found; on the third iteration, four groups are found, and so on. Since the number of courses in the data set (sample) is fixed, the program theoretically could continue until the absurd solution of one cluster for each course was found. Determining when an acceptable clustering solution has been found followed a rational trade off between:

1. decrease in within group variance (or increase in similarity of courses within their respective clusters)

2. reaching the point where the distance between clusters starts to decrease; i.e., clusters are formed, but they are getting too close to each other, allowing far too much overlap between groups

3. a subjective judgment that four to eight groups may be a practical limit on the number of groupings.

Number 1, above, is part of the clustering program output, but it was plotted offline. Number 2 used the clustering program output of group means as an input to another program whose output, between group distances, was also plotted offline. Number 3 was a subjective opinion of the author which took into account practical limitations on the number of clusters.

A typical computer run in this study involved setting the program to compute twice as many clusters as would likely be useful; i.e., 10 to 12 clusters. Then for each solution, the within group variance was plotted to observe the increase in similarity among courses in each group as additional clusters were formed. This revealed a steady decline in within group variance.

A program was written which took the group means for each iteration (each iteration produced one solution) and computed the average distance between the midpoints of each group. For a typical clustering run this average distance was plotted and showed the distance increasing over the first three to five solutions (4 to 5 clusters of courses). Then the average distance between clusters began to drop, indicating that previously computed clusters were decomposing or being broken up into smaller subgroups. Finally, the subjective cutoff judgment was made in concert with the two statistical indicators--within group variance and between group distance.

USE OF CATEGORY DATA IN DECISION MAKING. The potential utility of classification systems has been noted earlier. It is not possible, however, to specify the use of classification category data in a "by the numbers" way. The uses to which classification data will be put in support of decision making depend greatly on the specific problem to which the methodology is applied. Since the purpose of this study was to demonstrate the general methodology, the use of category data for specific decision making problems was not the primary concern. However, the remaining sections of this report are relevant to this final step in the overall approach.

SECTION III

RESULTS

This section presents the quantitative outcomes of the clustering runs described under "Clustering Strategies" in the preceding section. Each basis for classifying courses is given in tabular form showing the descriptor variables and the raw data means for each group (the cluster program standardized the variables to have zero means and unit variances) found by the clustering program's best solution. These courses are described by both their respective descriptor variables' values and a CANTRAC description of each of the courses. Finding the most typical courses for each classification group was achieved via another computer program which rank ordered the courses in the appropriate data subset in terms of their computed similarity to the means for each group.

Similarity in this case is computed as follows:

$$D_{gc} = \sqrt{\sum_{i=1}^{n} (X_{gi} - X_{ci})^2}$$

Where D_{gc} = physical distance between a set of course values and the mean values of an established group or category.

i = refers to the $i^{\underline{th}}$ or any one of the classification variables.

n = the total number of classification variables.

X_{gi} = value of the established group or category mean on the $i^{\underline{th}}$ variable.

X_{ci} = value of the course to be classified on the $i^{\underline{th}}$ variable.

$\sum_{i=1}^{n}$ = as used in the formula above, this symbol indicates that the squared differences between values of the established group and an individual course should be summed over all of the classification variables.

This formula is recommended for comparing similarity of profiles (Nunnally, 1967).

RMS BASED CLASSIFICATION

It should be remembered that the data subset for this clustering run was limited to "A" courses with no missing data. Table 7 shows the selected results of that analysis. Within the data set of 108 "A" courses with complete data, the majority (91 courses) belong to Group 1. The variables that seem most discriminating between Group 1 and Group 2 (14 courses) represent huge differences in student salaries and military labor, both of which are obviously correlated with the number of students put through such courses. And, to some extent, Group 2 courses use up more equipment and supplies than Group 1. However, Group 3 (with only 3 courses) must be considerably more hardware intensive than labor intensive, since these courses used up a dramatically higher amount of equipment than Groups 2 and 3.

TABLE 7. RMS BASED CLASSIFICATION MEANS
(rounded to nearest thousand)

Name of Variable	Group Number 1	2	3
Military Costs	159,000	641,000	250,000
Civilian Costs	90,000	74,000	107,000
Equipment Deprec.	11,000	49,000	230,000
Equip. Maintenance	19,000	41,000	35,000
Supplies	9,000	23,000	8,000
Student Salaries	274,000	976,000	252,000

The CANTRAC descriptions of courses which are most typical of each group follow. For each group, the three courses with values on the classification variables nearest the mean of the cluster (group) are given. Courses appear in terms of increasing distance from the means of the cluster of which they are members.

RMS GROUP I

COURSE NUMBER: A-711-0015
TITLE: Steelworkers Class A

PURPOSE:

To provide basic technical knowledges and basic practical skills in preparation for immediate usefulness as steelworkers.

SCOPE:

OXY-MAPP gas welding and cutting: Electric arc welding: steelworker mathematics; blueprint reading; sheetmetal layout and fabrication: placing and tying, reinforcing steel for concrete construction, identifying parts of a pre-engineered building.

PREREQUISITES:

Selected CN, CA, SN, and FN with BTB: GCT+MEC+SHO=150; ASVAB: WK+MC+SI=150. Candidates should be volunteers for Group VIII. Vision correctable to 20/20 is required. (ARI + MECH = 100 for reserves.)

COURSE NUMBER: A-670-0010
TITLE: Instrumentman Class A

PURPOSE:

To provide students with the basic knowledge and skills required to prepare them for early usefulness in the instrumentman rating in office machine repair and mechanical instrument repair and calibration shops.

SCOPE:

Instruction in basic mathematical operations with whole numbers, fractions and decimals; proper use of common hand and power tools; heat treating of metals; basic machine theory required for the maintenance, troubleshooting and overhaul techniques for mechanical office machines. Instruction in the theory, principle of operation, construction and overhaul and calibration techniques for pressure instruments, mechanical tachometers, thermometers, torque wrenches and liner measuring instruments.

PREREQUISITES:

SN, FN with BTB: GCT+MEC+SHO=163; ASVAB: WK+MC+SI=163. Normal color perception. Vision 20/100 correctable to 20/20.

SPECIAL INFORMATION:

This course is self-paced, hence actual course length will vary with the aptitude and experience of the trainee.

COURSE NUMBER: A-123-0127
TITLE: Torpedoman's Mates Class A1

PURPOSE:

To provide pay grades E-1 - E-4 the basic technical knowledge and skills required to accomplish operational and preventative maintenance on torpedo and launching equipment aboard submarine and surface combatant ships. Also prepares those personnel scheduled to become TM technicians for further specialized training.

SCOPE:

Provides a general knowledge of the characteristics and capabilities of advanced undersea weapons and associated handling and launching equipments. Trainees are provided 3 weeks of common core training, then an additional 3 weeks of submarine or surface torpedoes, depending upon ultimate fleet assignment. Trainees designated SS are given an additional 2 weeks on submarine launching equipment.

PREREQUISITES:

ARI + MECH or AR + MC = 96. CONFIDENTIAL clearance. Normal color perception.

SPECIAL INFORMATION:

Students scheduled for TM "A1" Submarine training must volunteer as specified in CHNAVPERS Manual, meet physical standards as set forth in BUMED Manual, have a background investigation initiated and have a preliminary reliability screening as set forth in BUPERSINST 5510.11 series, accomplished prior to transfer to school.

RMS Group II

COURSE NUMBER: C-602-2012
TITLE: Aviation Electrician's Mate Course Class A1

PURPOSE:

To prepare selected students with general fundamental knowledge and skills required to perform scheduled and unscheduled maintenance on representative Naval Aircraft electrical/electronic instrument systems under limited supervision and for entry into Class C Schools for specific systems. Completion of the school prepares the student for designation as an Aviation Electrician's Mate Striker.

SCOPE:

Reading of schematics and wiring diagrams, basic troubleshooting procedures, signal tracing of basic vacuum tube and transistorized circuits. Principles of aircraft electrical power generation, regulation, distribution, and troubleshooting. Basic aircraft instruments, electrohydraulic systems, ignition systems, lighting circuits, flight trim, flight control, fuel quantity, and VIDS - MAF usage; troubleshooting, operational checks, and maintenance procedures for all aircraft electrical systems.

PREREQUISITES:

Navy personnel must have a minimum combined score of BTB: ARI+2ETST=160; ASVAB: AR+MK+EI+GS=212. Marine Corps personnel must have a GT=105, GM=110, and ETST=55. Normal color perception is required. Electrical training, experience, or aptitude desired. Students must volunteer for aviation duty. Also, students must complete Aviation Fundamentals Course, Class AP, and the Basic Electricity and Electronics Course, Class AP, or equivalent. Security clearance is not required.

SPECIAL INFORMATION:

Obligated period of service: Twenty-five months upon entrance. Marine Corps personnel serving in initial enlistment must have 2 years active duty remaining upon graduation. If in a retraining status, 30 months of active obligated service are required upon reporting to school, or agreement to extend or reenlist to provide 30 months of obligated service upon reporting to school.

COURSE NUMBER: A-121-0142
TITLE: Polaris/Poseidon Electronics Class A

PURPOSE:

This course of instruction is intended to prepare recruits and/or convertees for further training in advanced courses of instruction in Fleet Ballistic Submarine Navigation, Fire Control, and Missile Subsystems by providing a basic knowledge of electricity, solid state electronics and related mathematics, inertial guidance theory, computer fundamentals and digital logic principles.

SCOPE:

This course is primarily an academic or theoretical instead of a practical or mechanical program, although laboratory sessions are scheduled in all areas of instruction. The Polaris Electronics "A" School is separated into three specific divisions; Basic Electricity (6 weeks) Basic Electronics (7 weeks), and the Computer Fundamentals (4 weeks). The Basic Electricity Division provides instruction in the mathematics related to electronics including powers and exponents, ratio and proportion, roots and radicals, electronics related algebra and trigonometry; the basic electrical science of atomic structure, electrostatics, and magnetism; electron theory related to voltage, current, resistance, and reactance as applicable to both alternating and direct current series, parallel, and series parallel circuits; coupling; basic test equipment; electronics safety. The Basic Electronics Division instruction includes the solid-state theory pertinent to the study of power supplies, filters and regulators; amplifiers; biasing, stabilization and regulation; limiters, clampers, coupling and regulation; oscillators and multivibrators; interrogators and differentiators; Newtonian physics; synchros, servos, and resolvers; gyro principles and basic stable platform. The Computer Fundamental Division covers: numbering systems, their interrelationships and application; computer mathematics; digital logic circuitry; basic computing units, including registers, counters, timing circuits; input/output devices, storage/memory devices, and arithmetic circuits and controls; basic computer programming and program analysis; basic computer operation and digital logic troubleshooting.

PREREQUISITES:

SECRET security clearance (forward results to Commanding Officer, Naval Guided Missile School, if incomplete upon selection). E-3 to E-6 with normal color perception and hearing. BTB: ARI+2ETST=171; ASVAB: MK+EI+GS=163, +AR=225. High School graduate or GED equivalent. Submarine duty volunteer. Must meet physical standards as set forth in Manual of the Medical Department, NAVMED P-117, Art, 15-29. Satisfactory reliability screening in accordance with BUPERINST 5510.11 (series) must be completed prior to execution of orders to this course of instruction.

SPECIAL INFORMATION:

Final selection for ETN, FTB, or MT determined by Commanding Officer, Naval Guided Missile School prior to graduation from the "A" School.

COURSE NUMBER: C-210-2010
TITLE: Aviation Antisubmarine Warfare Operator, Class A1

PURPOSE:

To provide selected enlisted Navy personnel with the knowledge and skills which will enable graduates to readily assimilate further training in a specific ASW platform and contribute to the fulfillment of the knowledge requirements for Aviation Antisubmarine Warfare Operator (AW) at the E-4 level.

SCOPE:

Instruction includes basic operation of airborne antisubmarine detection equipment including its capabilities, limitations, employment; fundamentals of antisubmarine warfare as it applies to ASW tactics and the environmental and oceanographic conditions affecting sensor equipment operation. In addition, the course includes basic sensor operator station equipment signal flow troubleshooting utilizing typical block diagrams. Airborne ASW systems include radar, magnetic anomaly detection, ECM, sonobuoys, and various acoustic sensor systems.

PREREQUISITES:

Navy enlisted personnel physically qualified and psychologically adapted for flight as required by the Manual of the Medical Department, U.S. Navy, Article 15-69. Volunteer for the duty involving flying. Combined BTB score of GCT+ARI=110, or ASVAB score of WK+AR=110. National Agency Check and able to qualify for a security clearance of SECRET. Have a clear speaking voice. No speech impediment. Visual acuity DDVA no worse than 20/200 OD/OS correctable to 20/20. Normal color perception. Normal hearing. Must be Class III swimmer with demonstrated strong potential to achieve qualification as Class I swimmer during AW course training.

SPECIAL INFORMATION:

Training costs incidental to attendance at this course are funded by the Navy. Any TAD, travel, and other costs are borne by the parent service or government agency involved.

Twenty-two months of obligated service is required. If in a retraining status, 25 months of active obligated service are required upon reporting to school, or agreement to extend or reenlist to provide 25 months obligated service upon reporting to school.

RMS GROUP III

COURSE NUMBER: A-652-0018
TITLE: Engineman Class A

PURPOSE:

To provide training in components and component parts, basic knowledge and skills related to the E-3/E-4 level, develop basic maintenance skills for small boat diesel engines, and provide indoctrination in shipboard engineering watches at the E-3/E-4 level.

SCOPE:

Individualized, self paced instruction in metal fasteners and hand tools, pipe tubing and fittings, packing, gaskets and insulation; valves, traps, bearings and lubrication, pumps, precision measuring instruments and technical manuals, heat properties and heat exchangers; indicating devices; turbines, couplings and gears; LO purifiers and strainers; LP air compressors, and oil pollution; internal combustion engine construction and component systems; maintenance and repair of small diesel engines, and watch indoctrination in messenger of the Watch and Petty Officer of the Watch for Main Propulsion diesel engines.

PREREQUISITES:

Selected FA and FN meeting the following criteria: BTB: GCT+MEC+SHO=156; ASVAB: WK+MC+SI=156.

COURSE NUMBER: A-231-0045
TITLE: Cryptologic Technician T - Class A Preparatory

PURPOSE:

To provide basic instruction and practical experience for the prospective CTT in intercept of non-Morse type communications.

SCOPE:

Includes instruction in the fundamental concepts of communications and techniques required to perform intercept of selected non-Morse signals. Instruction in International Morse Code is presented and the student learns to transcribe 8 GPM using the Morse Code Trainer and 15 GPM using paper and pen and develops skills to touch type at 25 WPM.

PREREQUISITES:

WK + AR = 100 and RADIO 60 (waiverable to 55). Normal hearing. Must have completed the 10th grade or higher. Typing ability desired. Be eligible for TS clearance and be eligible for access to SI as determined by COMNAVSECGRU.

SPECIAL INFORMATION:

This is an Executive Agent course. This is a self-paced individualized learning system course.

CDF AND MCRF BASED CLASSIFICATION

This clustering of courses was based on 20 CDF variables and six MCRF variables. This is the richest data base used for classification analysis. The results of the CDF and MCRF based clustering solution produced the four groups of courses in table 8. To help identify the CDF variables, the reader is again referred to appendix A.

With these many classification variables, no one or two variables distinguish one group from another. Thus, the reasons for one group differing from another are complex and appear to be a function of the number of variables. It would be possible, theoretically, to discover the weights for the variables that would maximally discriminate between the groups (Discriminant Function Analysis), but that does not seem warranted or necessary in this instance. Another reason for the difficulty in interpreting the results may be the diversity of attributes represented. This is particularly true of the CDF variables (3 through 17) which fall under the general heading "kinds of skills trained." It is sufficient, for purposes of this example, to say that while these groups are homogeneous over the set of classification variables, their profiles of group means overlap considerably.

TABLE 8. CDF AND MCRF BASED CLASSIFICATION MEANS

NAME OF VARIABLE	Group Number 1	2	3	4
1. % Time Devoted to Exams or Quizzes in Group Paced Instruction in the Classroom	10%	10%	<5%	10%
2. Self-paced Instructions Supported by Media "Other"	.75	.61	.21	.38
3. Operate Equipment Using Controls "Other"	.67	.44	.03	.41
4. Maintenance Skills: Hydraulic	.45	.48	.16	.31
5. Maintenance Skills: Structural (Air Frames, Hulls)	.37	.28	.14	.24
6. Maintenance Skills: Use Special Tools	.26	.25	.24	.17
7. Maintenance Skills: Follow Routine, Pre-Established Procedures	.19	.23	.59	.17
8. Maintenance Skills: Welding	.14	.14	.24	.38
9. Maintenance Skills: Other	.23	.09	.09	.28
10. Communicate Information: Sending/Receiving/Deciphering Coded Information	.24	.12	.12	.21
11. Numerical Calculation	.18	.28	.10	.24
12. Filling Out Forms	.21	.32	.36	.38
13. Process Information	.20	.36	.22	.14
14. Keep Records	.21	.23	.09	.21
15. Interpret/Estimate/ Translate or Plot Target Data	.24	.21	.12	.10

TABLE 8. CDF AND MCRF BASED CLASSIFICATION MEANS (continued)

NAME OF VARIABLE	Group Number 1	2	3	4
16. Detect/Analyze/Classify Signals	.25	.20	.09	.17
17. Operate Ordnance Equipment	.23	.21	.03	.34
18. Graduates Go to Another School (Course)	.23	.22	.50	.21
19. Graduates Assigned to a Ship	.16	.34	.29	.28
20. Graduates Assigned to a Shore Billet	.28	.29	.21	.24
The following are MCRF variables:				
21. Service Support: Navy = 1; Not Navy = 0	.30	.30	.81	.24
22. Navy Enlisted Code Awarded: Yes = 1; No = 0	.34	.39	.45	.38
23. Number of Rating Served by Course: General; i.e., more than 6 ratings = 1; less than 6 ratings = 0.	.46	.27	.09	.38
24. Course Length in Days	2.28	9.51	48.83	8.72
25. Frequency of Course Convenings Per Year	2.81	19.31	79.53	24.62
26. Total Planned Students in FY 1974	23.75	67.30	481.53	120.10

The CANTRAC descriptions of courses most typical of these 4 groups are given below.

CDF/MCRF GROUP I

COURSE NUMBER: C-102-3712
TITLE: 1202 KHA/1 Air Data Computer Intermediate Maintenance, AYB

PURPOSE:

To provide avionics maintenance personnel with the required knowledge and skills to enable them to perform the necessary maintenance on the air data computer in the AV-8A aircraft at intermediate levels.

SCOPE:

This course covers air data computer description and operation, testing and maintenance procedures.

PREREQUISTIES:

AV(A) School graduate or equivalent background knowledge of electronics. Source Ratings - AT, AQ, AE. Security Clearance - CONFIDENTIAL.

SPECIAL INFORMATION:

This course is conducted by: NAMTD 1006 (course manager)

COURSE NUMBER: C-102-3013
TITLE: AN/ARR-69 UHF Radio Receiver Intermediate Maintenance BCA

PURPOSE:

To provide fleet maintenance personnel with training on the theory of operation and the latest procedures in maintaining, servicing and troubleshooting the AN/ARR-69 UHF radio receiver within intermediate maintenance levels.

SCOPE:

This course covers introduction to AN/ARR-69 UHF radio receiver, circuit analysis and intermediate maintenance procedures.

PREREQUISITES:

Graduate of AV(A) school or equivalent background knowledge of electronics, source rating - AT. Security Clearance - None.

SPECIAL INFORMATION:

This course is conducted by:

NAMTD 1013
NAMTD 1014
NAMTD 1017
NAMTD 1024
NAMTD 1033 (Course Manager)
NAMTD 1034

COURSE NUMBER: C-602-3716
TITLE: A-4 Personnel Environmental Systems Organizational Maintenance AEH

PURPOSE:

To provide maintenance personnel with instructions on maintenance techniques, operation of systems, and servicing procedures.

SCOPE:

This course covers through the organizational level of maintenance. It includes oxygen systems, aircraft air conditioning, cockpit enclosure and ejection seat maintenance.

PREREQUISITES:

AME(A) School graduate. Source Rating - AME. Security Clearance - None

SPECIAL INFORMATION:

This course is conducted by: NAMTD 1100 (Course Manager)

CDF MCRF GROUP II

COURSE NUMBER: C-603-3532
TITLE: P-3 Airconditioning, Pressurization and Utilities Organizational Maintenance PKA

PURPOSE:

To teach maintenance personnel the latest maintenance and servicing procedures required to maintain the air conditioning, pressurization and utility systems of the P-3 aircraft at the organizational level.

SCOPE:

This course covers organizational maintenance on the air conditioning, pressurization, and utilities. This includes air conditioning, air conditioning system, temperature control system, pressurization, and utilities.

PREREQUISITES:

AM(A), AE(A) School graduate or equivalent background. Source rating - AE/AME. Security Clearance - None.

SPECIAL INFORMATION:

This course is conducted by:

NAMTD 1011 (Course Manager)
NAMTD 1012

This course is contained in Phase II of:

D-602-1060
E-602-1060

COURSE NUMBER: C-646-3531
TITLE: P-3A/B Armament Systems Organizational Maintenance, PJM

PURPOSE:

To provide fleet maintenance personnel with instruction in latest maintenance and servicing of the P-3A/B ordance systems including circuit analysis, troubleshooting, and repair by using applicable test equipment, publications and procedures.

SCOPE:

This course covers organizational maintenance on the ordnance system. This includes kill stores system, search stores systems, and related systems.

PREREQUISITES:

AO(A) School graduate or equivalent background knowledge of ordnance. Source Rating - AO. Security Clearance - CONFIDENTIAL.

SPECIAL INFORMATION:

This course is conducted by:

NAMTD 1011
NAMTD 1012 (Course Manager)

This course is contained in Phase II of:

D-646-1040
E-646-1040

COURSE NUMBER: C-602-3791
TITLE: A-7E Electrical and Instrument Systems Organizational Maintenance AMW

PURPOSE:

To provide fleet maintenance personnel with training in organizational maintenance of the A-7E electrical and instrument systems, which includes component location, function and theory of operation by using applicable training aids and instructional material.

SCOPE:

This course covers electrical power and lighting systems, pitot-static and instrument systems, electro-hydraulic and utility systems, and power plant related systems.

PREREQUISITES:

Graduate of AE (A) School or equivalent background knowledge of electricity, Source Rating - AE. Security Clearance - None.

SPECIAL INFORMATION:

This course is conducted by:

NAMTD 1033 (Course Manager)
NAMTD 1034

This course is contained in Phase II of:

D-602-1550
E-602-1551

COURSE NUMBER: A-130-0029
TITLE: *Submarine Sonar Technician STS Class A*

PURPOSE:

To provide the Fleet with Sonar Technicians qualified to:

A. Perform submarine sonar watchstander duties to include:

1. Proper watchstanding procedures
2. Target recognition procedures
3. Aural and physical classification procedures
4. Fire control plotting procedures
5. Submarine noise reduction procedures

B. Operate submarine sonar systems and auxiliary equipments, in all modes, in accordance with operating procedures contained in system operating and system technical manuals, adhering to all applicable safety precautions.

SCOPE:

This course includes instruction in the operation and system block diagram orientation on applicable installed submarine sonar systems, subsystems and auxiliary equipments. Includes sonar fundamental acoustic sources, classification procedures, sonar watchstanding procedures, underwater fire control, submarine noise reduction and maintenance and material management 3-M System.

PREREQUISITES:

CONFIDENTIAL clearance required in orders, SECRET clearance must have been initiated.

SPECIAL INFORMATION:

Trainees must meet physical qualifications for submarine duty in addition to meeting minimum auditory requirements for STS personnel by successful completion of audiometer. For further information concerning the eligibility requirements and course quotas, call Resources Management Officer, Telephone 225-4400/4408 or AUTOVON 957-4400/4408.

COURSE NUMBER: C-602-2010
TITLE: Aircrew Survival Equipmentman, Class A1

PURPOSE:

To prepare and qualify Navy, Marine Corps, and Coast Guard personnel with the basic technical knowledge and skills required to perform job related tasks pertinent within the scope of the aircrew survival equipmentman rating at their initial duty assignment.

SCOPE:

Aviation fundamentals, parachute rigging, packing and maintenance. Oxygen and carbon dioxide equipment and systems. Basics of standard Navy maintenance and material management system. Inflatable equipment and systems, rigid seat survival kits. Rescue kits and devices. Pilots' personal and aircrew survival equipment. Operation and basic maintenance of sewing machines. Basic fabric work.

PREREQUISITES:

BTB: GCT+MEC+SHO=156; ASVAB: WK+MC+SI=156. Marine Corps personnel must have GT=100, GM=100. Volunteer for aviation duty. While at school, personnel may volunteer to make premeditated freefall parachute jumps. Those who volunteer to make premeditated jump must meet physical qualifications equal to service entrance examinations, provided that no injury or illness is apparent in such examinations prior to transfer to the school. The aviation fundamentals course is a prerequisite to the basic Al course.

SPECIAL INFORMATION:

Satisfactory completion of C-602-2010 course is a requirement for entrance into PR rating. All instruction is self-paced, and is oriented to those tasks to which the student will be assigned, resulting in variable lengths of course tracks.

COURSE NUMBER: A-210-0011
TITLE: Ocean Systems Technician Class A

PURPOSE:

To provide basic knowledge and skills for operation and preventive maintenance of the AN/FQQ (Series) Sonar Systems.

SCOPE:

This course provides instruction in the theory and operation of the AN/FQQ (Series) Sonar Systems and related components. It also provides a three week module of instruction in basic electronic test equipment, and basic preventive maintenance procedures specifically oriented to the AN/FQQ (Series) Equipments. It is jointly attended by officers in Course A-2G-0018 for the first seven weeks of instruction. (Officers are not trained in maintenance.)

PREREQUISITES:

SECRET Security Clearance must be certified for all students prior to commencement of this course. Enlisted students must have a minimum battery test score of BTB: GCT+MECH+ETST=156; ASVAB: WK+MK+EI+MC+GS=258.

SPECIAL INFORMATION:

1. Contact quota control, AUTOVON 224-2891 for convening frequency (ACDU USN).

2. This course is of 10 weeks duration.

3. This course contains no training related to diving, scuba or salvage. Enlisted personnel desiring training in these fields should consult the index of this publication for further information. This course does not involve training in oceanography.

4. Temporary housing in the Norfolk area is scarce and expensive. Personnel with dependents ordered to this course should take this into consideration prior to reporting. Recommend personnel contact the school for the latest housing information (AUTOVON 690-8874).

CDF/MCRF GROUP IV

COURSE NUMBER: C-646-3104
TITLE: CVA/CV Air Launched Weapons General Ordnance, WCB

PURPOSE:

To teach conventional weapons handlers of the Weapons Department who are assigned to aircraft carriers the procedures and safety precautions in the complete chain of events of air launched weapons handling, including: receiving, inspection, strike down, storage, magazine breakout, strike up, assembly, and fuzing.

SCOPE:

This course covers orientation, ammunition stowage, miscellaneous munitions and associated equipment, aircraft bombs, fuses, and associated equipment, and general missile handling.

PREREQUISITES:

AO/GMG E-4 and below. Source Rating - AO/GMG. Security Clearance - CONFIDENTIAL.

SPECIAL INFORMATION:

This course is conducted by:

NAMTD 4030
NAMTD 4031 (Course Manager)
NAMTD 4032
NAMTD 4033

COURSE NUMBER: C-646-3806
TITLE: F-4B/J Armament, Missile and Weapon Control System Organizational Maintenance FAP

PURPOSE:

To provide maintenance personnel with instruction in the function and operation of the armament release system, missile and weapon control system, preflight, postflight, handling, safety and maintenance procedures dealing with armament and armament equipment at the organizational level.

SCOPE:

This course covers systems familiarization, F-4B/J missile launchers, centerline rack and wing fuel tank and pylon, multiple weapons systems, AN/AWW-8 and AWW-4 fuze function control system and AN/ALE-29A countermeasure chaff dispenser.

PREREQUISITES:

AO(A) School graduate. Background of basic electricity. Source rating - AO. Security Clearance - None.

SPECIAL INFORMATION:

This course is conducted by:

NAMTD 1013 (Course Manager)
NAMTD 1014

This course is contained in Phase II of:

D-646-1340
E-646-1340

COURSE NUMBER: C-646-3781
TITLE: A-7A/B Armament Systems Organizational Maintenance ALK

PURPOSE:

To provide maintenance personnel with a thorough understanding of the B7 Armament System in order to operate and maintain the system through organizational level maintenance.

SCOPE:

This course covers maintenance on the fuselage stations and control systems, wing pylons and associated equipment, armament system control, electrical fuzing system, and internal gun systems.

NOTE: Supervised practical training to be provided by Readiness Squadrons.

PREREQUISITES:

AO(A) School graduate or equivalent background. Source Rating - AO. Security Clearance - CONFIDENTIAL.

SPECIAL INFORMATION:

This course is conducted by:

NAMTD 1033
NAMTD 1034 (Course Manager)

This course is contained in Phase II of:

D-646-1440
E-646-1440

MCRF BASED CLASSIFICATION

This classification result is less complex than the previous one because it is based on only MCRF variables. Table 9 shows the group means for the five groups of courses found in the best solution. Of the 428 courses for which there were complete data in the data set for this cluster run, over one-half (252 courses) were in Group 4. The remaining groups were fairly uniform

TABLE 9. MCRF BASED CLASSIFICATION MEANS

NAME OF VARIABLE	Group Number 1	2	3	4	5
1. Service Support: Navy = 1; Not Navy = 0	.00	.91	1.00	1.00	1.00
2. Navy Enlisted Code (NEC) Awarded: Yes = 1; No = 0	.86	.88	.52	.83	.73
3. Number of Ratings Served by Course: General; i.e., more than 6 ratings = 1; less than 6 ratings = 0	.75	.84	.05	.74	.62
4. Course Length in Days	10.66	6.34	37.02	4.37	24.85
5. Frequency of Course Convenings Per Year	5.91	10.88	95.05	8.86	27.13
6. Total Planned Students in FY 1974	61.66	20.84	653.40	41.65	73.17

in size, containing from 30 to 60 courses each. Group 3 is quite distinctive because of its high average annual number of students. Group 1 stands out by virtue of its service support being provided primarily by services other than Navy. Otherwise, Group 1 is fairly similar to Groups 2 and 4--in that courses have relatively short average durations, few annual convenings, and a high probability of awarding an NEC. The most typical courses for each of the Groups follow:

MCRF GROUP I

COURSE NUMBER: C-602-3791
TITLE: A-7E Electrical and Instrument Systems Organizational Maintenance AMW

PURPOSE:

To provide fleet maintenance personnel with training in organizational maintenance of the A-7E electrical and instrument systems, which includes component location, function and theory of operation by using applicable training aids and instructional material.

SCOPE:

This course covers electrical power and lighting systems, pitot-static and instrument systems, electro-hydraulic and utility systems, and power plant related systems.

PREREQUISITES:

Graduate of AE (A) School or equivalent background knowledge of electricity. Source Rating - AE. Security Clearance - None.

SPECIAL INFORMATION:

This course is conducted by:

NAMTD 1033 (Course Manager)
NAMTD 1034

This course is contained in Phase II of:

D-602-1550
E-602-1551

COURSE NUMBER: C-603-3532
TITLE: P-3 Airconditioning, Pressurization and Utilities Organizational Maintenance PKA

PURPOSE:

To teach maintenance personnel the latest maintenance and servicing procedures required to maintain the air conditioning, pressurization and utility systems of the P-3 aircraft at the organizational level.

SCOPE:

This course covers organizational maintenance on the air conditioning, pressurization, and utilities. This includes air conditioning, air conditioning system, temperature control system, pressurization, and utilities.

PREREQUISITES:

AM(A), AE(A) School graduate or equivalent background. Source rating - AE/AME. Security Clearance - None.

SPECIAL INFORMATION:

This course is conducted by:

NAMTD 1011 (Course Manager)
NAMTD 1012

This course is contained in Phase II of:

D-602-1060
E-602-1060

COURSE NUMBER: A-121-0263
TITLE: MTRE MK 3 Measurement, Display and Simulation Groups Advanced Training

PURPOSE:

To provide instruction and practical training on the measurement, display and simulation groups of MTRE MK 3.

SCOPE:

This course provides advanced/refresher training to MT's on the theory to support troubleshooting on the following drawers:

1. Guidance Control
2. Platform Control
3. Upper Display
4. Lower Display
5. Test Point Selector
6. Register and Self-Test
7. Comparator
8. Indicator and Control
9. Printer

Lab sessions provide the student the opportunity to develop the necessary skills to adjust, calibrate and effectively troubleshoot and repair the drawers listed.

PREREQUISITES:

MT 3317

SPECIAL INFORMATION:

There are three MTRE courses available, and when possible, should be attended in the following sequence: A-121-0264, A-121-0262, and A-121-0263.

MCRF GROUP II

COURSE NUMBER: C-602-3716
TITLE: A-4 Personnel Environmental Systems Organizational Maintenance AEH

PURPOSE:

To provide maintenance personnel with instructions on maintenance techniques, operation of systems, and servicing procedures.

SCOPE:

This course covers through the organizational level of maintenance. It includes oxygen systems, aircraft air conditioning, cockpit enclosure and ejection seat maintenance.

PREREQUISITES:

AME(A) School graduate. Source Rating - AME. Security Clearance - None.

SPECIAL INFORMATION:

This course is conducted by:

NAMTD 1100 (Course Manager)

COURSE NUMBER: C-102-3031
TITLE: AN/APN-154(V) Radar Beacon Intermediate Maintenance BNB

PURPOSE:

To provide maintenance personnel with training at the intermediate maintenance level on the complete AN/APN-154(V) radar beacon including the use of associated test equipment.

SCOPE:

This course covers general information, AN/APN-154 radar beacon, and alignment and troubleshooting.

PREREQUISITES:

AV(A) School graduate or equivalent background. Source Rating - AT. Security Clearance - None.

SPECIAL INFORMATION:

This course is conducted by:

NAMTD 1024
NAMTD 1033
NAMTD 1034
NAMTD 1078 (Course Manager)

COURSE NUMBER: J-644-0914
TITLE: MAUW Shop Nuclear Weapons Technical

PURPOSE:

To train personnel in the special administrative and technical operational procedures specific to a MAUW Shop with a nuclear weapons capability.

SCOPE:

A. Fundamentals and technical administration, effects, security, weapons theory, hazards, radiation detection instruments, nuclear weapons safety program, reliability program, couriers and guards, technical and stockpile reports, accidents and incidents, technical inspections and modernization, logistics.

B. Subjects as applicable to the MK 57 weapon; familiarization, drop options, publications, records, reports, test and handling equipment, modifications and alterations, inspections and test criteria, assembly, tests, inspections and storage requirements, CNO Safety Rules, ship procedures and techniques.

PREREQUISITES:

Officers or rated ordnance personnel and designated strikers whose duties require a knowledge of the operational and administrative procedures for the MK 57 weapon. Non-rated, non-designated personnel must be graduates of Basic Nuclear Weapons, J-644-0916, and have 6 months in-shop training. A final SECRET clearance plus reliability screening in accordance with BUPERINST 5510-11C is required. A statement of clearance with its basis, plus the date of reliability screening must be forwarded by mail or message to reach COMNUWPNTRAGRULANT at least 1 week prior to the class convening date.

SPECIAL INFORMATION:

This course supersedes CIN J-4E/644-9142.

MCRF GROUP III

COURSE NUMBER: A-823-0012
TITLE: Ships Serviceman Class A1

PURPOSE:

To provide basic technical knowledge and skills required to prepare personnel for the lower Petty Officer rates in the Ship's Servicemen ratings.

SCOPE:

Introduction to the SH rating and its function aboard ship and within the Navy. Additionally, the course will cover basic SH records-keeping, face-to-face skills, and accountability for ships store stock.

PREREQUISITES:

Selected SA and SN with BTB: GCT+ARI=100; ASVAB: WK+AR=100, direct from recruit training or afloat who have some experience or have shown interest in the resale field.

COURSE NUMBER: C-602-2015
TITLE: Aviation Structural Mechanic E, Safety Equipment Course, Class A1

PURPOSE:

To provide selected enlisted Naval personnel with the basic technical skills and knowledge which will lead to the fulfillment of the technical requirements for Aviation Structural Mechanic E (Safety Equipment), Third Class.

SCOPE:

Aviation publications. Documentation of maintenance forms. Schematic interpretation. Canopy and ejection seat systems. Aircraft pressurization. Air Conditioning and auxiliary bleed air systems. Gaseous and liquid oxygen systems. Fixed fire extinguishing systems. Life raft release systems. Aircraft inspections. Fuels, oils, and lubrication. Dye penetrant inspection. Corrosion control. Preservation of aircraft.

PREREQUISITES:

Navy personnel must have combined BTB score of GCT + MECH = 96 or ASVAB score of WK + MC = 96. Marine Corps personnel must have GT-95 and GM-90. Volunteer for aviation duty. Normal color perception. Metalsmith or machine shop experience or training is desirable. Graduate of Aviation Fundamentals School, Class AP, C-000-2010.

SPECIAL INFORMATION:

Satisfactory completion of the AME(A1) Course is required for advancement to AME3.

COURSE NUMBER: C-222-2010
TITLE: Air Controlman School, Class A1

PURPOSE:

To provide selected aviation enlisted personnel with the basic control tower operator knowledge to meet the requirements of the Federal Aviation Administration for certification and the technical knowledge and skills which when followed by practical experience will lead to the fulfillment of the technical requirements for Air Controlman Third Class.

SCOPE:

This school provides those subjects and basic simulated operations concerned with air traffic control which are prerequisites for functioning as an air controlman apprentice in a Base Operations, a Control Tower and/or a Terminal Radar environment.

(1) Block I. FAA Certification: Airport traffic control, En Route Traffic Control, Air Traffic Rules, Flight Assistance Service, aviation communications, aviation weather, air navigational aids and basic air navigation. The Federal Aviation Administration Airman Examination for Control Tower Operator is administered.

(2) Block II. Base Operations: Flight Planning Facilities, publication and services; teletype operations, departure and arrival station functions including flight plan handling, communications, flight progress strips and flight reporting requirements. A typical functioning Base Operations is provided under simulated conditions.

(3) Block III. Control Tower Operations: Terminal facility equipment; airport facilities and lighting; visual signals; airport traffic control; taxi, departure and arrival procedures; aircraft characteristics and identification; and IFR and VFR terminal separation procedures. Simulated control tower operation involving local control, ground control and flight data operator functions are provided.

(4) Block IV. Terminal Radar Operations (GCA): Surveillance and precision radar familiarization; basic surveillance radar control training and precision approach control (GCA) training are provided using simulated aircraft targets.

PREREQUISITES:

Navy personnel - BTB: GCT+ARI=110; ASVAB: WK+AR=110. Marine personnel - GT-110, PA-105. Before being transferred to this course, medical records must include a complete standard form 88 indicating that within four months prior to entering the course the candidate has been examined and found to be physically qualified to control air traffic as set forth in the Manual of the Medical Department. Students must also possess written proof of physical qualifications (FAA Form 8500-9, Medical Certificate Class II). Students must have completed the Aviation Fundamentals Course Class AP, or have attained the rate of Airman or higher, and be at least 18 years of age upon enrollment.

SPECIAL INFORMATION:

Personnel reporting without medical certification in accordance with the prerequisites above will not be accepted for training unless orders or endorsements thereto fully justify the inability to achieve proper medical certification prior to arrival at this activity. Block IV -

Terminal Radar Operations (GCA) - may be taken separately by Fleet personnel, subject to class quota limitations, who have previously completed the Air Controlman School, Class A that did not contain GCA training. Such personnel must possess a valid Medical Certificate (FAA Form 8500-9, Medical Certification Class II) and a valid Control Tower Operators Certificate (Form FAA-1710). Block IV has a weekly convening frequency and a course length of approximately 35 days.

MCRF GROUP IV

COURSE NUMBER: C-602-3472
TITLE: E-2B C-2A Environmental Systems Organizational Maintenance PBJ

PURPOSE:

To provide maintenance personnel with the latest maintenance procedures for organizational maintenance on the E-2B/C-2A environmental systems.

SCOPE:

This course covers air conditioning and pressurization systems, equipment cooling system, and utility and survival systems. It includes proper diagnosis of troubles, maintenance and servicing of the E-2B/C-2A Environmental Systems.

PREREQUISITES:

AME (A) School graduate or equivalent background. Source Rating - AME. Security Clearance - None.

SPECIAL INFORMATION:

This course is conducted by:

NAMTD 1025 (Course Manager)

COURSE NUMBER: A-121-0293
TITLE: Magnetic Disk File Maintenance, FCS MK 88 MOD I

PURPOSE:

To provide the trainee with the knowledge and skill necessary to maintain the FCS MK 88 Magnetic Disk File.

SCOPE:

This course covers detailed maintenance and diagnostic routines associated with the FCS MK 88 Magnetic Disk File. Emphasis is directed towards practical experience which includes fault isolation techniques, repairs, adjustments, replacements, and usage of appropriate documentation.

PREREQUISITES:

FTB's who have completed course A-121-0292, Magnetic Disk File MDF FCS MK 88 MOD 1. A SECRET clearance is required.

QUOTA CONTROL:

FLEBALMISUBTRACEN, Charleston, SC; CO, NAVSUBSCOL NLOND

SPECIAL INFORMATION:

Course length is 5 days at FLEBALMISUBTRACEN, Charleston, SC.

COURSE NUMBER: C-102-3441
TITLE: CH-53 Communication, Navigation, and Identification Systems Organizational Maintenance, HGU

PURPOSE:

To provide organizational level maintenance personnel with instruction in the maintenance of the CN-53A/D Communication Navigation Identification System including theory of operation, troubleshooting and maintenance procedures using applicable test equipment and publications.

SCOPE:

This course covers indoctrination, communication systems, organizational maintenance procedures, navigation systems, identification systems and aircraft related information, and maintenance and material management systems.

PREREQUISITES:

AV(A) School graduate or equivalent background. Source Rating - AT. Security Clearance - CONFIDENTIAL.

SPECIAL INFORMATION:

This course is conducted by:

NAMTD 1032 (Course Manager)

MCRF GROUP V

COURSE NUMBER: A-201-0016
TITLE: Advanced Communication - Supervisor

PURPOSE:

The purpose of this course is to train/retrain selected enlisted personnel to perform supervisory tasks related to today's modern methods of rapid communications.

SCOPE:

Defense communication systems, publications and security, advanced communication procedures, communication planning and reports manpower utilization, management of shipboard communication systems, message processing techniques, and facilities control.

PREREQUISITES:

SECRET security clearance. RM3 and above.

COURSE NUMBER: C-122-3111
TITLE: Air Launched Weapons Guided Missile Intermediate Maintenance WMI

PURPOSE:

To provide maintenance personnel who are assigned to guided missile divisions with instructions on all air launched guided missiles, including basic operation, maintenance procedures in handling, disassembly, assembly, testing, storage and all applicable safety precautions.

SCOPE:

This course covers introduction, air to air guided missiles, and air to surface guided missiles. It includes basic carrier organization, introduction to air launched guided missiles, Sparrow III semi-active weapon system, Sidewinder passive weapon system, Phoenix weapon system, anti-radar type missile system, automatic television guided system, command type guidance system, and optical guidance system.

PREREQUISITES:

Graduate of AO(A) school or equivalent experience. Source Rating - AO. Security Clearance - CONFIDENTIAL.

SPECIAL INFORMATION:

This course is conducted by:

NAMTD 4030 (Course Manager)
NAMTD 4033

COURSE NUMBER: C-602-3397
TITLE: SH-3A/D Electrical Systems Organizational Maintenance HEG

PURPOSE:

To provide maintenance personnel with training on the latest maintenance and servicing procedures required to maintain the electrical systems of the SH-3A/D helicopter at the organizational level.

SCOPE:

This course covers power supply systems, power plants and related systems, rotor and related systems, fuel system, and miscellaneous and utility systems.

PREREQUISITES:

AE(A) School graduate or equivalent background. Security Clearance - None.

SPECIAL INFORMATION:

This course is conducted by:

NAMTD 1068 (Course Manager)
NAMTD 1069

This course is contained in Phase II of:

D-602-0550
E-602-0550

RESULTS OF CDF SURVEY

The CDF survey produced much previously unavailable information concerning the structure, or organization, of a large number of technical training courses. Not all of the variables on which data were gathered were used in the classification analyses. Since this information will be of interest to the Training Command, however, it is presented in appendix A. The CDF form used to collect data is reprinted in appendix A. The responses to the survey items are given (as averages) next to each item of the CDF. Most of the items required only a "check" or "no check" response. The "checks" were coded as "1" and the "no checks" were coded as "0." Thus, for those items the mean is actually the proportion of the respondents in the data set who checked the item as being descriptive of their course. The items that called for a subjective percentage judgment have means that are rounded to the nearest decile; i.e., 10%, 20%, 30%, etc.

SECTION IV

CONCLUSIONS AND RECOMMENDATIONS

This section contains conclusions about the utility of clustering techniques in the classification of technical training courses, recommendations for the improvement of the methodology, and suggestions for additional applications.

CONCLUSIONS

The most important conclusion of this study is that clustering methodology can be used to identify homogeneous subgroups of courses. Several other conclusions concern the specific data sets employed in this study. These were:

- RMS or other resource-based classifications are most useful to personnel charged with economic or financial analysis of training resources. However, the ultimate value of such a classification depends on the detail and accuracy of the data employed in the clustering routine.

- CDF/MCRF based classifications had the richest descriptive potential of those data bases employed in this study. This classification should be of interest to managers of training technology charged with the responsibility of designing efficient and effective training systems. It has the potential for identifying commonalities of skills, teaching strategies, and management categories across courses.

- The MCRF classification groups courses on the basis of physical and organizational features. These data are routinely available. Classifications based on the MCRF should become more useful and informative as this data base is refined and expanded.

The following conclusions were reached regarding the use and/or improvement of the clustering methodology:

- No single, data-based classification can serve the diverse information needs of training managers. However, some classifications may serve several such needs.

- The bases; i.e., the variables, on which classifications are made require careful examination to determine their relevancy and usefulness for specific applications.

- Sample size should be dictated by the problem at hand and weighed against cost of data acquisition.

- Specific applications of this technique may require further data reduction to identify more precisely the variables on which courses cluster. The addition of a multiple discriminant analysis program to the clustering algorithm would produce a useful analytical tool for achieving this result.

RECOMMENDATIONS

Based on this study the following recommendations are offered for CNET consideration:

- Data similar to that gathered via the CDF survey should be routinely acquired. This could be done on a special reporting basis or as a formal addition to the data elements in the required MCRF reporting system. These data could provide answers for many questions about CNET-controlled training.

- Consideration should be given to adding a course classification clustering algorithm to the NITRAS software. This would permit cluster analyses for specific purposes to be performed routinely and rapidly on request.

ADDITIONAL APPLICATIONS

The following list is provided to illustrate areas of interest to CNET where classification methodology might be fruitfully applied:

- An RMS classification could be used in the preparation of PE 81112N in the budget/programming cycle for resources and incremental funding associated with "A" courses.

- The clustering algorithm could be used to identify and track specific courses as indicators or bench marks for management indices, evaluation of training effectiveness, or the management of trainee attrition.

- The algorithm can cluster training management positions with respect to organizational structure, division of labor, or specialization of functions and duties.

- Training activities at all locations can be classified on the basis of RMS variables.

- The methodology may have value for determining the commonality of training tasks across a variety of courses.

- A classification analysis of Resource Requirement Requests (RRR's) may be useful in the development of CNET's Program Objective Memorandum (POM) and annual budget submissions.

REFERENCES

Anderson, T. W. An Introduction to Multivariate Statistical Analysis. New York: Wiley. 1958.

CNET INSTRUCTION 7310.2, Per Capita Cost of Navy Education and Training Courses. September 1974.

CNET INSTRUCTION 7300.1, Resource Management System Reporting Requirements Within the Naval Education and Training Command. 19 March 1974.

Dixon, W. J. (Ed.) Biomedical Computer Programs. Berkeley: University of California Press. 1973.

Hartigan, J. A. Clustering Algorithms. New York: Wiley. 1975.

Howard, R. N. "Classifying a Population into Homogeneous Groups" in S. R. Lawrence (Ed.) Operational Research & Social Sciences. London: Tavistock Publications. 1966. pp. 585-594.

Navy Comptroller Manual. NAVSO P-1000, Volume 2, "Accounting Classifications." 4 February 1952. Office of the Comptroller, Department of the Navy.

Nunnally, J. C. Psychometric Theory. New York: McGraw-Hill. 1967.

Rice, C. E. and Lorr, M. An Empirical Comparison of Typological Analysis Methods. 1969. Office of Naval Research Contract N00014-67-A-0214. The George Washington University, Washington, D.C.

Sokal, R. R. "Numerical Taxonomy." In Mathematical Thinking in Behavioral Sciences. San Francisco: W. H. Freeman & Co. 1968.

Swope, W. M. and Cordell, C. C. A Study to Develop Management Indices for CNET: Phase I -- Personnel Indices. TAEG Technical Memorandum 75-7, December 1975. Training Analysis and Evaluation Group, Orlando, FL.

Wessel, R. H. and Willett, E. R. Statistics as Applied to Economics and Business. New York: Holt, Rinehart and Winston. 1959.

APPENDIX A

TRAINING COURSE DESCRIPTION FORM AND RESULTS

This appendix presents a sample of the Training Course Description Form (CDF) used to collect data about CNET training courses. The form is annotated to provide the results of the survey. All results are given as percentages at the left edge of the form. Interpretation of the values should be made in terms of the instructions for each section of the form. All values are based on 435 courses.

TRAINING COURSE DESCRIPTION FORM

Training Analysis and Evaluation Group
Department of the Navy
Orlando, Florida 32813

BACKGROUND

The Training Analysis and Evaluation Group (TAEG) has been tasked by the Chief of Naval Education and Training (CNET) to work out a way of describing Navy training courses more accurately. The present classification of Navy courses into "A" and "C" schools does not adequately describe the complex and diverse nature of Navy training. A better description and classification of courses can provide training management with information to support decisions about:

- Distribution of training resources
  - Instructor requirements
  - Training media and equipment
  - Training facilities
- Management of the training process
  - Kinds of skills trained
  - Strategies for training

A large sample of training courses for enlisted personnel has been selected. Descriptive information on which to carry out a classification analysis is needed for these courses. Several ways of classifying courses will be tried because it may be useful to categorize Navy training in various ways.

DIRECTIONS FOR FILLING OUT THE FORM

It is requested that the form be filled out completely by those individuals who are most familiar with the course. In most cases, this will be the current or most recent instructor of the course. If there is no one who can describe the course or if the course is no longer being taught, return the form with a note indicating why it cannot be filled out to the address below.

Check off or fill in the items that describe the course as it is presently taught (regardless of plans to change or revise it). Be as objective and factual as possible, especially when the description requires a subjective judgment. The success of this task depends heavily on the honesty and completeness with which the course description form is filled out.

Return the completed form no later than 10 days after it is received by the person(s) who is to fill it out. (Estimated time to complete this form is less than one-half hour.) Completed forms should be returned to:

Director, Training Analysis and Evaluation Group
Department of the Navy
Orlando, FL 32813

If there are any questions concerning this task, please contact:

Dr. William C. Rankin
Training Analysis and Evaluation Group
Autovon 791-5673

IDENTIFICATION SHEET

Name of the course selected:

____
(Title)

______________________ ______________________
(Catalog Number) (Location)

______________________ ______________________
(CDP Number) (NEC) (Type)

Name(s) of person filling out course description form:

1. ______________________________ ______________
(Name and Rank) (Autovon Number)

Job Title ______________________________

____

2. ______________________________ ______________
(Name and Rank) (Autovon Number)

Job Title ______________________________

____

MANAGEMENT OF THE INSTRUCTION PROCESS

Training courses may employ several different approaches to teaching. Check the items below which describe the activities or practices that are currently used to teach this course. Then estimate the percentage of time devoted to each teaching activity or practice.

First, indicate whether this course is completely or partially self-paced, as follows:

PERCENT

(83) Not self-paced (group paced, traditional instruction) (fill out the classroom and lab sections below as they apply)

(6) Completely self-paced (fill out only the self-paced section below)

(10) A combination of self-paced _10_ % and group-paced _10_ % (fill out all three sections: classroom, lab, self-paced)

This course is conducted:

_60_ % in the classroom

_40_ % in the laboratory

10/27
5701

Check the items below which describe that part of the course that is group paced. Then estimate the percentage of time devoted to each teaching activity or practice.

GROUP PACED

(11) Not Applicable

Activities and practices in the CLASSROOM

% TIME	% OF COURSES	
50%	(86)	Lectures
20%	(69)	Discussion
10%	(68)	Demonstrations by instructors/students
<10%	(38)	Self-study (reading) of materials in the classroom
10%	(88)	Examinations or quizzes
<10%	(11)	Other ______________________

INSTRUCTION SUPPORTED BY MEDIA IN THE CLASSROOM

% USE	% OF COURSES	
40%	(90)	Training Aids (transparencies, large scale drawings, charts, etc.)
10%	(60)	Audio-Visual Equipment (projectors, recorders, TV, etc.)
<10%	(26)	Mock-Ups
20%	(58)	Training Equipment (operational equipment used for training purposes)
10%	(35)	Training Devices (equipment which simulates all or part of some operational equipment)
10%	(18)	Other (this is your chance to describe another medium ______________________

10/27
5706

Check the items below which describe that part of the course that is group paced. Then estimate the percentage of time devoted to each teaching activity or practice.

GROUP PACED

(13) Not Applicable

Activities and practices in the LAB

% TIME	% OF COURSES	
<10%	(37)	Lectures
<10%	(48)	Discussion
10%	(80)	Demonstration by instructors/students
50%	(84)	"Hands-on" guided practice
10%	(52)	Examinations or quizzes
<10%	(6)	Something really different (specify) ____________

INSTRUCTION SUPPORTED BY MEDIA IN THE LAB

% USE	% OF COURSES	
<10%	(29)	Training Aids (transparencies, models, large scale drawings, charts, etc.)
<10%	(6)	Audio-Visual Equipment (projectors, recorders, TV, etc.)
<10%	(15)	Mock-Ups
60%	(75)	Training Equipment (operational equipment used for training purposes)
10%	(29)	Training Devices (equipment which simulates all or part of some operational equipment)
<10%	(6)	Other ____________

10/27/77
5702

If the course is completely or partially self-paced, check the items below which describe that part of the course that is self-paced. Then estimate the percentage of time devoted to each teaching activity or practice. If no portion of this course is self-paced, check "not applicable" and go on to the next section.

SELF-PACED

(82) Not Applicable

Activities and practices in SELF-PACED INSTRUCTION

% TIME	% OF COURSES	
<10%	(1)	Computer-based Instruction (CAI)
<10%	(00)	Computer-based testing and scheduling (CMI)
10%	(14)	Programmed learning materials (text material)
<10%	(3)	Other ______
<10%	(3)	Use of individual study spaces
10%	(13)	Use of "Learning Laboratory" (individual work stations)

SELF-PACED INSTRUCTION SUPPORTED BY MEDIA

% USE	% OF COURSES	
<10%	(4)	Training Aids (transparencies, models, large scale drawings, charts, etc.)
<10%	(6)	Audio-Visual Equipment (projectors, recorders, TV, etc.)
<10%	(1)	Mock-Ups
10%	(10)	Training Equipment (operational equipment used for training purposes)
<10%	(4)	Training Devices (equipment which simulates all or part of some operational equipment)
<10%	(3)	Other

KINDS OF SKILLS TRAINED IN THE COURSE

It is recognized that some courses teach a number of skills while others are designed to teach a single skill. In this section, describe the kinds of skills that are taught in this course. Indicating this will require careful judgment because the skills that are of interest must be skills that are acquired only in this course, not those that are acquired on the job or prior to entering the course. Certainly not all of the skills listed will apply. Therefore, read the list over once or twice before making any judgments. Then, check only the skills that are most emphasized in this course.

First, indicate whether this course teaches knowledge, skills, or both by checking below:

PERCENT

(60) Knowledge (learning of instructions or where information is stored, specific facts, rules, principles, concepts)

(40) Skills (such as those listed below)

(15) Not Applicable

Operate equipment using controls

% OF COURSES

(70) By reading gauges, meters, or other indicators

(60) Responding to displayed information (i.e., scopes, grams, status boards)

(81) Following routine, preestablished procedures (e.g., checkout sequences)

(2) Other ______________________________

(14) Not Applicable

Maintenance Skills

10/27/77
5704

Check only those that are taught in this course.

% OF COURSES	
(39)	Electrical
(50)	Electronic
(45)	Mechanical
(17)	Hydraulic
(4)	Structural (air frames, hulls)
(57)	Preventive maintenance (PMS or other)
(59)	Calibration/Adjustment of Equipment
(75)	Use manuals or job aids (troubleshooting diagrams, drawings, etc.)
(65)	Use test equipment
(41)	Use special tools (not hammers, pliers, screwdrivers, knife, fork, spoon)
(65)	Malfunction isolation
(46)	Replace whole subsystems or modules
(53)	Repair or replace components
(48)	Follow routine, preestablished procedure (not published job aids)
(21)	Soldering
(2)	Welding
(5)	Other ______________________

10/27/77
5705

(75) Not Applicable

Communicate Information

% OF
COURSES

(11) Primarily by voice, using standardized procedures (such as air traffic control)

(5) Signaling (hand, flag, flashing lights, etc.)

(4) "Hunt and peck," or special keyboard skills

(8) Typing, teletyping, or other keyboard skills

(5) Sending/receiving or deciphering coded information

(4) Other ______________________________

(16) Not Applicable

Other Skills

Provide an example of each skill below that is applicable to this course.

% OF COURSES	
(66)	Interpret symbols. Example ______
(31)	Numerical calculation/computation (such as pay and allowances) ______
(51)	Rule using (such as Ohm's Law, other formulas, or table look-ups) ______
(32)	Filling out forms (requisition materials, correspondence, job orders) ______
(21)	Process information (interpret instructions, prepare schedules, compile statistics) ______
(19)	Keep records (such as maintaining files of control documents) ______
(12)	Interpret/estimate/translate or plot target data (such as closure rates, angles, relative speeds) ______
(26)	Detect/analyze/classify signals ______
(7)	Operate ordnance equipment (loading, firing of ammunition, missiles, depth charges or mines) ______

If None of the Above Skills Fit

([illegible]) Write in the skill category you require to describe the skill(s) trained in this course. ______

7/29/77
5826

WHERE GRADUATES GO AFTER TRAINING

Describe where the typical graduate goes after completing the course. For example, the graduates of some courses will proceed immediately to additional formal training; the graduates of other courses will return to or proceed to job assignments.

Read the following categories of training outcome and choose only those which apply to this course. More than one may apply.

After completion of this course, graduates will most likely:

% OF COURSES	
(35)	Go to another school; go to another course of instruction
(51)	Be assigned to a ship
(43)	Be assigned to a shore billet
(33)	Work as an operator of equipment
(43)	Work as a maintainer of equipment: PMS and preventive maintenance
(58)	Work as a maintainer of equipment: Corrective maintenance
(1)	Don't know ______
(11)	Other (specify) ______

MEASUREMENT AND EVALUATION

Describe how students are tested and evaluated. Also, describe how the course itself is, or has been, evaluated. We are not concerned with the results of its evaluation, but rather how it gets evaluated.

Pretesting of students

Sometimes students are tested at the beginning of a course in order to determine their level(s) of knowledge and skill. Regarding the pretesting of students in this course, check the description(s) that best applies.

% OF COURSES	
(90)	No pretesting
(10)	Routine pretesting of all students
(10)	Pretesting in special cases only

Testing during the course

Which of the following is most descriptive of the testing of student achievement during the course? Check all that apply.

% OF COURSES	
(45)	Criterion referenced testing. (Test items based on learning objectives with standards for scoring pass-fail, satisfactory-unsatisfactory)
(31)	Traditional testing
(28)	Both are used

% USE	
50	Criterion referenced testing
40	Traditional testing

% OF COURSES	
(20)	Paper and pencil approaches to testing
(14)	Performance tests (actual observation of specific skills scored by instructor)
(69)	Both paper and pencil <u>and</u> performance testing

% USE	
50	Paper and pencil
40	Performance testing

(18) Oral testing

(39) End of course testing on major course objectives

(73) End of phase/unit/module testing on major objectives

(45) End of course comprehensive test

Course feedback

Select the procedure which best describes how information concerning how well the graduates of this course perform at their next assignment is obtained.

(20) Return of prepared questionnaires from gradautes

(20) Return of prepared questionnaires from supervisors of graduates

(17) Interviews with graduates or their supervisors

(70) Informal feedback from Fleet personnel

% OF
COURSES

(8) Other (specify) ____________________

(7) Do not know of any external evaluation program

(10) No external evaluation is conducted

In what ways can/should this course be modified? Check only those items which apply.

(35) Increase aptitude requirements for entering students

(24) Allow more time for all or part of the course

(35) Provide other, or make available, training aids, media, or equipment

(31) Provide more instructors/tutors per student

(8) Provide professional assistance in the development of objective student proficiency tests

(14) Receive more precise knowledge about future assignments of course graduate (i.e., better job knowledge)

(51) Provide information (feedback) on how well graduates perform specific tasks on the job

(14) Other (specify) ____________________

($\overline{X}$ = 2.11) Add the number of checks in the last section on ways to improve the course.

ON THE AVERAGE 2 ITEMS WERE CHECKED FOR EACH COURSE.

DISTRIBUTION LIST

Air Force

Headquarters, Air Training Command (XPTD, Dr. D. E. Meyer)
Headquarters, Air Training Command (XPTIA, Mr. Goldman)
Air Force Human Resources Laboratory, Brooks Air Force Base
Air Force Human Resources Laboratory (Library), Lowry Air Force Base
Air Force Office of Scientific Research/AR (Dr. A. R. Fregly)

Army

Commandant, TRADOC (Technical Library)
ARI (Dr. Ralph R. Canter, 316C; Dr. Edgar Johnson)
ARI Field Unit - Leavenworth

Coast Guard

Commandant, U.S. Coast Guard Headquarters (G-P-1/62; G-RT/81)

Marine Corps

CMC (Code OT)
CGMCDEC (Mr. Greenup)
Director, Marine Corps Institute

Navy

ASN (R&D) (Dr. S. Koslov)
ASN (MRA&L) (Dr. B. D. Rostker)
DASN (M) (Miss M. Snavely)
CNO (OP-987P7, CAPT Connery; OP-991B, M. Malehorn; OP-987P10, Dr. R. Smith; OP-987, H. Stone)
NAVCOMPT (Code NCD-7)
ONR (Code 458, 455)
ONRBO Boston (J. Lester)
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