Navy Personnel Research and Development Center
San Diego, California 92152-6800 TR-91-3 December 1990

(2)

Developing and Implementing the NEC "C" School Planner (CSCHOOL)

Stephen W. Sorensen

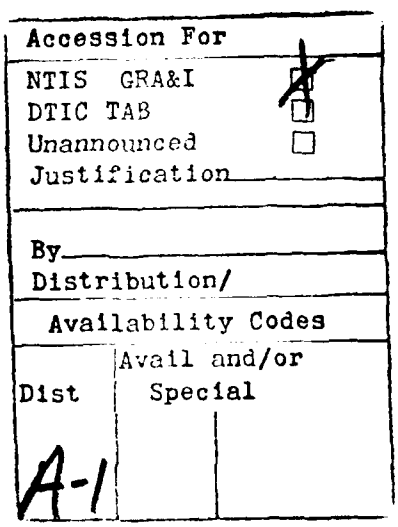
NPRDC-TR-91-3 December 1990

Developing and Implementing the NEC "C" School Planner (CSCHOOL)

Stephen W. Sorensen

Reviewed and approved by
Jules I. Borack
Director, Personnel Systems Department

Released by
B. E. Bacon
Captain, U.S. Navy
Commanding Officer
and
Richard C. Sorenson
Technical Director, Acting



Navy Personnel Research and Development Center
San Diego, California 92152-6800

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATE COVERED
	December 1990	Final--May 88-Nov 89

4. TITLE AND SUBTITLE
Developing and Implementing the NEC "C" School Planner (CSCHOOL)

5. FUNDING NUMBERS
Program Element 0603720N
Work Unit R1772

6. AUTHOR(S)
Stephen W. Sorensen

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Navy Personnel Research and Development Center
San Diego, California 92152-6800

8. PERFORMING ORGANIZATION
NPRDC-TR-91-3

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Office of the Chief of Naval Operations
(OP-112)
Washington, DC 20350-2000

10. SPONSORING/MONITORING

11. SUPPLEMENTARY NOTES

12a DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

This report describes the development and implementation of the NEC "C" School Planner (CSCHOOL). CSCHOOL organizes data and reports to model the training requirements. The latest version was implemented in 1989 and is being used in the Arlington Annex.

14. SUBJECT TERMS
Planning, training, NEC "C" School

15. NUMBER OF PAGES
26

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UNLIMITED

FOREWORD

This report describes the development and implementation of the NEC "C" School Planner (CSCHOOL). OP-11 asked the Navy Personnel Research and Development Center (NPRDC) to investigate ways to improve NEC "C" school planning. NPRDC built CSCHOOL to organize data and reports for training requirements. Version 1 was implemented in 1988 and Version 2 was implemented in 1989. Both versions were implemented on microcomputers in the Arlington Annex (OP-112).

This research is part of the Training Resource Management (TRM) project whose goal is to develop computerized tools for decision making in Navy training. The effort was sponsored by the Chief of Naval Operations (OP-112) and conducted under the product line Total Force Training and is funded under Program Element (PE) 0603720N, Work Unit R1772.

CAPT M. Steen (OP-112), and members of his staff, LCDR R. Chenette, LCDR S. Ongley, and LCDR E. Sullivan, actively participated in the development of the NEC "C" School Planner.

B. E. BACON
Captain, U.S. Navy
Commanding Officer

RICHARD C. SORENSON
Technical Director, Acting

SUMMARY

Problem

The total management of Navy NEC "C" schools cuts across organizations: resource sponsors (OP-29, OP-39, OP-59, and others), the Navy Manpower and Personnel Command (NMPC), community managers (OP-13), and the Chief of Naval Education and Training (CNET) and its functionals. Training plans are used by resource sponsors for their budget submissions; Navy training commands use the plans to schedule courses; and detailers use the schedules to assign personnel to the courses. Accurate plans are imperative. Inaccurate plans can lead to faulty budget submissions, undermanned ships and squadrons, poor utilization of training resources, and personnel who do not use their skills when they report to the fleet.

Objective

This report describes the development and implementation of the NEC "C" School Planner (CSCHOOL), a decision support system (DSS). The planners in the Total Force Training and Education Division (OP-11), under the Office of the Deputy Chief of Naval Operations for Manpower, Personnel, and Training (OP-01), must coordinate inputs from the different organizations and set the annual requirements for training at NEC "C" schools. The DSS was built to facilitate and improve planning. It organizes the data, prints reports, and will eventually incorporate planning models.

Approach

NPRDC developed CSCHOOL to meet OP-11's needs. CSCHOOL is a decision support system that organizes the data needed for planning and calculates a proposed training plan. We planned to implement three distinct versions of CSCHOOL, encourage the user to play an active role in defining each version, and make modest changes to each version based on the user's experience.

Results

We reviewed the current planning system and determined the problems and the places where a new system might have the largest impacts. Versions 1 and 2 of CSCHOOL met the most pressing problems by providing data management and dialog management for the DSS We reviewed models that might be used to determine NEC "C" school requirements in Version 3. Although many models have been proposed, none of the models match the existing NEC "C" school planning process; all of the models have problems with the data. It appeared that the most readily accessible goal was to minimize the turbulence in scheduling courses at the training agent level and, at the same time, improve the course utilization rates.

Conclusion

The decision support system, CSCHOOL, has already had a positive impact on the planning process. The incremental approach to implementation gradually surfaced the important problems. Some of these problems are solvable at this time but others await future developments.

CONTENTS

	Page
INTRODUCTION	1
Problem	1
Objective and Purpose	1
Background	2
APPROACH AND METHOD	3
RESULTS AND FINDINGS	5
The Problems of NEC "C" School Planning	5
Data Inaccuracies	5
Long Time Line for Planning	5
Disruptions in Execution	6
Control Course Utilization Rates	6
Comments	7
CSCHOOL, Version 1: Data Management	7
CSCHOOL, Version 2: Dialog Management	8
CSCHOOL, Version 3: Model Management	10
Proposed Planning Models	10
Zero-Based Planning: Requirements As the Difference Between Authorizations and Inventory	11
Increments/Decrements of Previous Utilization	11
Capacity of Inventory	12
Capacity of Schools: Scheduling Models	12
Expert System of the Planning Conference	13
Comments	13
Future Developments: Effectiveness and Policy Testing	13
CONCLUSIONS	14
REFERENCES	15
APPENDIX A--DATA BASES USED BY CSCHOOL	A-0
DISTRIBUTION LIST	

INTRODUCTION

Problem

This report describes the development and implementation of the NEC "C" School Planner (CSCHOOL), a decision support system (DSS). The planners in the Total Force Training and Education Division (OP-11), under the Office of the Deputy Chief of Naval Operations for Manpower, Personnel, and Training (OP-01), must coordinate inputs from the different organizations and set the annual requirements for training at NEC "C" schools. The DSS was built to facilitate and improve planning. It organizes the data, prints reports, and will eventually incorporate planning models.

The total management of Navy NEC "C" schools cuts across organizations: resource sponsors (OP-29, OP-39, OP-59, and others), the Navy Manpower and Personnel Command (NMPC), community managers (OP-13), and the Chief of Naval Education and Training (CNET) and its functionals. Training plans are used by resource sponsors for their budget submissions; Navy training commands use the plans to schedule courses; and detailers use the schedules to assign personnel to the courses. Accurate plans are imperative. Inaccurate plans can lead to faulty budget submissions, undermanned ships and squadrons, poor utilization of training resources, and personnel who do not use their skills when they report to the fleet.

Once a year, the Navy plans training for over 1000 Navy Enlisted Classifications (NECs) (Quester & Corliss, 1986). NEC "C" school training requirements are determined at OP-11's annual NEC "C" School Planning Conferences. The conferences are attended by resource sponsors, community managers, and detailers. During the planning, each NEC is considered separately and aggregate constraints are seldom included. Later, the Chief Of Naval Technical Training (CNTECHTRA) calculates the feasibility of the training requirements, constrains them by training resources, and schedules classes.

Objective and Purpose

This research is part of the Training Resource Management (TRM) project whose goal is to develop computerized tools for decision making in Navy training. As part of TRM, OP-11 asked Navy Personnel Research and Development Center (NPRDC) to investigate ways to improve NEC "C" school planning. NPRDC built CSCHOOL to help OP-11 with planning. Version 1 was implemented in 1988 and Version 2 in 1989. This report is based on Version 2. Both versions were implemented on microcomputers in the Arlington Annex.

CSCHOOL is being developed incrementally: Version 1 concentrated on data management and Version 2 developed the dialog interface. Version 1 was written in dBase III Plus and Version 2 in Clipper, a compiler for dBase III Plus.

CSCHOOL was built in a modular way so that it can be expanded. Version 3, which should be available in 1991, has not been completely specified. Version 3 will include one or more planning models. This report describes some of the goals and constraints that Version 3 must contain, but the goals of planning are not yet prioritized.

Background

In an earlier report, Ganeshan (1987) reviewed the process of planning NEC "C" school requirements. She described the time line of the planning process, detailed the discrepancies between the plans and execution, and pointed out problems with the data. Ganeshan did not discuss the annual NEC "C" School Planning Conference where the requirements decisions are made. Since the conference is the most important part of the planning process, it forms the background for this report. The time line, data, decision making, and execution form the environment in which the decision support system must operate.

A typical NEC "C" School Planning Conference convened in May 1988 and made the training requirements plans for FY 1990. Stretched over 3 calendar weeks, the conference lasted 6 days. A group of ratings were considered each day, as shown in Table 1. The conference sessions were chaired by the NEC "C" school planner from the Training Policy and Programming Branch (OP-112) of the Total Force Education and Training Division (OP-11). The attendees included one or more representatives from NPMC (typically the detailer for the rating), the resource sponsor, the community manager, one or more representatives from the USNR community, and one or more representatives from the training and administering reserves (TAR) components. Training requirements for civilians, foreign nationals, and other services were handled separately. The exact roster of attendees changed during the day as different ratings were considered, but at any one time, there were about 12 to 15 persons in the room. Most attendees were military and ranged in rank from E-5 to O-5.

Table 1

NEC "C" School Planning Conferences, May 1988

Day	Ratings
1	Engineering/Hull
2	Technical
3	Aviation/Avionics Support
4	Admin/Deck/Supply
5	Submarine/Nuclear and Crypto/Intel
6	Seabee/UDT/EOD/SEAL/Medical/Dental

Each rating was considered and every NEC was analyzed for the rating. For USN training requirements, the following data were considered: the training plan made last year, the Navy

Training Plan (NTP) for the NEC, authorized billets for the NEC, inventory for the NEC, and the previous utilization of training for the "C" school courses that were taught for that NEC.

Each participant had his own point of view. The resource manager was concerned with the money. The community manager was concerned with unusual peaks and valleys in the time history of the NEC. The detailer said how many persons he needed to train. The detailer provided special expertise and feedback since he knew the fleet's demand for the NEC based on the volume of phone calls he received. A typical comment from a detailer might be: "The authorizations imply that we are not training enough for this NEC, but I'm not getting any complaints. I think we can lower the plan." Training requirements for USNR and TAR were usually made by the community. The requirements were questioned only when OP-112 or the resource sponsor thought they seemed high. The resource sponsor, when he chose, had the final say on USN training requirements. When the resource sponsor did not have a strong opinion, the detailer's estimate was usually the most important in the discussion.

OP-112, in addition to moderating the discussion, provided a normalizing check by saying that training requirements should not be more than one-third the sea authorizations (approximately the annual turnover). A particular requirement of the 1988 conference was that training requirements for that year should not be more than the number actually trained in past years. This requirement was imposed by OP-01 to minimize low utilization of training courses. If the resource sponsor pointed to an NTP that showed the NEC would grow or if the detailer said that he had a heavy demand for the NEC from the fleet, then the constraints were relaxed.

Each day's conference seemed different from those of other days. Usually the amount of participation and preparation by the attendees differed, and the individual personalities in the room mattered. Also each rating had its own special characteristics. For example, CTs often reutilize training in later tours, but most other ratings have little or no reutilization. Aviation schooling usually involved pipelines that required special analysis. In some cases the NTPs were used, but in others they were dismissed as inaccurate.

Callahan and Sorensen (1989) reviewed the plans after they were made to identify the factors that influence planning. The largest impact on the new plan for NEC training was the plan that existed the previous year. Approximately 41 percent of the plans were not changed from the previous year. A plan existed from the previous year's conference for 785 courses, and that plan was changed only 464 times. Callahan and Sorensen investigated the causes of change, when change occurred, but unfortunately, no clear pattern was detected. The authorizations for the NEC and the previous utilization of training were important, but nothing statistically definite could be said.

After the requirements were determined at the NEC "C" School Planning Conference they were sent to CNTECHTRA to be constrained by resources, as Ganeshan (1987) described.

APPROACH AND METHOD

NPRDC developed CSCHOOL to meet OP-11's needs. CSCHOOL is a decision support system that organizes the data needed for planning and calculates a proposed training plan. The discussion of DSS technology in this report follows the terminology of Ariav and Ginzberg (1985).

The three key parts of CSCHOOL are shown in Figure 1. Data management corresponds roughly with Version 1 of CSCHOOL; dialog management corresponds with Version 2; and model management will correspond to Version 3. Since the data, programs, and goals were relatively undefined, we believed that an incremental approach to implementation such as that advocated by Keen and Gambino (1983) would work best. We planned to implement the three distinct versions of CSCHOOL, encourage the user to play an active role in defining each version, and make modest changes to each version based on the user's experience.

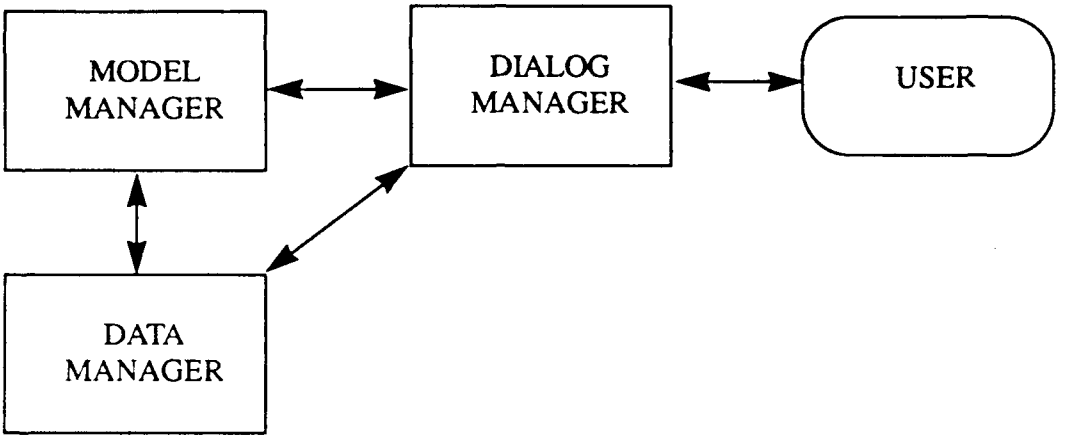


Figure 1. Parts of CSCHOOL.

During the development of CSCHOOL, we first reviewed the current planning system to determine the problems of the system and the places where a new system might have the largest impacts. Versions 1 and 2 of CSCHOOL met the most pressing problems by providing data management and dialog management for the DSS.

We reviewed models that might be used to determine NEC "C" school requirements in Version 3. Many models have been proposed; surprisingly, they are radically different in structure and purpose. They included a Markov model, a network assignment model, and a course scheduling model. None of the models match the existing NEC "C" school planning process. All of the models have problems with the data.

Finally, we considered NEC "C" school planning in a larger context. The immediate need was to provide a tool to make the annual NEC "C" school plans. A broader need is to use the NEC "C" school planning system to test policies that might improve fleet manning and that might reduce training costs. We looked at some of the broader issues to determine how the planning system could fit into those needs.

RESULTS AND FINDINGS

The Problems of NEC "C" School Planning

The problems of Navy NEC "C" school planning are documented in reports by Lindahl and May (1979) and by Ganeshan (1987). In spite of the 8 year span between these reports, the discussions are essentially the same. The problems can be categorized as (1) inaccuracies in the authorization data and the difficulty of projecting the inventory over the Five Year Defense Plan (FYDP), (2) the need to plan along a time line, (3) the disruptions in executing the plan caused by the different goals of different organizations, and (4) the need to control course utilization rates. A brief summary of each will show the complications in a "C" school plan.

Data Inaccuracies

Every model requires accurate data or must be structured in a way that the inaccuracies are unimportant. Navy "C" school planning be ins with NEC requirements that are calculated from billet data. Ganeshan (1987) describes three problems with the billet file: lags in attaching quality information to funded billets by the resource sponsors, changes in projected requirements due to equipment changes, and inconsistencies in the coding of NECs (e.g. two similar activities may have dissimilar requirements). The Enlisted Master Record (EMR) may not give accurate NEC information because of delays in recording intra-activity transfers, failures of Naval Information Training Tracking System (NITRAS) to update the EMR, and the limit (5) on the number of NECs that can be recorded for an individual. Until recently, many individuals who completed NEC "C" school never received their NEC. This occurred because NECs were awarded after the individual reported for duty (i.e. the activity, not the school, gave the NEC). Sometimes the activity never did the necessary paperwork.

For several reasons it is difficult to project the inventory of an NEC. The skill may degrade for an individual over time. Some NECs are only valid for one deployment; others may be used again. Projections of attrition and survival are complicated by statistically small population sizes (most projections for Navy planning are by rating--a larger population). Many individuals are unwilling to use their older NECs as they advance in pay grade because the NEC is associated with a lower rate. Each NEC has a different combination of these factors.

Long Time Line for Planning

Current planning occurs along a time line where information is less accurate at the beginning and more accurate at the end. Ganeshan (1987) states that the initial FY89 NEC "C" school requirements were developed in June 1986 when only 65 percent of the FY89 billets had accurate quality descriptions. In June 1987 when the FY89 NEC "C" school plan was finished, 95 percent of the FY89 billets had quality descriptions. But that was too late. The planning--including coordination with training agents--had to begin in June 1986 based on incomplete information.[1]

The time line is also a factor in Program Objectives Memorandum (POM) development. Lindahl and May (1979) concluded that the time line's constraints should preclude the training

[1]The time line has been shortened since Ganeshan's report--in part as a result of the DSS described in this report.

agents from an active role in the POM process. Training agents have a micro view of training: they can only assess a POM package by decomposing it to the individual course level. "In the POM development process at the Headquarters level," Lindahl and May write, "... a much more macro view of training is required....[I]t becomes necessary to evaluate various decision alternatives in terms of their macro resource implications and to do so rapidly in order to respond to time constraints that govern the process."

Lindahl and May's (1979) opinions correspond to current practice where OP-11 makes the plans and CNTECHTRA, who is not represented at the conferences, executes the plans. However. Lindahl and May's concerns may be less important since recent advances in computer technology obviate part of the problem. The Naval Education and Training Management Information System (NETMIS) contains data on individual schools that may be useful for macro planning. Personal computers exist in almost every activity so management and planning data can be passed electronically (via modem or floppy disks) between every organization involved in NEC "C" school planning.

Disruptions in Execution

The NEC "C" school plan is executed by two distinct functions: the training agents (CNTECHTRA) establish the class schedules and the detailers (NMPC) assign individuals to class. The exact details of class schedules and individual assignments cannot be anticipated when the NEC "C" school plans are made. The training agents constrain the plan after the planning conference. Before execution, the training agents and schools make up plans for class schedules based on the availability of instructors, classroom space, training equipment, and facilities such as berthing. Because of the long lead time in planning, the plans are frequently changed before execution. These modifications cause severe disruptions at the training agent level. A class schedule can be set a year or longer ahead, but it usually must be modified dynamically based on unexpected events.

The second distinct function is the assignment of students to the class. Sometimes the detailer's primary goal is not to fill the class quotas. A class assignment can be used as a reward for reenlistment, as a way to fill a billet that requires a particular NEC, or as a place to assign an individual who cannot otherwise be placed. Thus, assignments to class depend on a dynamic balance between individuals who need to be assigned, the characteristics of those individuals, and the billets that are required at a particular time.

Control Course Utilization Rates

The U.S. General Accounting Office (GAO) (1985) defined utilization rate as the actual number of attendees at a course (the utilization) divided by the planned requirements. They said that a course is over-utilized if actual is 20 percent greater than planned for 3 years and under-utilized if actual is 20 percent less than planned for 3 years. GAO counted over- and under-utilization for "A," "C," and "F" schools for the 1982 to 1984 period. The Navy took administrative steps to deal with under- and over-utilized courses at that time. Also, the Navy adopted its own definitions where under-utilization is 30 percent less than planned for 2 years and over-utilization is 30 percent greater than planned for 2 years.

The GAO said that over- and under-utilized courses showed poor planning. They said that the poor planning resulted in misallocation of resources at the schools. The plans are made to optimize fleet manning and school utilization is only considered in special situations--as it was in the May 1988 Conference described above. In the case of NEC "C" schools, CNTECHTRA takes the plans from OP-112 and accepts them or constrains them as necessary.

Comments

After considering this list of problems for a DSS, we decided to focus immediately on reducing the time line for planning. A reduction in the time line cuts down the chaos in the system caused by incomplete data and changing plans. The principal constraint on the time line is that class schedules must be loaded by March so that detailers can make assignments beginning the following October. Currently, the NEC "C" School Planning Conference occurs 12 months before this March constraint. We believe that a good DSS, especially one that ties OP-11 to CNTECHTRA, can cut planning to 6 months or less.

The CSCHOOL must improve the Navy's ability to provide trained manning to the fleet, decrease turbulence in the execution of training, improve course utilization rates, and test policies during the POM. Focusing on the time line will reduce turbulence, but the other three goals require models for planning. Unfortunately, there is little agreement on what the models should look like. We believe that, as the CSCHOOL takes care of immediate problems, the longer range problems will become clearer.

CSCHOOL, Version 1: Data Management

When this project began, OP-112 had a set of Fortran computer programs that ran on a mainframe computer at National Institute of Health. These programs are described in Peeples and Hodak (1988). In general, the programs were poorly documented, difficult to use, and contained several bugs.

Version 1 of CSCHOOL is described by Sorensen, Escamilla, and Tang (1988). Version 1 revised and improved OP-112's Fortran programs. The new CSCHOOL was written in dBase III Plus to run on a Z-248 microcomputer. The programming language was chosen because the users in OP-112 knew it and were comfortable with it. Version 1 contained a menu interface between the user and the reports, and direct interaction with the data came through dBase III Plus. This was adequate for the experienced computer users in OP-112.

OP-112 used the system from June 1988 to June 1989. The reports from the system gave information on courses and requirements for each NEC. Individual reports presented the data for resource sponsors, detailers, the training commands, and for the senior chief who monitors the execution year. One report gave a proposed training requirements plan.

The user made fewer changes to the program than was expected. As the user discovered the capabilities of the system, suggested changes to the report were made by NPRDC. Often the user tried to use the programs in ways no one anticipated and these new applications led to changes. Five separate modifications were made to Version 1. These modifications dropped reports that existed in the previous Fortran system, added new reports and data elements, and performed new

calculations. Version 1 met its goals. OP-112 dropped the old Fortran programs entirely and adopted the dBase III Plus programs. According to OP-112, the new programs shortened their time in preparing the plans.

CSCHOOL, Version 2: Dialog Management

As we hoped, Version 1 was a victim of its own success. We began work on Version 2 while the users were still learning Version 1. Version 2 contained significantly more capability and since it was compiled by Clipper, the running speeds were improved (dBase III Plus problems that previously took an hour took only 5 minutes in Clipper). When Version 2 was implemented in July 1989, the user quickly adopted it. As with Version 1, the user began making suggestions for changes and improvements and started using CSCHOOL in ways not anticipated.

Sorensen and Jefferson (1989) give a complete description of CSCHOOL, Version 2. The principal data bases for Version 2 are given in Appendix A. These data bases come from several different sources and some must be built by hand. CSCHOOL relates the data bases through the variable NEC. The program has three modes of operation:

1. Manage the data for NEC "C" school planning. The report programs produce planning data for sponsors, for CNTECHTRA, and for the execution year monitoring. Figure 2 is a page from the report giving the plans for FY 1991 to 1995. The editors modify the data bases used in planning. Utility programs pack the data and update it at the end of each year.

2. Manage the data for execution year monitoring. The report and editor programs allow the user to keep track of changes and maintain an audit trail. The user can see the effects of changes on overall planning at any time .

3. Extract and manage data for non-Navy personnel at Navy schools. Also, track Navy training requirements at other service schools.

The user's interface with the program resembles the dBase III Plus "Assist" screen. A set of pull-down menus operate from a selection screen. When a report or editor is operating, the user is asked questions about the date, file names, and other matters specific to the report. The questions are pop-ups on the screen. The user has had no difficulty in running the system. The user originally objected to the compiled program (that he could not change), but quickly accepted it after use. The user's suggested improvements showed that the system further contributed to giving him a "big-picture" of the process.

FY91 TO 95 NEC "C" SCHOOL REQUIREMENTS
PREPARED JUNE 1989

NEC 1175 SPONSOR (CODE(S): 02

CIN	CDP	TITLE	ACTIVITY	UIC	LEN	TPC	P/I
A-130-0300	108T	ADCAP MAINT	NAVSUBSCOL GROTN	30565	26	02130	

TRAINING INPUT REQUIREMENTS

NEC	RATE	ARATE	1991	1992	1993	1994	1995	CDP
1175	CIV		1	1	3	0	0	108T
1175	FTG		36	36	36	36	36	
		TOTAL	37	37	39	36	36	

NEC 1177 SPONSOR CODE(S): 02

CIN	CDP	TITLE	ACTIVITY	UIC	LEN	TPC	P/I
A-130-0278	094Z	CCS MK1 CM	NAVSUBSCOL GROTN	30565	96	02130	
A-113-0132	0977	CCS MK1 MAINT	NAVSUBSCOLGROTN	30565	154	02130	

TRAINING INPUT REQUIREMENTS

NEC	RATE	ARATE	1991	1992	1993	1994	1995	CDP
1177	CIV		12	7	7	6	3	094Z
1174	FTG	SS	48	48	48	48	48	094Z
1177	FTG	6YO	210	210	210	210	210	0977
		TOTAL	270	265	265	264	261	

***PIPELINE RESTRUCTURED. FORMERLY NEC 1638, 1174, 1176.

NEC 1179 SPONSOR CODE(S): 02

CIN	CDP	TITLE	ACTIVITY	UIC	LEN	TPC	P/I
A-113-0120	199D	AN/BSY-1 CC CM	NAVSUBSCOL GROTN	30565	75	02130	

TRAINING INPUT REQUIREMENTS

NEC	RATE	ARATE	1991	1992	1993	1994	1995	CDP
1177	CIV		6	6	2	0	0	199D
1179	FTG	18	18	18	18	18	18	
1179	FTG	6YO	30	30	30	30	30	
		TOTAL	54	54	50	48	48	

Figure 2. Sample report from CSCHOOL.

CSCHOOL, Version 3: Model Management

Version 3 of CSCHOOL will include one or more models that calculate training plans. A stated goal in OP-112 is to replace the NEC "C" School Planning Conference with a model for training requirements. Resource sponsors, detailers, and community managers can review the model's output requirements for accuracy. The training agents can use the requirements to adjust the supply of training that they schedule. A good model can also be used for policy testing.

The specifics of Version 3, which should be available in 1991, have not been completed. This report describes some of the goals and issues that Version 3 must address, but the goals of planning are not yet prioritized.

Other problems must also be addressed by the finished system. The decision support system only considers training in formal courses; but, in some cases, an NEC is awarded after on-the-job training. Sometimes, more than one course is involved in the training and a sequence of courses are combined into a pipeline. At this time, the decision support system is only applied to the pipeline as a whole and not to individual courses. Since some pipelines (especially in the aviation ratings) share courses, a finished version of the decision support system will include individual courses in the pipeline.

Most important, the DSS does not presently include consideration of the feasibility of training plans. As mentioned above, feasibility is calculated by CNTECHTRA. We want to include feasibility and the related issue of course utilization in Version 3 of CSCHOOL, since we believe these are important goals of the system.

Proposed Planning Models

Demand for training can be defined as requirements for training or as the utilization of training. These are different concepts and lead to different models. Requirements are based on fleet manning: how many individuals of a particular skill does the Navy need to operate its ships and aircraft. Utilization is the number of individuals the Navy has trained in the past; the amount trained depends on the capacity of the schools and on the availability of inventory that can be trained.

Given the alternate definitions, demand can be calculated in five ways.

1. The requirements for NEC "C" school training can be calculated as the difference between authorizations and inventory adjusted for rotation. This is essentially zero-based planning: the plan is made from scratch each year with no consideration of previous utilization of training.

2. Demand can be calculated by adding an increment/decrement to previous utilization. For example, the adjustment might be calculated as a percent of the short-fall between authorizations and inventory.

3. A plan can be based on the capability of the personnel system to supply individuals for training. This ignores requirements and the capacity of the schools.

4. A plan can be based on the capacities of the schools and ignore the fleet's requirements.

5. A plan can be based on what the experts do now.

The NEC "C" School Planning Conference is a meeting of experts and their expertise can be captured in an expert system of the conference. Examples of these five approaches, and the strengths and weaknesses of each, are given below.

Zero-Based Planning: Requirements as the Difference Between Authorizations and Inventory

Although NEC "C" school planning has remained a manual process, "A" school planning uses the Skilled Accession Training (SKAT) Model. Mathematically, SKAT is a Markov model based on transitions over time. SKAT works at the rating level and aggregates pay grades to the top 6 and bottom 3. It starts with inventory projections from the FAST model, ages the inventory, and compares it to authorizations. From that, SKAT computes an unconstrained "A" school requirement, then computes a constrained "A" school requirement that will reduce a short-fall in a get-well year. SKAT is a simple zero-based model whose strength is data management. The calculations are arithmetic formulas. SKAT never considers constraints at the school level and does not get the costs of training.

Marcus (1989) built a Lotus 1-2-3 spreadsheet on a microcomputer for NEC "C" school planning. His data were for all NECs rather than each individual NEC. That gave him a very large population size. Marcus used the model for policy testing questions such as: What percent of the turnover should be used to calculate training. He included a factor for the reutilization of training on second and third tours.

The SKAT and Marcus models use large population groups. Since NEC "C" school training is planned for individual NECs, the statistical problems of small samples become important. As Ganeshan (1987) mentioned, authorizations and inventory data at the NEC level are not trusted by many persons. The advantages of the two models are simplicity, ease of use, and applicability to policy testing. The disadvantage of zero-based planning is that it does not use previous plans or utilizations. This can cause severe disruptions at the school level as training agents adjust to plans that cannot be executed by either the detailers or the schools.

Increments/Decrements of Previous Utilization

No one has proposed a model of NEC "C" school planning based on previous utilization of training. Training for "F" school and non-NEC "C" school courses use this approach because neither authorizations or inventory are available for those skills. There are two justifications for this approach to planning. First, as a general rule, most organizations plan for incremental changes in demand. A zero-based plan is only used for new products or new organizations. Since most Navy NEC "C" school courses are on-going from year to year, it makes sense to construct incremental plans. Second, a plan based on previous utilization would be less disruptive to the training agents than a zero-based plan. Utilization rates for NEC "C" school courses would be better and there would be less waste for instructors and facilities.

Two disadvantages of this approach are that a plan based strictly on previous utilization is likely to be too static and the plan might not take fleet requirements into account. To meet these

disadvantages, the plan would have to be adjusted based on requirements for new NECs and growing or declining NECs and would have to include the difference between authorizations and inventory.

Capacity of Inventory

Liang and Buclatin (1988) proposed an extension of the Enlisted Personnel Allocation and Nomination System (EPANS) to NEC "C" school planning. EPANS is described by Liang and Thompson (1987). Liang and Buclatin want to extend the actions of the detailers to the NEC "C" school planning function. They included the cost of enroute training in their personnel assignment model and showed training costs could be decreased while maintaining optimum assignment if they are allowed to adjust the number of classroom seats. They stated that this adjustment would serve as a better way to obtain an NEC "C" school plan than the current system.

The Liang and Buclatin approach does not match the current NEC "C" school planning process very well. NEC "C" school planning is a projection into the future for a number of years. EPANS works with execution year data. The monthly data on upcoming assignment options that EPANS uses does not exist when the NEC "C" school plans are made. As previously stated, billet and inventory data at the NEC level are suspect.

Capacity of Schools: Scheduling Models

An NEC "C" school planning model can be based on the feasibility of training at the school level. Feasibility is the ability of schools to deliver training based on constraints of instructors, classrooms, equipment, and berthing. No model of this kind has been built. Several models are available on the related problem of scheduling courses given the constraints. Lindahl and May (1979) recommended an approach like this. The Training Analysis and Evaluation Group (TAEG) built user friendly software and data bases to calculate a feasible course schedule.

A series of three reports (Lindahl & Lin, 1977; Lin & Hodak, 1979; Lin, Guitard & Hodak, 1981) trace the evolution of the TAEG course scheduling model. The first report provided a way to replace the manual process. It suggests balancing the planned input requirements against the availability of instructors, equipment, and facilities. The scheduling program in the report did not include a mathematical model, but an appendix to the report describes a possible application of network modeling. Lindahl and Lin concluded that schedules are difficult to establish because of varying course lengths and start dates; varying class sizes, student/instructor ratios, and contact hours; course resource interactions and dependencies; the multiple resources required for each course; availability of resources; delays in resource acquisitions; and a factorial growth in the complexity of the problem as more variables are considered.

Lin and Hodak (1979) continued the work with an automated course scheduling system. The system was developed for a microcomputer. It was user friendly, interactive, and based on available data. No model was involved; the basic goal was to replace the manual system with an automated one that is easy to use. Lin, Guitard, and Hodak (1981) developed a more advanced microcomputer system. The main idea was still the same: organize and manage a large number of data elements on courses, instructors, and facilities. The model produced a feasible schedule for 5 years.

Recently, Sorensen and Stasuzzo (1989) developed a scheduler for the LAMPS MK III course at the Anti-Submarine Warfare School in San Diego. The scheduler worked within a course to schedule the individual segments given the course constraints. It can also improve the course throughput by simulating "what-if" questions.

Like EPANS, the scheduling models don't agree with the current planning process. Course scheduling is not an OP-11 function and the amount of data involved is very large. However, if one purpose of planning is to minimize dislocations, then the OP-11 planning model can interface with course scheduling model as the basis for feasibility analysis of NEC "C" school plans.

Expert System of the Planning Conference

An expert system, based on the NEC "C" School Planning Conference, can contain the collected expertise of the participants. The expert system contains the rules by which decisions were made at other conferences. The idea is that the experts make good plans, so their rules should be followed by a model. The expert system can moderate the conference from year to year and give new participants the benefit of previous decisions. Callahan and Sorensen (1989) used the inputs and outputs from the 1988 Conference and a machine learning algorithm to capture the decision rules at the conference. As mentioned earlier, about half of the decisions at the conference repeated the previous year's decision. In cases where the decision changed, the authors were not able to determine the reasons for the change based on existing data.

The expert system approach is a short-cut "model." Much better is a normative model based on one of the other techniques. The expert system approach may, however, provide a useful alternative model in a DSS and a way for participants to learn from previous conferences.

Comments

While the models are interesting, and in some cases ingenious, they do not match the planning process and data very well. The author concluded that the best planning model causes the least disruption in the execution of training. For example, this model might consider past utilization and plans and then increment and decrement those figures based on anticipated fleet requirements. However, Headquarters planners typically favor a zero-based model. Interestingly, as Versions 1 and 2 of CSCHOOL have been implemented, the thinking of planners shifted to focus on minimizing disruption in execution. One reason for the shift was the external pressure to improve utilization rates. Another reason, however, was that CSCHOOL allowed OP-11 and CNTECHTRA to cooperate more effectively; CNTECHTRA's problems began to be reflected at the Washington level. Currently, Version 3 of CSCHOOL is being developed along two lines: a zero-based model and an increment/decrement model.

Future Developments: Effectiveness and Policy Testing

The NEC "C" School Planning Conference is expensive because of the participants' time and travel. If new budget guidelines are given or if new policies are suggested, the conferences cannot be reconvened. Because of the long lead time (18 months) between the conference and the start of the execution year, the plans are frequently changed after the conference. These later changes are usually accepted without analysis or question.

When making a plan, how can you know that the plan is good? For this you need an outcome measure of the effectiveness of the plan. At this time, only one measure exists--course utilization rate--but several others have been proposed. The problem with all the measures is the time lag between the point where the plan is made and the end of its execution. For example, the plan that was made in April 1988 will not begin execution until October 1989 and will not complete execution until September 1990.

Course utilization rate is the easiest goal for training. But the Navy uses training to maximize ship readiness. It also wants to minimize training costs, including the number of courses. The Navy wants to fill the class quotas while minimizing attrition and set-backs in the classes. It wants to utilize the NECs that are awarded (Ganeshan & Rowe, 1987), but it doesn't want to send individuals to billets if their skills are no longer valid. The relative importance of the goals varies depending on the questions that are currently being asked by Congress, the particular NEC that is being considered, or data that indicates that one goal is out of line.

In fact, all the goals are important and interact. Suppose, on the one hand, that readiness considerations forced the Navy to insist that a particular NEC is fully manned. Then the Navy might overtrain for that NEC. The overtraining would drive up training costs and lower NEC utilization by individuals since some individuals would not be assigned to a billet for the NEC. (On the other hand, if an NEC is not important to readiness, the Navy might undertrain and lower training costs while getting high utilization by individuals and lower readiness.)

Later versions of the decision support system can include the analysis of these goals. Initially, the control of course utilization rates will serve as the primary objective Course utilization is the most readily measured number and the one with the greatest effect on the training agents.

CONCLUSIONS

NEC "C" school planning decisions are now made at annual planning conferences that are both expensive and cumbersome. The decision support system that is being built in this research has already had a positive impact on the planning process. After the implementation of CSCHOOL, Version 1, OP-11 wrote NPRDC, "The software, Users Manual, and personal assistance... provided throughout the FY90-FY94 training requirements planning cycle were crucial to our success."

The incremental approach to implementation has gradually surfaced the important problems. Some of these problems are solvable at this time but others await future developments. The successes of Versions 1 and 2 of CSCHOOL show the value of the approach. Version 3, which will include a model, requires information about the goals of the planning system. It appears that the most readily accessible goal is to minimize the turbulence in scheduling courses at the training agent level while time to improving the course utilization rates.

REFERENCES

Ariav, G., & Ginzberg, M. (1985). DSS design: A systematic view of decision support. *Communications of the ACM, 28*(10).

Callahan, J., & Sorensen, S. (1989). *Rule induction for group decisions with statistical data, an example*. Paper submitted for publication.

Ganeshan, J. (1987). *NEC related "C" school planning* (NPRDC-TR-87-22). San Diego: Navy Personnel Research and Development Center.

Ganeshan, J., & Rowe, M. (1987). *An investigation of NEC utilization* (NPRDC-TR -87-18). San Diego: Navy Personnel Research and Development Center.

Keen, P., & Gambino, T. (1983). Building a decision support system: The mythical man-month revisited. In J. Bennett (Ed.), *In Building Decision Support Systems*, Reading, MA: Addison-Wesley Publishing Company.

Liang, T., & Buclatin, B. (1988). Improving the utilization of training resources through optimal personnel assignment in the U.S. Navy. *European Journal of Operational Research, 33*(2).

Liang, T., & Thompson, T. (1987). A large-scale personnel assignment model for the Navy. *Decision Sciences, 18*(2).

Lin, B., Guitard, C., & Hodak, G. (1981). *Course scheduling model for the Naval Training Command* (TAEG Report No. 97). Orlando, FL: Training Analysis and Evaluation Group.

Lin, B., & Hodak, G. (1979). *Automated course scheduling system for naval training* (TAEG Report No. 72). Orlando, FL: Training Analysis and Evaluation Group.

Lindahl, W., & Lin, B. (1977). *An heuristic approach for the scheduling of Navy training courses* (TAEG Report No. 52). Orlando, FL: Training Analysis and Evaluation Group.

Lindahl, W., & May, D. (1979). *An appraisal of Navy specialized training*. Report for the Deputy Assistant Secretary of Navy (Manpower) (Informal).

Marcus, A. (1989). *A model of C-school training requirements* (CNA Research Memorandum, CRM 88-258). Alexandria, VA: Center for Naval Analysis.

Peeples, T., & Hodak, G. (1988). *Navy "C" school loading plan: Computer program users and programmer documentation* (Special Report No. 88-004). Orlando, FL: Naval Training Systems Center.

Quester, A., & Corliss, G. (1986). *The Navy enlisted classifications (NECs): A history* (CNA Research Memorandum, CRM 86-84). Alexandria, VA: Center for Naval Analysis.

Skilled accession training (SKAT) model. Unpublished description.

Sorensen, S., Escamilla, B., & Tang, M. (1988). *"C" school planning system: Users manual.* San Diego: Navy Personnel Research and Development Center.

Sorensen, S., & Jefferson, R. (1989). *NEC "C" school planner (CSCHOOL): Users manual.* San Diego: Navy Personnel Research and Development Center.

Sorensen, S., & Stasuzzo, P. (1989). *Time line and the Lamps Mk III course of instruction.* San Diego: Navy Personnel Research and Development Center.

U.S. General Accounting Office. (1985). *Observations on the Navy's process for determining annual enrollment requirements* (GAO/NSIAD-85-156). Washington, DC: U.S. General Accounting Office.

APPENDIX A

DATA BASES USED BY CSCHOOL

DATA BASES USED BY CSCHOOL

The XREF data base relates each NEC to one or more sponsors.

XREF
Source: Entered by hand

Field	Field Name	Type	Width
1	NEC	Character	4
2	SPONSOR	Character	5

The REQTS data base gives the training requirements for each NEC/rate/arate combination.

REQTS

Source: Entered by hand

Field	Field Name	Type	Width
1	NEC	Character	4
2	RATE	Character	6
3	ARATE	Character	5
4	YEAR1	Numeric	4
5	YR1	Numeric	5
6	YR2	Numeric	5
7	YR3	Numeric	5
8	YR4	Numeric	5
9	YR5	Numeric	5
10	CDPR	Character	4

The HEADER data base gives information about each course.

HEADER

Source: NITRAS

Field	Field Name	Type	Width
1	NEC	Character	4
2	CDP	Character	4
3	CIN	Character	10
4	TITLE	Character	16
5	LENGTH	Numeric	4
6	ACTIVITY	Character	16
7	UIC	Character	5
8	TYPE	Character	2
9	P_I	Character	1
10	SPONSOR	Character	5
11	ECM	Character	5
12	TPC	Character	5
13	A_P_D	Character	1
14	DATE	Character	6
15	NPNAVY	Numeric	4
16	NPOTH	Numeric	4
17	OPNAVY	Numeric	4
18	OPOTH	Numeric	4
19	REMARKS	Character	10

The REMARKS data base gives special information about an NEC.

REMARKS

Source: Entered by hand

Field	Field Name	Type	Width
1	NEC	Character	4
2	COMMENT1	Character	120

The UTIL data base gives utilization for each course in earlier years.

UTIL

Source: Entered by hand

Field	Field Name	Type	Width
1	NEC	Character	10
2	CDP	Character	4
3	NEC	Character	4
4	SOC	Character	6
5	UTILYR1	Numeric	4
6	PLANFYi	Numeric	4
7	ACTUALFY1	Numeric	4
8	PLANFY2	Numeric	4
9	ACTUALFY2	Numeric	4
10	PLANFY3	Numeric	4
11	ACTUALFY3	Numeric	4

The RATEAUTH data base gives authorizations for each NEC.

RATEAUTH
Source: Entered by hand

Field	Field Name	Type	Width
1	NEC	Character	4
2	PRISEC	Character	1
3	RATE	Character	3
4	INDICATOR	Numeric	1
5	YEAR	Numeric	4
6	YR1	Numeric	5
7	YR2	Numeric	5
8	YR3	Numeric	5
9	YR4	Numeric	5
10	YR5	Numeric	5
11	YR6	Numeric	5
12	YR7	Numeric	5

DISTRIBUTION LIST

Distribution:
Chief of Naval Operations (OP-01B2), (OP-112), (OP-112F1)
Defense Technical Information Center (DTIC) (2)

Copy to:
Commanding Officer, Naval Training Systems Center
Scientific and Technical Information (STINFO) Office
Superintendent, Naval Postgraduate School