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NAVAL POSTGRADUATE SCHOOL

Monterey, California



THESIS

TARPS: A PROTOTYPE EXPERT SYSTEM
FOR
TRAINING AND ADMINISTRATION OF RESERVES (TAR)
OFFICER PLACEMENT

by

George A. Zolla Jr.

September, 1991

Thesis Advisor:

Magdi N. Kamel

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T259337

REPORT DOCUMENTATION PAGE

1a REPORT SECURITY CLASSIFICATION UNCLASSIFIED		1b RESTRICTIVE MARKINGS	
2a SECURITY CLASSIFICATION AUTHORITY		3 DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution is unlimited.	
2b DECLASSIFICATION/DOWNGRADING SCHEDULE			
4 PERFORMING ORGANIZATION REPORT NUMBER(S)		5 MONITORING ORGANIZATION REPORT NUMBER(S)	
6a NAME OF PERFORMING ORGANIZATION Naval Postgraduate School	6b OFFICE SYMBOL (If applicable) 37	7a NAME OF MONITORING ORGANIZATION Naval Postgraduate School	
6c ADDRESS (City, State, and ZIP Code) Monterey, CA 93943-5000		7b ADDRESS (City, State, and ZIP Code) Monterey, CA 93943-5000	
8a NAME OF FUNDING/SPONSORING ORGANIZATION	8b OFFICE SYMBOL (If applicable)	9 PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER	
8c ADDRESS (City, State, and ZIP Code)		10 SOURCE OF FUNDING NUMBERS	
		Program Element No	Project No
		Task No	Work Unit Accession Number
11 TITLE (Include Security Classification) TARPS: A PROTOTYPE EXPERT SYSTEM FOR TRAINING AND ADMINISTRATION OF RESERVES (TAR) OFFICER PLACEMENT			
12 PERSONAL AUTHOR(S) George A. Zolla Jr.			
13a TYPE OF REPORT Master's Thesis	13b TIME COVERED From To	14 DATE OF REPORT (year, month, day) 1991, September	15 PAGE COUNT 79
16 SUPPLEMENTARY NOTATION The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.			
17 COSATI CODES		18 SUBJECT TERMS (continue on reverse if necessary and identify by block number)	
FIELD	GROUP	SUBGROUP	
		Expert Systems; Expert Database	
19 ABSTRACT (continue on reverse if necessary and identify by block number)			
<p>The billet assignment for Training and Administration of Reserves (TAR) officers is normally two to three years. A placement officer determines where the TAR officer's subsequent assignment will be based on the officer's qualifications and billet requirements. This assignment is vitally important because it significantly affects the officer's career opportunities for promotion and command.</p> <p>This thesis describes the design and implementation of a prototype expert database system that enhances the placement officer's ability to efficiently select the optimum billet for each officer. The prototype integrates a rule based expert system with officer and billet databases to produce a list of billets that match an officer's qualifications and desires.</p> <p>A rudimentary prototype of TARPS has already been evaluated in the field. Initial feedback is encouraging. Placement officer recommendations have been implemented into an enhanced prototype, detailed in this thesis.</p>			
20 DISTRIBUTION/AVAILABILITY OF ABSTRACT <input checked="" type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS REPORT <input type="checkbox"/> DTIC USERS		21 ABSTRACT SECURITY CLASSIFICATION Unclassified	
22a NAME OF RESPONSIBLE INDIVIDUAL Prof. Magdi N. Kamel		22b TELEPHONE (Include Area code) (408) 646-2494	22c OFFICE SYMBOL Code AS/KA

Approved for public release; distribution is unlimited.

TARPS : A PROTOTYPE EXPERT SYSTEM
FOR
TRAINING AND ADMINISTRATION OF RESERVES (TAR)
OFFICER PLACEMENT

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Submitted in partial fulfillment
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MASTER OF SCIENCE IN INFORMATION SYSTEMS

from the

NAVAL POSTGRADUATE SCHOOL
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ABSTRACT

The billet assignment duration for Training and Administration of Reserves (TAR) officers is normally two to three years. A placement officer determines where the TAR officer's subsequent assignment will be based on the officer's qualifications and billet requirements. This assignment is vitally important because it significantly affects the officer's career opportunities for promotion and command. This thesis describes the design and implementation of a prototype expert database system that enhances the placement officer's ability to efficiently select the optimum billet for each officer. The prototype integrates a rule based expert system with officer and billet databases to produce a list of billets that match an officer's qualifications and desires.

A rudimentary prototype of TARPS has already been evaluated in the field. Initial feedback is encouraging. Placement officer recommendations have been implemented into an enhanced prototype, detailed in this thesis.

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I. INTRODUCTION

A. BACKGROUND

The United States Navy has thousands of commands located worldwide that require thousands of officers with a diversity of skills. The mission of these commands varies greatly from providing continuing education for officers to conducting flight operations in a combat environment. Each command wants the most highly qualified and motivated officers to enhance their mission readiness.

Naval officers aspire to billets which provide job satisfaction, career enhancement, and prepare them for leadership roles. Because of the large variety and numbers involved, finding the right billet at the right time is an extremely difficult task.

The Bureau of Naval Personnel (BUPERS) is charged with the dual responsibility of providing Naval commands with highly qualified officers while at the same time balancing the career needs of the individuals. BUPERS assigns officers as detailers and placement officers to coordinate this process. Detailers talk directly to the individual officers in the commands who are due for reassignment. The detailers work to find the best possible billet for that officer, balancing the individual officers desires, qualifications and career needs.

Placement officers work directly with the commands to find the best possible officer to fill present and future vacancies. The detailer and placement officer must work together to effectively fulfill command and individual requirements.

B. OBJECTIVES

This thesis describes the design and development of a prototype Expert Database System that serves as an expert assistant to the TAR placement officer who functions as both a detailer and a placement officer. The prototype provides the TAR placement officer with several acceptable choices for officer reassignment, based upon placement officer input, transferring officer's duty preference, officer and billet database information and expert rules extracted from a knowledge base.

C. RESEARCH QUESTIONS

This thesis addresses the following two research questions: (1) Can an expert system be developed and implemented to assist the TAR placement officer in assigning TAR officers to their upcoming duty assignments? and (2) Can the required domain expertise be captured in a rule base?

D. SCOPE

The selection process for the entire U.S. Navy is very broad and beyond the scope of this thesis. An illustrative branch of the Bureau of Naval Personnel, PERS-4417, is used to

analyze possible solutions. PERS-4417 has the responsibility for assignment of officers for a subspecialty of the Navy, Training and Administration of Reserves (TAR). In this branch of BUPERS, one officer effectively acts as both detailer and placement officer for TAR officers and TAR commands.

E. LITERATURE REVIEW

A comprehensive literature review was conducted on previous efforts to automate the officer placement process as well as possible new approaches to automate the present system based on expert system technology. The previous approaches have ranged from simple database management systems to advanced linear programming models. However, none of these approaches have gained BUPERS approval. A review of these previous efforts is presented in Chapter II.

F. ORGANIZATION OF STUDY

The organization of the thesis is as follows: Chapter II describes the existing placement process, discusses previous attempts to automate the system and examines the benefits of an expert database system. Chapter III explains the domain of expertise needed for the expert system. Chapter IV describes the BUPERS databases and the attributes required to produce the expert system database. Chapter V overviews the expert system development methodology, develops the rule base, and explains the design of the prototype expert system. Finally,

Chapter VI draws some conclusions and states objectives for future research.

II. BACKGROUND

A. CURRENT PROCESS

The placement officer's primary responsibility is to select the best possible assignment for officers who are transferring from their current assignments. The four placement officers who serve in the Training and Administration of Reserves (TAR) branch of the Bureau of Naval Personnel (PERS-4417) are responsible for approximately 2200 officers and 2200 billets. The present method of billet selection is done manually. First the placement officer goes through the list of officers due for new assignments and receives their duty preference. Second the placement officer methodically goes through a list of billets to see which ones will be open at the right time and have requirements that match the officer qualifications. Complicating the task is the fact that the officer and billet information are in separate databases. These databases, Officer Assignment and Information System (OAIS) and Officer billet Description Information System (ODIS) are not linked and have only rudimentary query capabilities. They do, however, contain an enormous quantity of information on both the officers and the billets. The following is a sampling of data contained in the Officer Assignment and Information System (OAIS) and the

Officer billet Description Information System (ODIS)

databases:

Officer Assignment and Information System (OAIS):

- Name
- Rank
- SSN - Social Security Number
- Designator - pilot, surface warfare, submariner etc.
- Seniority
- Promotion Status
- Homeport - Geographic location (City)
- Billet Title
- PRD - Planned Rotation Date (transfer month)
- Subspecialty - Educational specialty
- AQD - Additional Qualification Designator

Officer billet Description Information System (ODIS):

- UIC - Unit Identification Code
- BSC - Billet Sequence Code
- Billet Title
- Activity - Command
- Homeport
- Rank
- Billet Designator
- PRD - Planned Rotation Date for incumbent
- Subspecialty - if required
- AQD - if required

UIC specifies the Naval activity and the BSC identifies the specific billet in that command. Rank and designator are specific qualifications. Planned Rotation Date (PRD) determines if a timely match can be made. Homeport is the number one priority for most officers when requesting a billet. AOD defines the type of equipment the officer is qualified in.

There are many rules that experts use to match officers with billets. For example, a billet may be specified for a particular rank but may accept a higher or lower rank. These rules are normally assimilated by experience since they are not specified in any single document. Training and transition for a new placement officer requires a minimum of two to three months of overlap with an experienced placement officer before the new placement officer is ready to make placement decisions. After receiving his training, the new placement officer accesses the databases for information on officers and billets and applies his knowledge of the rules to make a selection.

At the Bureau of Naval Personnel there are several branches that have similar responsibilities covering all the officers in the U.S. Navy. A study of all these branches shows that the billet selection process is also done manually with no advanced computer system being designed for the placement officers.

B. PREVIOUS ATTEMPTS TO AUTOMATE THE PLACEMENT SYSTEM

There have been several attempts to produce computer based systems to enhance the placement decision process. Paul (1990) used operational analysis to develop an approach to Naval officer placement based on an assignment problem with hierarchical objectives. Paul defines four objectives: (1) the needs of the Navy, (2) the career and qualification needs of the officer, (3) the desires of the officer and (4) cost of the reassignment. The objectives are prioritized in the same order as listed and then are used as the hierarchical basis for the assignment problem. Rapp (1987) used a model based on the classical transportation model of linear programming to design a system for assignment of officers during a massive mobilization to the U.S. Marines. Strouzas (1986) designed a database application to integrate billets and officer assignment for the Greek Navy. Alston (1987) designed an expert system to assign enlisted personnel to maintenance billets in aviation squadrons. Alston used Insight 2+ as an expert system tool for its user friendliness and its capability to access dBase files.

Although interesting, none of the above approaches seem to be well suited to the placement officer's decision making process. Paul's assignment problem approach to officer reassignment is mathematically robust and does address officer desires but uses predetermined priorities. Making the "needs of the Navy" as first priority is normally appropriate, but

there must be some flexibility built in to the system to allow placement officer evaluation of priorities. Furthermore, no mention is made of real-time interaction with the transferring officer. Rapp's linear programming model produces only one billet for each officer. Rapp does not allow placement officer interaction to share expertise and additional knowledge that may be important, nor does he consider the preference of the transferring officer. Strouzas' database application automates query selection of billets and personnel but does not build any decision model for officer placement. Alston's model deals only with squadron level enlisted personnel assignments.

C. BENEFITS OF AN EXPERT DATABASE SYSTEM

Because the process of officer placement uses expert knowledge, an expert system is a good choice for automating this process (Boose 1986). The placement officer could use the expert system as an assistant to filter the available choices to a reasonable number, then personally make the final decision (Hart 1986). Additionally, the process of officer placement is well suited for an expert system as it meets the general requirements for such systems (Turban 1990):

- The task requires only cognitive skills.
- At least one genuine expert, who is willing to cooperate exists.

- The experts involved can articulate their methods of problem solving.
- The task is not too difficult.
- The task is well understood, and is defined clearly.
- The solution to the problem has a high payoff (The task is important).
- The Expert System can preserve scarce human expertise.
- The expertise will improve performance and/or quality.
- The system can be used for training.

Because the databases provide information for the knowledge base, the placement process is ideal for a computer based system that combines an Expert System (ES) with the available Database Management System (DBMS) (Brachman and Levesque 1987). This combination is known as an Expert Database System (EDS) (Smith 1986). The coupling of the expert system and database could be either tight or loose. In a tightly coupled architecture, the expert system controls the DBMS with the ES functioning as a front end data entry system for the database or, alternatively, the database management system controls the ES (Missikoff and Wiederhold 1986). If the database controls the ES, the expert system is used to optimize database access. When the expert system controls the database, the database can only be accessed through the user interface generated by the expert system. This can be advantageous for simplifying or restricting user interaction with the database. In a loosely coupled architecture, both

subsystems retain their original structure and appearance. The database can be accessed independently of the expert system to create ad hoc queries and reports. A loosely coupled architecture is best suited for the officer placement application. The expert systems component uses its rule base, placement officer input, and access to the two databases to propose a selection while the databases could be manipulated independently to maintain information on officers and billets.

III. THE OFFICER'S BILLET PLACEMENT PROCESS

A. DOMAIN OF EXPERTISE

Gathering the expertise needed to build an expert system is often the most difficult part of the development of the system (Hayes-Roth and Waterman 1983). Since the author of this thesis has served as a TAR placement officer, the process of building and testing an expert system is greatly simplified.

Placing an officer into an available billet can be perceived from two different perspectives. If the priority is placed on assigning the best qualified officer to a billet, then the problem can be viewed as starting from the billet and working backward to find the best qualified officer to fill that billet. However, this method does not consider the officer's preference or career requirements. If, on the other hand, we view the problem from the officer's perspective, the solution would be to find the exact billet that fills his needs and desires. In most branches of BUPERS there are two officers working on officer placement, one who works with the officer being reassigned, the detailer, and one who works with the commands that are trying to fill their billets, the placement officer. The detailer and placement officer are both considered domain experts. The placement officer queries

the officer database to find the best qualified officer for the command's billets and the detailer queries the billet database to find the best possible billet for the officer.

In PERS-4417, the placement officer manages both the billets and the officers. He can choose to prioritize either one. This thesis documents the approach that prioritizes the officer's wishes. This approach attempts to find the best billet available for his career needs. This approach increases retention and morale but must be realistically balanced against command requirements. No officer can be placed in a requested billet just because he wants it, there must be a valid billet requirement and he must be qualified to fill that billet.

The first step used by the placement officer is to retrieve the transferring officer's record from the BUPERS database and review his qualifications. The officer information retrieved includes: Name, Rank, Social Security Number (SSN), Designator, Present Homeport, Planned Rotation Date (PRD), and Requested Homeport. This data gives a good sketch of the officer's qualifications and what the billet requirements need to be. For example, it would be advantageous to put a pilot in a billet that has a pilot designator code and a commander in a billet that is rank coded for commander. In addition, the officer's requested homeport will show his requested geographic location.

The next step is to retrieve the billet attributes needed for billet identification and officer matching. The minimum billet traits needed are as follows: Unit Identification Code (UIC), Billet Sequence Code (BSC), Rank, Designator, PRD of the incumbent officer, and Homeport. These attributes are just a small portion of billet requirements but they represent the most important aspects for a first examination.

Armed with officer qualifications and billet requirements, the next step would normally be querying the billet database with the officer qualifications and requested homeport to find what matches could be made. Since the databases are not linked, the placement officer is forced to do a lengthy and complicated query to produce a list of billets in the requested geographic area that match the officer's qualifications. At this point, the placement officer still would not have any information on the personnel that are in the selected billets nor the incumbent's PRDs.

In practice, the placement officer keeps a paper list (slate) of each of his commands and their billets. The slate displays each billet plus its required rank and designator codes. Directly below the billet information is a strip of paper showing the officer assigned with his name, rank, SSN, designator and PRD.

The process of billet selection is not simply based on exact matches for rank, designator and PRD. There are rules that allow the billet to be filled by an officer of a

different rank than specified. Normally an officer of the next higher or next lower rank can fill the billet. Billet designators do not exactly match officer designators, they define what officer designators may be assigned to these billets. There are billet designators that allow any officer to be assigned. Some pilot billets may be filled by Naval Flight Officers and some Naval Flight Officer billets may be filled by pilots. There are also billets that require an officer with any warfare specialty.

PRDs do not have to be an exact match either. There may be an overlap of officers and at times there may be a gap. Normally a plus or minus 2 month window is acceptable. The billet Additional Qualification Code (AQD) may require an exact officer AQD match or may allow several different officer AQDs. For instance, an aviation staff or training billet may accept pilots with different aircraft qualification types. Billet subspecialty codes are not exact matches with officer subspecialty codes. Billet subspecialty codes specify a set of officer subspecialty codes that are acceptable matches for the billet's educational requirements.

B. CASE STUDIES

The following simplistic yet typical cases with fictitious names are provided to clarify the assignment process. They provide a realistic view of placement decisions that are made for officers of different ranks and various warfare skills:

CASE 1. Lt Nickerson makes a morning telephone call and schedules a meeting with the placement officer at PERS-4417 in Washington, D.C. for the afternoon to discuss his next duty assignment. Before he arrives, the placement officer checks the officer database and finds that Lt Nickerson is a 1317 (TAR pilot) stationed at Norfolk, Va flying the F-14 Tomcat. His PRD is June of 1991 and his duty preference shows that he is requesting Fighter Squadron Three Zero One, an F-14 squadron at Naval Air Station Miramar, California as his next duty assignment. The placement officer mentally goes through his knowledge base and deduces that this officer could be assigned to a LT, LTJG or LCDR billet. As a pilot he is eligible to fill a pilot or Naval Flight Officer billet (1317 or 1327). His PRD of 9106 probably could be adjusted by plus or minus 2 months. The placement officer then determines what commands are located at Miramar, California. He manually checks each command's billets (slates) to determine what billets match Lt Nickerson qualifications and which billets have incumbents with PRDs aligned with June of 1991. A review of these billets suggest there are no matches in Fighter Squadron Three Zero One but Fighter Squadron Three Zero Two, also an F-14 squadron at Miramar, California has a billet with a PRD of August, 1991. Lt Nickerson arrives for the meeting and is very happy to accept the billet at Fighter Squadron Three Zero Two because he has received his geographic preference and will continue to fly the F-14.

Case 2. LCDR Wood calls PERS-4417 to request orders to his next duty assignment. While he is on the telephone, the placement officer retrieves his record from the OAIS. LCDR Wood is a 1307 (Non-flying aviation officer) stationed at Naval Air Station Glenview, Illinois with a PRD of September 1991. He has no homeport preference in the database. He states that he would like to be transferred to Atlanta, Georgia. With a designator of 1307 he qualifies for 1300 (non-flying aviation) and 1000 (any officer) billets. A check of the Atlanta area shows that the only Atlanta commands, Naval Air Station Atlanta and Naval Reserve Center Atlanta have no billet openings that match his qualifications. The placement officer conveys this information, and LCDR Wood states that Boston would be his second choice for duty. A review of the commands at Boston reveals no billets available for him. Dallas, Texas is LCDR Wood's third choice. Reviewing the commands located at Dallas reveals a 1300 LCDR billet open in July 1991. LCDR Wood accepts the billet.

Case 3. Captain Baker calls the placement officer and states that he would like to be transferred to any available billet in Tampa, Florida. OAIS shows that Captain Baker has a 1117 designator (surface warfare officer). He is stationed in Washington D.C and has a PRD of July 1991. A surface warfare officer is qualified for 1000, 1050 (any warfare specialty) and 1110 (surface warfare) designated billets. A check of

Tampa shows one command that has a 1100 Captain billet but it is not open until 1993. Captain Baker states that he would like to know what other billets he could fit into for the summer of 1991. The placement officer states that he will have to call him back because it will take some time to manually search through all the billets that match his rank and qualifications.

C. ADDITIONAL CONSIDERATIONS

There are many additional rules that must be considered before an officer can actually be transferred. After testing an initial prototype of the proposed system, PERS-4417 pinpointed several of the most important rules that are commonly used. In addition, PERS-4417 requested that several additional rules be developed to produce information that is not readily available to the placement officer. The information that will be produced from the additional rules include:

- Postgraduate school eligibility.
- Postgraduate school payback status
- Obligated service end date.
- Mandatory retirement or separation date.
- Earliest transfer date based on Congressional mandated rules.

Postgraduate school eligibility details the specific areas of postgraduate education that are open to the officer. Postgraduate school payback status reports whether the officer served in a tour using education he achieved at the Navy's expense. This information is not available from the current database normally used by the placement officer, because it must be extracted from a different database. Transfer orders can actually be blocked if an officer has not completed a payback tour in his postgraduate education area within specific guidelines. Obligated service end dates are based on bonuses and training received. Many officers have no obligated service remaining. A flag that displays when an officer has obligated service would greatly assist the placement officer. Mandatory separation or retirement dates require several pieces of information to compute and often involve complex calculations. Promotion status, rank, total commissioned service and active duty start date are needed for this calculation. Earliest transfer date is the most complex and one of the most important of the computed values. The rules that determine this date have been mandated by Congress and must be strictly adhered to. The type of activity that the officer is presently serving in as well as the type of activity he is transferring to plus present geographic location are just a few of the values needed to compute this date.

The additional considerations will produce a much more complex rule base. However, this additional complexity will produce an efficient system that specifically matches the requirements of the user.

D. SUMMARY AND JUSTIFICATION

The current process can be summarized as follows. First the officer's qualifications and personal data are retrieved from OASIS. Then his desires for homeport and type of duty are determined, normally through telephone communications. Next, the placement officer applies a set of rules to the officer's data and qualifications to determine what billets he is authorized to fill. Finally, the placement officer manually queries all the billets at the requested homeport to find any billets that are expected to be vacant and match the officer's qualifications. If no matches are found, the search must be expanded to include other geographic locations.

This manual process is exceedingly tedious and time consuming. The required information is not readily available to the placement officer. He must retrieve data from different databases and then manually go through his hard copy slates for each command. Because the time to accomplish this manual query is so long, the placement officer is normally interrupted by other officers requesting reassignment. This cycle of repeated interruptions compounds the delays inherent in the laborious manual query process.

Automating the process will provide the placement officer with more time to communicate with transferring officers and consider placement options resulting in improved decision making. TARPS will parallel the current decision making process. First, officer qualifications would be retrieved from the officer database. Next, the requested homeport would be entered into the system. The EDS would then take the officer information, process it through a rule based model and determine the criteria to query the billet database. A printout will be displayed matching officer qualifications and desires with billet requirements. The placement officer will scan this list and decide which billet, if any, is optimum for the officer's career. If a mutually acceptable billet is not found then the system can be queried repeatedly for different homeports.

The ability to search through the billet database quickly and completely will enable productive, one-on-one conversations with the transferring officer, thus alleviating time consuming hours investigating possible billets. The additional capabilities for assessment of postgraduate education, mandatory retirement and acceptable transfer dates will produce critical information for the decision making process. These improvements will dramatically expedite and improve the entire officer placement process.

IV. THE OFFICER AND BILLET DATABASES

A. OFFICER ASSIGNMENT AND INFORMATION SYSTEM (OAIS)

The Officer Assignment and Information System (OAIS) database contains detailed information on all active duty officers in the United States Navy. OAIS is available to all placement officers via a desktop computer terminal linked directly to the Bureau of Naval Personnel's mainframe. The information available is grouped by specific topics. Each topic is referenced by page number.

There are hundreds of data fields for each officer within in OAIS, including fitness reports, previous duty assignments, promotion history, qualifications and duty preferences.

Officer data is retrieved by entering the individual's social security number. Access is restricted through the use of passwords. There are only rudimentary data query and data retrieval capabilities available in OAIS. Officer information can only be entered or viewed by means of predetermined menu selections. OAIS ad hoc data queries and reports must be initiated at the Bureau of Naval Personnel's Information Services Development Branch (PERS-470).

PERS-4417 added more requirements that mandate additional officer information be available for the TAR Officer Placement

System (TARPS). The following data fields are the complete OAIS requirements for TARPS:

- OFFICER_NAME
- OFFICER_RANK
- OFFICER_SSN - Social Security Number
- OFFICER_PROMSTAT - Promotion Status
- OFFICER_APC - Additional Qualification Designator
- OFFICER_PB - Navy Funded Education Payback Code
- OFFICER_AVEND - Aviation Bonus End Date
- OFFICER_REPT - Date reported to present activity
- OFFICER_UIC - Unit Identification Code
- OFFICER_ACBD - Active Commissioning Base Date
- OFFICER_ADSD - Active Duty Start Date
- OFFICER_DESIGNATOR
- OFFICER_SUBSPEC - Educational Subspecialty
- OFFICER_PRD - Planned Rotation Date

The field names have been modified slightly from OAIS for TARPS to clarify the difference between officer and billet information. Appendix A displays a relational diagram for the OFFICER database.

B. OFFICER BILLET DATABASE INFORMATION SYSTEM (ODIS)

The Officer billet Database Information System (ODIS) contains detailed information on every officer billet in the

United States Navy. It is also maintained at BUPERS. ODIS information is available to each placement officer via the same desktop terminal that displays OAIS information. ODIS and OAIS information cannot be viewed simultaneously.

ODIS contains a complete list of information on officer billets such as geographic location, rank, designator, AQD and required subspecialty. ODIS contains a cognizant placement officer (COG) field that identifies the placement officer responsible for each billet. COG 51 identifies TAR aviation placement officer billets and COG 65 identifies TAR surface placement officer billets.

ODIS supports ad hoc query retrievals. This system enables the placement officer to print out lists based on such fields as location, rank or designator. There are several limitations to ODIS. The billet query and extraction procedures are arduous and not user-friendly. Officer information or billet information can be queried independently but they can not be manipulated simultaneously. Therefore, a list of command billets and officers assigned to these billets can not be created. The inability to transfer information between databases is the system's most significant limitation. PERS-470 has the ability to manually transfer information between OAIS and ODIS and can produce a list of billets by activity that will display information on incumbent officers.

The following data fields are the ODIS requirements for TARPS:

- BILLET_PRD - PRD of incumbent officer
- BILLET_UEDA - EDA for an incoming officer
- BILLET_RANK
- BILLET_DESIGNATOR
- BILLET_ACTIVITY - Command where billet located
- BILLET_TITLE - Job Description
- BILLET_COG - Cognizant placement officer
- BILLET_AQD - Additional Qualification Designator
- BILLET_SUBSPEC - Required Educational Subspecialty
- BILLET_HOMEPORT

C. DATA EXTRACTION

ODIS and OAIS are very large databases. Accessing all their fields of information during every TARPS billet selection process would result in a very slow and inefficient system. To provide a rapid response time, only the data actually required by TARPS is used. The ODIS and OAIS databases are filtered and the required data is extracted by PERS-470. OAIS and ODIS information is downloaded as ASCII files then transformed into standard database files by PERS-470. The files used for the prototype system are downloaded onto standard 360K floppy disks. This provides an easy way to initialize and update the required information for TARPS on an available microcomputer in PERS-4417. Appendix A displays a relational diagram for the OFFICER and BILLET database files.

V. THE TARPS EXPERT SYSTEM

A. EXPERT SYSTEM DEVELOPMENT PROCESS

Developing an expert system application involves the following phases:

- Decision Making Process Study
- Knowledge Representation
- System Design and Development
- Prototype Construction

Studying the decision making process identifies the problem domain, specific task and contributing domain expert. Documented sources, interviews with human experts and task observation are used as sources of information.

Knowledge representation can be achieved by a variety of techniques but they all employ a knowledge base that is manipulated by an inference system. The inference system uses search and pattern-matching techniques on the knowledge base to answer questions, draw conclusions or otherwise perform an intelligent function. The knowledge base is usually constructed from a list of IF THEN rules. (Turban 1990)

System design determines the required components such as input/output capabilities, inference engine and user interface specifications.

The final phase of expert system development is building a prototype. Prototyping is used because it produces a small-scale system that includes, in rudimentary form, the major components of a final system. The developer and user can get a good idea of the capabilities of the final system without dedicating all the resources needed to develop the final version. Additionally, expert and user feedback can be used to change the prototype design with much less effort than a full system redesign. Prototyping also gives the user an opportunity to experiment and see firsthand the capabilities of an Expert System. Usually the system goes through several design iterations. This process continues until the system is ready for testing in the field. (Turban 1990)

An expert system shell provides the framework for building a system that cohesively binds the databases, knowledge base and user interface.

Figure 1 is a graphical representation of the TARPS development process. The decision making process for TARPS was discussed in Chapter III. Knowledge representation, system design and prototype development are detailed in the following sections.

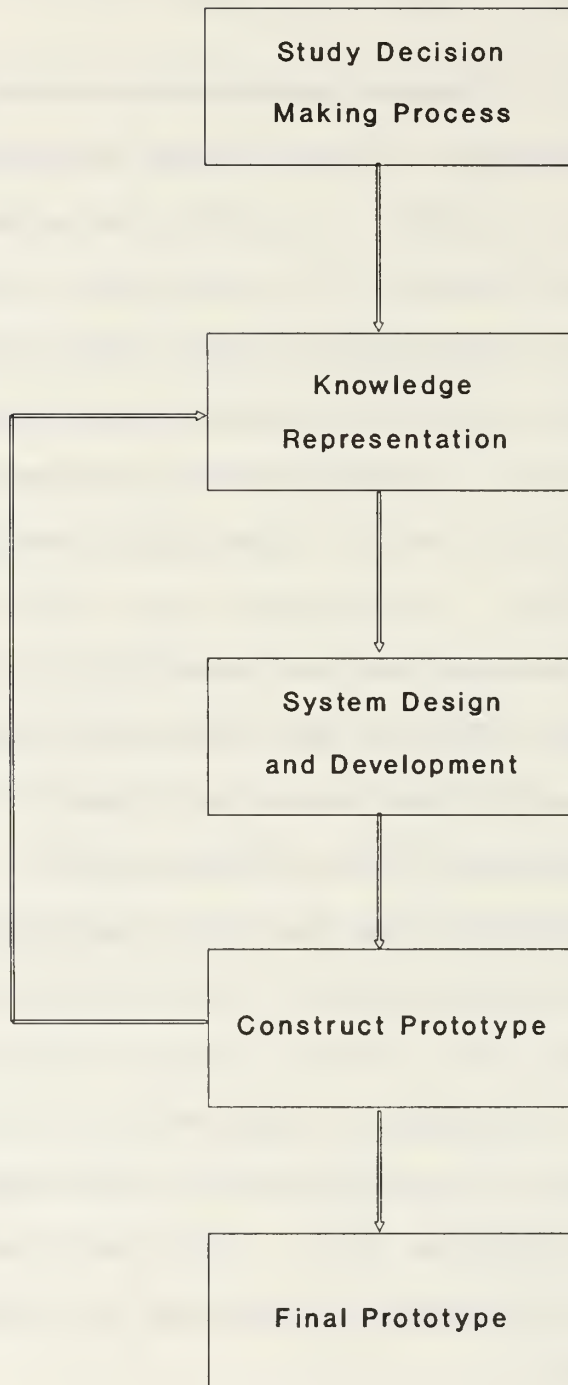


Figure 1. TARPS Design Process

B. KNOWLEDGE REPRESENTATION

To transform the processes that are currently in use to an expert system, a collection of IF THEN rules (Hayes-Roth 1985) are developed. These rules are applied to the information retrieved from the OFFICER database just as the placement officer applies his knowledge of the rules to the information he retrieves from the OASIS database. There are eight main decision areas that use rules:

- Postgraduate School Eligibility and Payback Information
- Retirement Eligibility, Bonus & Minimum Tour Information
- Billet PRD
- Billet Rank
- Billet Designator
- Billet AQD
- Billet Subspecialty
- Billet Homeport

Postgraduate (PG) School eligibility and payback status are determined from officer promotion status, rank, APC and Navy funded education payback codes. The information displayed from these rules, specifies whether the officer is eligible for PG School and lists the permissible curriculum. Officer payback status indicates whether the officer has paid back Navy funded education received by serving in a qualifying billet and if not how many tours it has been since the education was received. Examples of the rules used are:

```
IF      OFFICER_APC<=345 AND      (ACADEMIC PROFILE CODE)
      OFFICER_APC>335
THEN    PG=CAT2
      DISPLAY "Officer qualified for FM only at NPGS"
```

and

```
IF      OFFICER_PB=X                (PAYBACK)
THEN    PAYBACK=YES
      DISPLAY "Officer has paid back Navy funded educ."
```

In the first example, the officer is eligible for enrollment in the financial management program at the Naval Postgraduate School because his Academic Profile Code (APC) is between 335 and 345. If his APC was lower than 335, he would be eligible for additional educational programs. If his APC was higher than 345 he would not be eligible for any educational programs. The second example shows that the officer's payback data field, OFFICER_PB, contains an "X" which means he has paid back the Navy funded education he received by serving in a designated Naval billet that requires this educational background.

Retirement, Billet PRD, Aviation Continuation Pay (Bonus), and Minimum Activity Tour (MAT) information are determined from rules applied to: officer promotion status, Aviation Continuation Pay End-date, Activity report date, Unit Identification Code (UIC), Active Commissioning Base Date (ACBD), Active Duty Start Date (ADSD), rank and PRD. Officer

PRD is a direct input from the placement officer because it provides flexibility in determining when to move the transferring officer. The rules determine if the officer has met the Minimum Activity Tour length, whether he is too close to retirement for transfer, and if the officer is eligible to be moved after a failure to select for promotion. The end of obligated service for an officer who is receiving the Aviation Continuation Bonus is displayed. Billet PRD is also determined from these inputs. Matching billets are determined by checking for billets that have an incumbent with a PRD in a plus or minus three month window from the date the placement officer has entered. This gives the placement officer the ability to overlap or gap a billet. Examples of the rules used to determine this information are:

```
IF      OFFICER_PRD < (OFFICER_AVEND/100)
THEN    BONUS=YES
        DISPLAY "OFFICER IS UNDER BONUS UNTIL
                (OFFICER_AVEN) ."
```

and

```
IF      OFFICER_PRD > ((OFFICER_ADSD/100)+1799.5) AND
        OFFICER_RANK=CDR AND
        OFFICER_PROMSTAT=F12
THEN    RETIRE = YES
        DISPLAY "OFFICER CANNOT BE MOVED BECAUSE OF
                MANDATORY RETIREMENT."
```

The first example shows the rule used to determine if the officer's PRD is before the termination of his aviation bonus. If it is, the end date of the aviation bonus is displayed. The second example determines if an officer's PRD comes after 18 valid active duty years for retirement and he is a Commander who has failed to select for promotion twice. If he meets these criteria, he must be given orders for mandatory retirement and can not be transferred.

The next set of rules determine billet ranks available to the officer. Officer's present rank and promotion status are used to determine billet rank. For instance, if the officer's rank is LCDR, he is qualified to fill a billet for a CDR, LCDR or LT. This is illustrated in the following example:

```
IF      OFFICER_RANK = LCDR
THEN    BILLET_RANK = CDR
        BILLET_RANK = LCDR
        BILLET_RANK = LT
```

Appendix B gives a list of all billet ranks and acceptable substitutions.

Another area that requires a rule base is billet designator. For example, if the officer's designator is 1327, he is qualified for assignment to billets with designators of 1000, 1050, 1300, 1301, 1320, 1321, and 1322. The rule for this example is written as:

```

IF      OFFICER_DESIGNATOR = 1327
THEN    BILLET_DESIGNATOR = 1000
        BILLET_DESIGNATOR = 1050
        BILLET_DESIGNATOR = 1300
        BILLET_DESIGNATOR = 1301
        BILLET_DESIGNATOR = 1302
        BILLET_DESIGNATOR = 1320
        BILLET_DESIGNATOR = 1321
        BILLET_DESIGNATOR = 1322

```

Appendix C gives the definitions for all TAR officer designators, and Appendix D lists all billet designators and their matching officer designators.

The next area that requires a rule base is Billet Additional Qualification Designator (AQD). Officer designator, rank and AQD are the required inputs. The AQD will ensure that a billet designated for an F-14 pilot will receive a pilot qualified to fly an F-14. It also allows an F-14 pilot or an F-18 pilot to be assigned to a billet that accepts either one. An example of one of these rules is:

```

IF      OFFICER_AQD = DB4 OR          F-14 Fighter
        OFFICER_AQD = DA1 OR          A-4  Attack
        OFFICER_AQD = DA7 OR          FA-18 Attack
        OFFICER_AQD = DB6             FA-18 Fighter
THEN    BILLET_AQD  = DB3             F-5   Fighter

```

This rule states that if an officer's AQD is for the fighter version of the F-14, the attack version of the A-4, or the attack or fighter version of the FA-18, he is eligible to be assigned to a billet to fly the F-5 aircraft. Appendix E is a illustrative listing of Billet AQDs. A complete listing of Billet and Officer AQDs can be found in the Manual of Navy Officer Manpower and Personnel Classifications, Volume I.

Billet subspecialty needs a rule base because there are many subspecialty substitutions permissible. In addition, billets without subspecialty requirements must be considered for the officer. The only input needed for this rule base is officer subspecialty. An example of a subspecialty rule is:

```
IF      OFFICER_SUBSPEC=0042G OR
        OFFICER_SUBSPEC=0042P OR
        OFFICER_SUBSPEC=6042G
THEN    BILLET_SUBSPEC=6042Q
        BILLET_SUBSPEC=(BLANK)
```

This rule explains that if an officer has a master's level degree in Operations Analysis that meets or does not fully meet the Navy's criteria for graduate education in this field, he is eligible to be assigned to an Operations Analysis billet that is designated for a proven subspecialist. These officers are also qualified to be assigned to any billet that does not require a subspecialty.

Appendix F gives a brief list of subspecialties. A complete listing can be found in the Manual of Navy Officer Manpower and Personnel Classifications, Volume I.

The final rule base is for homeport preference. This is normally the officer's primary concern when requesting billet placement. The placement officer enters the office's requested homeport directly into TARPS because in most cases the officers do not make their final decision for homeport preference until the last possible moment. There are several geographic locations that have many homeports in close proximity. For example, an officer requesting Washington, D.C. normally means he would like to be stationed in the Washington, D.C. metropolitan area. This area includes several cities in Virginia and Maryland. Often an officer designates an area of the country that he prefers. A very effective rule base can be developed that greatly enhances the placement officers ability to look at several homeports either in close proximity or in the same area of the country. As an example, the homeport rule for Washington, D.C. is written as:

```
IF      OFFICER_HOMEPORT=DC
THEN    BILLET_HOMEPORT=WASHDC
        BILLET_HOMEPORT=ARLINGTON
        BILLET_HOMEPORT=ADELPHI
        BILLET_HOMEPORT=ALEXANDRIA
        BILLET_HOMEPORT=ANDAFB
```


BILLET_HOMEPORT=BETHES

BILLET_HOMEPORT=SUITLN

The billet PRD, rank, designator, AQD, subspecialty and homeport generated by the rule base is then used to query the billet database for matches. Figure 2 illustrates the architecture of the rule base (Mockler 1989). Appendix G gives a complete listing of the TARPS rule base.

C. SYSTEM DESIGN AND DEVELOPMENT

1. System Architecture

The next phase combines the components of the TAR officer Placement System (TARPS) into a cohesive system. TARPS is developed as an expert database system that couples the OFFICER and BILLET databases to an expert system (Brodie and Mylopoulos 1986).

Figure 2 illustrates the rule base architecture required for TARPS. As shown, the officer attributes are retrieved from the OFFICER database, passed to the rule base where they are processed by an inference engine to produce a list of query criteria. These query criteria plus placement officer input is passed to the BILLET database to produce a list of matching billets. Figure 3 is a diagram showing the interaction between the rule base, databases and user. (Harmon and King 1985).

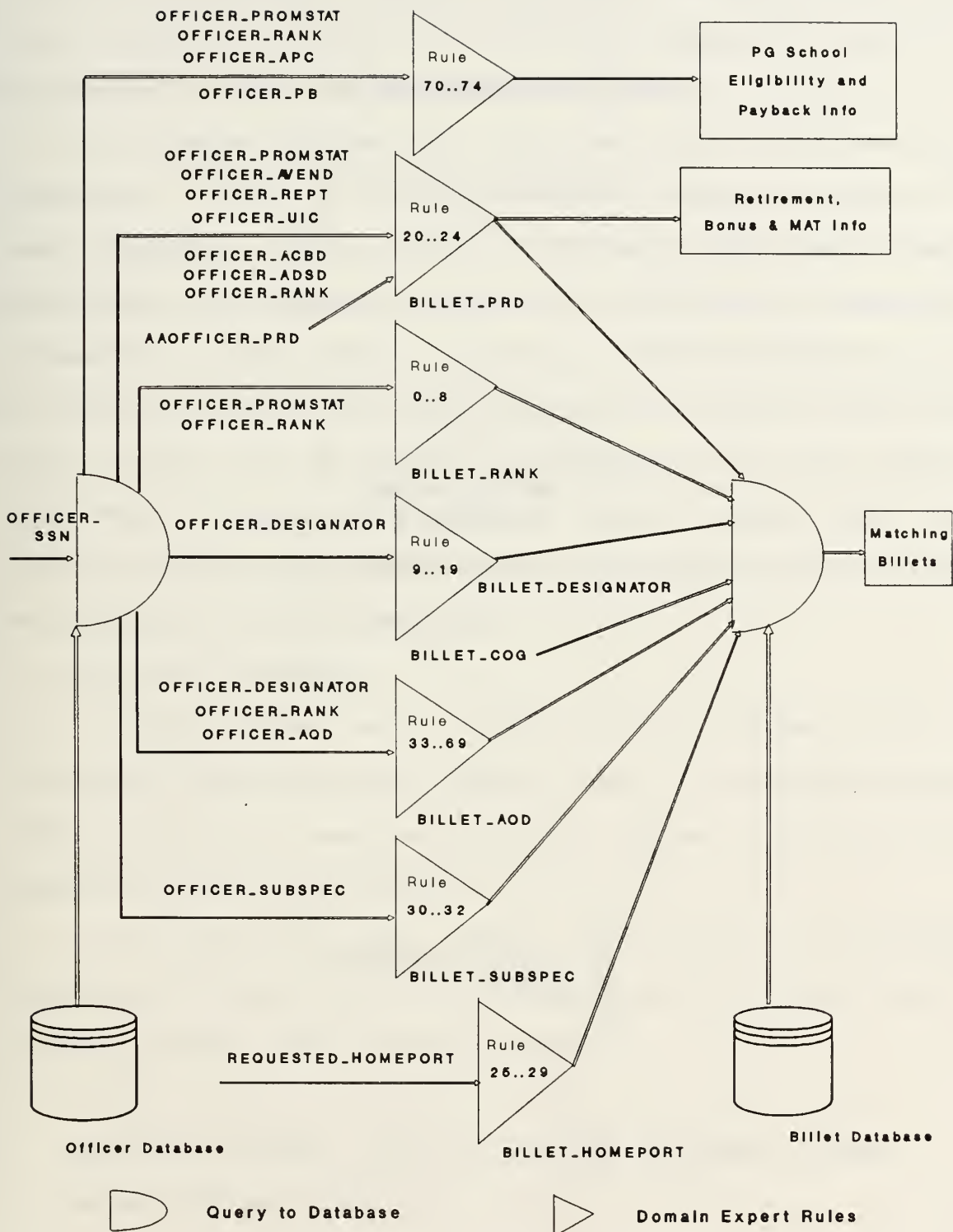


Figure 2. TARPS Rule Base Architecture

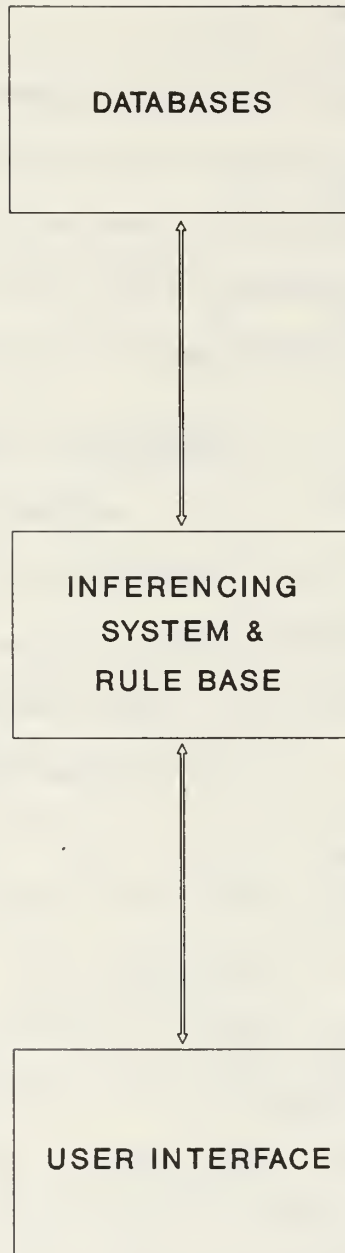


Figure 3. TARPS System Architecture

Microcomputer expert system shells are especially good for developing expert system prototypes (Mockler 1989). An expert system shell is used for TARPS to capture the rule base and couple it with the associated databases.

An expert system shell requires little coding from the developer. It has a built-in inference engine as well as a user interface. The rule base is defined, then simple query statements are added to process the databases and make it accessible to the shell. Finally, the user interface is tailored to create the prompts needed for inputs to the rule base. Rules can be added or modified easily for future refinement of the system. The VP expert system shell was selected because of its capability to access databases and availability on microcomputers.

2. User Interface

This system uses a simple user interface that is integrated with the expert system shell. A question-answer dialogue style is used because there are not finite sets of answers for most user inputs.

To retrieve the officer data from the OFFICER database, the user enters the transferring officer's social security number (SSN) as shown below:

```
WELCOME TO TARPS - THE TAR OFFICER PLACEMENT SYSTEM
```

```
Enter Officer's SSN:
```

The required officer data is retrieved and displayed on the screen for user verification.

The expected rotation date of the transferring officer is entered next. The system displays:

Enter Expected Rotation Date:

This gives the placement officer flexibility in determining when he wants to transfer the officer. The user may input a wildcard symbol "*" to select billets with any PRD. This input triggers several rules. TARPS informs the user if a Minimum Activity Tour (MAT) waiver is required, whether there is a mandatory retirement date that affects the officers rotation date availability and displays information on the officer's Postgraduate School eligibility and payback status.

Next, the Cognizant placement officer billet code is entered to determine which billets are searched for matches. The placement officer decides if the transferring officer is going only to an aviation placement officer billet or possibly a Washington, D.C. tour. VP Expert enables the user to select any combination of choices:

ENTER COG: ANY-*, WASH-41, AIR-51, SURFACE-65

51

41

*

65

The final input from the placement officer is the transferring officer's homeport preference. A question and answer prompt is used:

Enter officer's requested homeport:

The available options are known by the placement officer and can be entered directly. TARPS has the ability to accept actual homeport names, city titles and some geographic areas. The user may input the wildcard symbol "*" to select all billet homeports. After accepting the placement officers input, TARPS queries the BILLET database and produces a list of the detailed information on matching billets. The billet listing contains the following information:

- BILLET_DESIG
- BILLET_RANK
- BILLET_ACTIVITY
- BILLET_HOMEPORT
- BILLET_TITLE
- BILLET_SUBSPECIALTY
- BILLET_UEDA
- BILLET_PRD

The BILLET_PRD shows if there is an officer assigned to this billet and if so when the incumbent officer is scheduled for

transfer. The BILLET_UEDA shows if an officer is already ordered into the billet and if so his Estimated Date of Arrival (EDA). Finally, TARPS informs the user that the search is complete and remind him that the WHAT IF capability is available:

SEARCH COMPLETE! <F3> TO ENTER DIFFERENT HOMEPORT, PRD
OR COG.

Selection of the WHAT IF procedure produces a list of the inputs that can be changed. After the user has chosen the input to be changed, the system prompts the user to enter a value for the variable to be changed. The BILLET database is then queried and the matching billets are displayed.

Future versions of TARPS can easily be designed with enhanced versions of the user interface because VP Expert has sophisticated capabilities for user interaction with the system. Appendix H contains a complete session with TARPS.

D. PROTOTYPING

After the first prototype was developed, it was evaluated and redesigned by the author, the domain expert for this project. It was then forwarded to PERS-4417, TAR officer placement, for their initial review. As mentioned earlier, several additional rules were added to the knowledge base to

produce supplementary information requested by the placement office.

PERS-4417 requested the ability to repeatedly interrogate the system while changing only one query criteria. In response, an enhanced WHAT IF capability from VP Expert was designed into TARPS. The placement officer now has the capability to change specific query criteria one at a time. Billet COG, OFFICER_PRD and Homeport preference can be changed as many times as needed. This capability matches the actual process for placement; the transferring officer is given several options during the course of the decision making process until he and the placement officer reach a mutually beneficial decision. Repeated WHAT IF inquiries are particularly helpful while interacting with transferring officers, providing real-time information on available billets. After all of the PERS-4417 inputs were evaluated, the present prototype was developed and is now ready for field testing.

VI. CONCLUSIONS AND RECOMMENDATIONS

A. BENEFITS

This thesis addressed the feasibility of developing an expert system for placing TAR officers in their upcoming duty assignments. It also addressed the ability of capturing the required domain expertise into a rule base. The prototype demonstrates that it is possible to develop an expert system for officer placement and that it is feasible to capture a major portion of the expertise required to do so in a rule base.

The implementation of the rule base proved to be exceptionally beneficial. The rules that govern officer assignments have previously been assimilated primarily by experience. They became so intertwined that decisions were difficult to explain. Development of the rule base produced clarification of many of the building blocks that are used to make decisions. These rules will be very beneficial for training new placement officers.

Trimming the databases to include only TAR officers and their billets proved to be advantageous. It made the performance of the system very acceptable.

Filtering all TAR billets by the criteria determined from the knowledge base quickly trimmed the quantity of acceptable

billets down to a reasonable number. These resultant billets have proven to be a very good starting point for the placement officer. In addition, the ability to perform multiple WHAT IF queries on the placement officer inputs is an effective way to quickly look for available billets with just one input change.

Use of an expert system shell proved to be extremely efficient. Very little coding was required beyond incorporating the IF THEN rules. Development of an expert system interface with a programming language like PROLOG or LISP appeared to be a much more difficult undertaking.

B. SUGGESTIONS FOR FUTURE ENHANCEMENTS

Future refinement of the prototype should include the addition of a field in the OFFICER database to document geographic area reporting dates. This will provide an input to a new set of rules that would automatically determine officer transfer availability based on Time On Station (TOS) policies. The data field already exists in the OAIS database and is current for each officer. Placement officers now manually search through the OAIS database to find exactly when and where an officer has been stationed.

Further enhancement of TARS could be achieved by either providing each placement officer with a microcomputer linked directly to the mainframe or by migrating the entire TARPS process to the BUPERS mainframe.

A dedicated microcomputer linked with the mainframe would enable the placement officer's to automate the OFFICER and BILLET databases daily. It would also provide the placement officer with the ability to manipulate the OFFICER and BILLET databases individually for ad hoc queries. Migrating TARPS to the mainframe would produce a system that would not require acquisition of any additional hardware, just application software. Placement officers could access the expert database system by menu selection. The OFFICER and BILLET databases could be automatically updated daily without placement officer interaction. This option will not give the users any independent ad hoc query capabilities to the OFFICER and BILLET databases.

In conclusion, TARPS is an expert database system prototype that effectively shows how the placement officer's domain expertise can be captured into a rule base then used to assign TAR officers to their upcoming duty assignments.

APPENDIX A

TARPS RELATIONAL DIAGRAM

OFFICER

<u>SSN#</u>	NAME	RANK	DESIGNATOR	UIC*	BSC*	...
-------------	------	------	------------	------	------	-----



BILLET

<u>UIC*</u>	<u>BSC*</u>	DESIG	RANK	ACTIVITY	HOMEPORT	AQD	...
-------------	-------------	-------	------	----------	----------	-----	-----

— Key field

* - Foreign Key

— Mandatory relationship

○ - Optional Relationship

Relation Definitions

OFFICER			BILLET		
ITEM	LENGTH	TYPE	ITEM	LENGTH	TYPE
SSN #	9	Alpha	ACTIVITY	16	Alpha
NAME	27	Alpha	UIC	5	Alpha
RANK	4	Alpha	BSC	5	Alpha
PRD	4	Alpha	RANK	4	Alpha
DESIG	4	Alpha	DESIG	4	Alpha
PROMSTAT	4	Alpha	BILLET	40	Alpha
ACTIVITY	16	Alpha	SUBSPEC	5	Alpha
UIC	5	Alpha	HOMEPORT	6	Alpha
BSC	5	Alpha	AQD	3	Alpha
SUBSPEC	5	Alpha	COG	2	Alpha
AQD	4	Alpha	PRD	4	Alpha
HOMEPORT	6	Alpha	ULTEDA	4	Alpha
BILLET	40	Alpha			
RECVD	6	Alpha			
ADSD	6	Alpha			
ACBD	6	Alpha			
PB	1	Alpha			
APC	3	Alpha			
AVEND	6	Alpha			
YRG	3	Alpha			

APPENDIX B

OFFICER RANKS AND SUBSTITUTIONS

BILLET RANK

ACCEPTABLE RANK

RDMU	- Rear Admiral Upper Half	RDMU/RDML
RDML	- Rear Admiral Lower Half	RDMU/RDML
CAPT	- Captain	CAPT
CDR	- Commander	CAPT/CDR
LCDR	- Lieutenant Commander	CDR/LCDR/LT
LT	- Lieutenant	LCDR/LT/LTJG
LTJG	- Lieutenant Junior Grade	LT/LTJG/ENS
ENS	- Ensign	LT/LTJG/ENS

APPENDIX C

OFFICER DESIGNATORS

<u>DESIGNATOR</u>	<u>DEFINITION</u>
1107	General Unrestricted Line
1117	Surface Warfare
1127	Submarine Warfare
1137	Special Warfare
1147	Special Operations
1167	Surface Warfare (In-training)
1197	Special Operations (In-training)
1307	Non-flying aviation
1317	Pilot
1327	NFO (Naval Flight Officer)
1637	Intelligence
3107	Supply

APPENDIX D

BILLET/OFFICER MATCHING DESIGNATORS

<u>BILLET DESIGNATORS</u>	<u>MATCHING OFFICER DESIGNATORS</u>
1000 - Any officer	Any
1050 - Any warfare specialty	1117/1127/1137 1147/1317/1327
1110 - Surface Warfare Officer	1117/1167
1120 - Submarine Warfare Officer	1127
1130 - Special Warfare Officer	1137
1140 - Special Operations Officer	1147
1160 - In-training for Surface Warfare Officer	1117/1167
1190 - In-training for Special Operations Officer	1197/1147
1300 - Pilot or NFO non-flying	1307/1317/1327
1301/1302 - Pilot or NFO flying	1317/1327
1310 - Pilot non-flying	1317
1311/1312 - Pilot flying	1317
1320 - NFO non-flying	1327
1321/1322 - NFO flying	1327
1630 - Special Duty Officer (Intel)	1637
3100 - Supply Officer	3107

APPENDIX E

ADDITIONAL QUALIFICATION DESIGNATOR CODES

Additional Qualification Designator (AQD) codes having the first character of "D" or "E" are used to indicate specific billet requirements and personnel qualifications in the Aviation Warfare specialty. These AQD codes are assigned to officers by NMPC and assigned to billets by OP-01. The three characters of the aviation warfare AQD structure are interpreted as follows:

Jet Aircraft

<u>Mission Class</u>	<u>Code</u>	<u>Mission Type</u>	<u>Aircraft</u>
Fighter			
	DB1	FTR/Bomber	F-8
	DB2	FTR/Bomber	F-4
	DB3	FTR/Bomber	F-5
	DB4	FTR/Bomber	F-14
	DB5	FTR/Bomber	VFX
	DB6	FTR/Bomber	F-18
	DB7	TOPGUN GRAD	Fighter
	DB8	Adversary Grad	Fighter
	DB9	TOPGUN INSTRUCTOR	Fighter
	DB10	Any	Fighter

A complete listing of AQD codes can be found in the Manual of Navy Officer Manpower and Personnel Classifications, Volume I.

APPENDIX F

SUBSPECIALTY CODE DEFINITIONS

The Subspecialty Code is a five character code. The first two characters are not germane to this thesis. The third and fourth characters indicate the subspecialty functional area. The last character, the subspecialty suffix defines the level of educational attained by an individual or required by a billet.

The following is a list of the subspecialty functional areas used by TARPS:

<u>Code</u>	<u>Educational function</u>
xx31	Financial Management
xx42	Operations Analysis
xx44	Antisubmarine Warfare
xx90	Computer Technology (General)
xx91	Computer Science
xx95	Computer Systems Management

The following is a list of a few subspecialty suffixes:

<u>Suffix</u>	<u>Definition</u>
D	Doctoral level of education
H	Billet code to indicate master's level education desirable but not required
P	Master's level of education
Q	Master's level of education - proven subspecialist

A complete listing is available in the Manual of Navy Officer Manpower and Personnel Classifications, Volume I.

APPENDIX G

TARPS RULE BASE

1. The rules used to determine billet rank are:

RULE 0

IF OFFICER_RANK=RDMU OR
OFFICER_RANK=RDML
THEN BILLET_RANK=RDMU
BILLET_RANK=RDML

RULE 1

IF OFFICER_RANK=CAPT AND
OFFICER_PROMSTAT=S1 OR
OFFICER_PROMSTAT=S2
THEN BILLET_RANK=RDMU
BILLET_RANK=RDML

RULE 1A

IF OFFICER_RANK=CAPT AND
OFFICER_PROMSTAT=C1 OR
OFFICER_PROMSTAT=C2 OR
OFFICER_PROMSTAT=C12 OR
OFFICER_PROMSTAT=(BLANK)
THEN BILLET_RANK=CAPT

RULE 2

IF OFFICER_RANK=CDR AND
OFFICER_PROMSTAT=S0 OR
OFFICER_PROMSTAT=S1
THEN BILLET_RANK=CAPT

RULE 3

IF OFFICER_RANK=CDR AND
OFFICER_PROMSTAT=F01 OR
OFFICER_PROMSTAT=F1 OR
OFFICER_PROMSTAT=(BLANK)
THEN BILLET_RANK=CDR

RULE 4

IF OFFICER_RANK=LCDR AND
OFFICER_PROMSTAT=S0 OR
OFFICER_PROMSTAT=S1
THEN BILLET_RANK=CDR

RULE 5
IF OFFICER_RANK=LCDR AND
OFFICER_PROMSTAT=F01 OR
OFFICER_PROMSTAT=F1
THEN BILLET_RANK=LCDR

RULE 5A
IF OFFICER_RANK=LCDR AND
OFFICER_PROMSTAT=(BLANK)
THEN BILLET_RANK=CDR
BILLET_RANK=LCDR
BILLET_RANK=LT

RULE 6
IF OFFICER_RANK=LT
THEN BILLET_RANK=LCDR
BILLET_RANK=LT
BILLET_RANK=LTJG

RULE 7
IF OFFICER_RANK=LTJG
THEN BILLET_RANK=LCDR
BILLET_RANK=LT
BILLET_RANK=LTJG
BILLET_RANK=ENS

RULE 8
IF OFFICER_RANK=ENS
THEN BILLET_RANK=LT
BILLET_RANK=LTJG
BILLET_RANK=ENS

2. The rules used to determine billet designators:

RULE 9
IF OFFICER_DESIGNATOR=1107
THEN BILLET_DESIGNATOR=1000

RULE 10
IF OFFICER_DESIGNATOR=1117
THEN BILLET_DESIGNATOR=10**
BILLET_DESIGNATOR=1110

RULE 11
IF OFFICER_DESIGNATOR=1127
THEN BILLET_DESIGNATOR=10**
BILLET_DESIGNATOR=1120

RULE 12
IF OFFICER DESIGNATOR=1137
THEN BILLET DESIGNATOR=10**
BILLET DESIGNATOR=1130

RULE 13
IF OFFICER DESIGNATOR=1147
THEN BILLET DESIGNATOR=10**
BILLET DESIGNATOR=1140
BILLET DESIGNATOR=1190

RULE 14
IF OFFICER DESIGNATOR=1167
THEN BILLET DESIGNATOR=1000
BILLET DESIGNATOR=1110
BILLET DESIGNATOR=1160

RULE 15
IF OFFICER DESIGNATOR=1197
THEN BILLET DESIGNATOR=1000
BILLET DESIGNATOR=1140
BILLET DESIGNATOR=1190

RULE 16
IF OFFICER DESIGNATOR=1307
THEN BILLET DESIGNATOR=1000
BILLET DESIGNATOR=1300

RULE 17
IF OFFICER DESIGNATOR=1317
THEN BILLET DESIGNATOR=10**
BILLET DESIGNATOR=13**

RULE 18
IF OFFICER DESIGNATOR=1327
THEN BILLET DESIGNATOR=10**
BILLET DESIGNATOR=13**

RULE 18A
IF OFFICER DESIGNATOR=1527
THEN BILLET DESIGNATOR=1000
BILLET DESIGNATOR=1300
BILLET DESIGNATOR=1520

RULE 19
IF OFFICER DESIGNATOR=1637
THEN BILLET DESIGNATOR=1630

RULE 19A
IF OFFICER DESIGNATOR=3107
THEN BILLET DESIGNATOR=3100

3. The rules used to determine eligibility for transfer at the PRD the placement officer has chosen:

RULE 20

```
IF      OFFICER_PRD > ((OFFICER_REPT/100)+199.5) OR
        OFFICER_UIC=31405 OR !NPGS
        OFFICER_UIC=30486 OR !WAR COLLEGE NEWPORT
        OFFICER_UIC=31008 OR !AF WAR COLLEGE MAXWELL
        OFFICER_UIC=31051 OR !ICAF
        OFFICER_UIC=31052 !NATIONAL WAR COLLEGE
THEN    MAT=NO
        DISPLAY "MAT NOT REQUIRED"
ELSE    MAT=YES
        DISPLAY "MAT REQUIRED FOR THIS PRD"
```

RULE 20A

```
IF      OFFICER_PRD < (OFFICER_AVEND/100)
THEN    BONUS=YES
        DISPLAY "OFFICER IS UNDER BONUS UNTIL
                {OFFICER_AVEND}."
```

RULE 20B

```
IF      OFFICER_PRD > ((OFFICER_A CBD/100)+2799.5)
THEN    RETIRE=YES
        DISPLAY "DOES NOT HAVE 2 YEARS OF ELIGIBILITY BEFORE
                30 YR MANDATORY RETIREMENT DATE"
```

RULE 20C

```
IF      OFFICER_PRD > ((OFFICER_ADSD/100)+1799.5) AND
        OFFICER_PROMSTAT=F12 OR
        OFFICER_PROMSTAT=F012 OR
        OFFICER_PROMSTAT=F01 OR
        OFFICER_PROMSTAT=F901
THEN    RETIRE=YES
        DISPLAY "DOES NOT HAVE 2 YEARS ELIGIBILITY BEFORE 20
                YR MANDATORY RETIREMENT DATE"
```

RULE 20D

```
IF      OFFICER_PRD > ((OFFICER_ADSD/100)+1799.5) AND
        OFFICER_RANK=CDR AND
        OFFICER_PROMSTAT=F2
THEN    RETIRE=PROBABLY
        DISPLAY "OFFICER CANNOT BE MOVED BECAUSE OF CAPT
                PASSOVER"
```

```

RULE 20E
IF      OFFICER_PRD > ((OFFICER_ADSD/100)+1799.5) AND
        OFFICER_RANK=CDR AND
        OFFICER_PROMSTAT=F12
THEN    RETIRE=̄YES
        DISPLAY "DOES NOT HAVE 2 YEARS OF ELIGIBILITY LEFT
                BEFORE MANDATORY RETIREMENT"

RULE 20F
IF      OFFICER_PRD < ((OFFICER_ADSD/100)+1799.5) AND
        OFFICER_RANK=CDR AND
        OFFICER_PROMSTAT=F2 OR
        OFFICER_PROMSTAT=F12
THEN    RETIRE=̄NO
        DISPLAY "OFFICER HAS OVER 2 YEARS OF ELIGIBILITY
                LEFT BEFORE MANDATORY RETIREMENT DATE"

RULE 20G
IF      OFFICER_PRD > ((OFFICER_ADSD/100)+1799.5) AND
        OFFICER_RANK=LT AND
        OFFICER_PROMSTAT=F012 OR
        OFFICER_PROMSTAT=F12 OR
        OFFICER_PROMSTAT=F2
THEN    RETIRE=̄YES
        DISPLAY "DOES NOT HAVE 2 YEARS ELIGIBILITY LEFT
                BEFORE MANDATORY RETIREMENT"

RULE 20H
IF      OFFICER_PRD < ((OFFICER_ADSD/100)+1799.5) AND
        OFFICER_RANK=LT AND
        OFFICER_PROMSTAT=F01
THEN    RETIRE=̄YES
        DISPLAY "CANNOT MOVE BECAUSE OF LCDR PASSOVER AND
                MANDATORY SEPARATION"

RULE 20I
IF      OFFICER_PRD < ((OFFICER_ADSD/100)+1799.5) AND
        OFFICER_RANK=LT AND
        OFFICER_PROMSTAT=F0 OR
        OFFICER_PROMSTAT=F1
THEN    RETIRE =̄PROBABLY
        DISPLAY "CANNOT MOVE OFFICER BECAUSE OF SINGLE
                PASSOVER FOR LCDR"

```

4. The rules used to determine Billet PRD:

RULE 21

```
IF OFFICER_PRD<=9999
THEN  BILLET_PRD=OFFICER_PRD - (THREE_MONTHS)
      BILLET_PRD=OFFICER_PRD - (TWO_MONTHS)
      BILLET_PRD=OFFICER_PRD - (ONE_MONTH)
      BILLET_PRD=OFFICER_PRD
      BILLET_PRD=OFFICER_PRD + (ONE_MONTH)
      BILLET_PRD=OFFICER_PRD + (TWO_MONTHS)
      BILLET_PRD=OFFICER_PRD + (THREE_MONTHS)
      BILLET_PRD=(BLANK)
```

RULE 22

```
IF OFFICER_PRD=* /* FOR ANY MONTH */
THEN BILLET_PRD=*
```

RULE 23

```
IF OFFICER_PRD>999
THEN BILLET_PRD=9999
     DISPLAY "PRD IS OUTSIDE OF THE PROTOTYPE'S
             PARAMETERS"
```

5. The rules used to determine Billet Homeport:

RULE 24

```
IF OFFICER_HOMEPORT=DC
THEN BILLET_HOMEPORT=ADELPHI
     BILLET_HOMEPORT=ALEXANDRIA
     BILLET_HOMEPORT=ANDAFB
     BILLET_HOMEPORT=ARLINGTON
     BILLET_HOMEPORT=BETHES
     BILLET_HOMEPORT=SUITLN
     BILLET_HOMEPORT=WASHDC
```

RULE 25A

```
IF OFFICER_HOMEPORT=SD
THEN BILLET_HOMEPORT=CORNDO
     BILLET_HOMEPORT=MIRAMAR
     BILLET_HOMEPORT=NORTI
     BILLET_HOMEPORT=SDGO;
```

RULE 25B

```
IF OFFICER_HOMEPORT=ATLANTA
THEN BILLET_HOMEPORT=ATLANT
     BILLET_HOMEPORT=MARIETTA;
```


RULE 26
IF OFFICER HOMEPORT=NORFOLK
THEN BILLET HOMEPORT=NORVA
BILLET HOMEPORT=DNECK
BILLET HOMEPORT=LCRK
BILLET HOMEPORT=OCEANA

RULE 27
IF OFFICER HOMEPORT=SF
THEN BILLET HOMEPORT=ALAMEDA
BILLET HOMEPORT=MOFFET
BILLET HOMEPORT=OAKLAN
BILLET HOMEPORT=SFRAN
BILLET HOMEPORT=TRISL

RULE 28
IF OFFICER HOMEPORT=JAX
THEN BILLET HOMEPORT=CECIL
BILLET HOMEPORT=MAYPRT

RULE 28A
IF OFFICER HOMEPORT=NE
THEN BILLET HOMEPORT=ANDAFB
BILLET HOMEPORT=BRUNS
BILLET HOMEPORT=COLUMB
BILLET HOMEPORT=SELFRI
BILLET HOMEPORT=SOWEY
BILLET HOMEPORT=WASHDC
BILLET HOMEPORT=WIGROV
BILLET HOMEPORT=NORVA
BILLET HOMEPORT=OCEANA

RULE 28B
IF OFFICER HOMEPORT=MID
THEN BILLET HOMEPORT=ARORA
BILLET HOMEPORT=DALLAS
BILLET HOMEPORT=GLVIEW
BILLET HOMEPORT=MINNAP
BILLET HOMEPORT=OLATHE

RULE 28C
IF OFFICER HOMEPORT=SE
THEN BILLET HOMEPORT=CECIL
BILLET HOMEPORT=JAX
BILLET HOMEPORT=MARIET
BILLET HOMEPORT=ORLEAN
BILLET HOMEPORT=MILLIN

RULE 28D
IF OFFICER HOMEPORT=NW
THEN BILLET HOMEPORT=WHIDBY

RULE 28E

```
IF OFFICER_HOMEPORT=SW
THEN BILLET_HOMEPORT=ALAMED
      BILLET_HOMEPORT=LEMORE
      BILLET_HOMEPORT=MIRAMA
      BILLET_HOMEPORT=MOFFET
      BILLET_HOMEPORT=NORTI
      BILLET_HOMEPORT=PGMUGU
      BILLET_HOMEPORT=SDGO
```

RULE 29

```
IF OFFICER_HOMEPORT=OV
THEN BILLET_HOMEPORT=AIEA
      BILLET_HOMEPORT=BARBER
      BILLET_HOMEPORT=HONOL
      BILLET_HOMEPORT=PEARL
      BILLET_HOMEPORT=YOKSKA
      BILLET_HOMEPORT=LONDON
      BILLET_HOMEPORT=KEFLAV
      BILLET_HOMEPORT=SJUAN
      BILLET_HOMEPORT=BALBOA
ELSE BILLET_HOMEPORT=(OFFICER_HOMEPORT)
```

6. The rules to determine Billet Subspecialty:

RULE 30

```
IF OFFICER_SUBSPEC=0095T OR
   OFFICER_SUBSPEC=0095P OR
   OFFICER_SUBSPEC=0091P OR
   OFFICER_SUBSPEC=5091P OR
   OFFICER_SUBSPEC=5091Q OR
   OFFICER_SUBSPEC=5095Q
THEN BILLET_SUBSPEC=009*
      BILLET_SUBSPEC=909*
```

RULE 31

```
IF OFFICER_SUBSPEC=0031P OR
   OFFICER_SUBSPEC=0031T OR
   OFFICER_SUBSPEC=6031P OR
   OFFICER_SUBSPEC=6031Q
THEN BILLET_SUBSPEC=0031*
      BILLET_SUBSPEC=6321*
      BILLET_SUBSPEC=9031*
```

```

RULE 32
IF      OFFICER SUBSPEC=0042G OR
        OFFICER SUBSPEC=0042P OR
        OFFICER SUBSPEC=0042T OR
        OFFICER SUBSPEC=6042G
THEN    BILLET SUBSPEC=6042Q
        BILLET SUBSPEC=(BLANK)
ELSE    BILLET SUBSPEC=(BLANK)

```

7. The rules to determine Billet Additional Qualification Designators (AQD):

```

RULE 33
IF      OFFICER AQD=DA7
THEN    BILLET AQD=DB6

```

```

RULE 34
IF      OFFICER AQD=DB4
THEN    BILLET AQD=DC4

```

```

RULE 35
IF      OFFICER DESIGNATOR=1317 AND
        OFFICER AQD=DB1 OR
        OFFICER AQD=DB2 OR
        OFFICER AQD=DB3 OR
        OFFICER AQD=DA7 OR
        OFFICER AQD=DB4 OR
        OFFICER AQD=DB6 OR
        OFFICER AQD=DC4
THEN    BILLET AQD=DA1

```

```

RULE 36
IF      OFFICER AQD=DB4 OR
        OFFICER AQD=DA1 OR
        OFFICER AQD=DA7 OR
        OFFICER AQD=DB6
THEN    BILLET AQD=DB2

```

```

RULE 37
IF      OFFICER AQD=DD1 OR
        OFFICER AQD=DD4 OR
        OFFICER AQD=DE2 OR
        OFFICER AQD=DE4
THEN    BILLET AQD=DE3

```

```

RULE 38
IF      OFFICER AQD=DE1 OR
        OFFICER AQD=DE2 OR
        OFFICER AQD=DE3
THEN    BILLET AQD=DE0

```

RULE 39
IF OFFICER_AQD=DF3
THEN BILLET_AQD=DF2

RULE 40
IF OFFICER_AQD=DA2 OR
OFFICER_AQD=DA4 OR
OFFICER_AQD=DA7 OR
OFFICER_AQD=DB4 OR
OFFICER_AQD=DB6 OR
OFFICER_AQD=DC4 OR
OFFICER_AQD=DD2 OR
OFFICER_AQD=DA1
THEN BILLET_AQD=DG0

RULE 41
IF OFFICER_AQD=DJ1 OR
OFFICER_AQD=DJ2 OR
OFFICER_AQD=DJ3 OR
OFFICER_AQD=DJ4
THEN BILLET_AQD=DJ0

RULE 42
IF OFFICER_AQD=DK2 AND
OFFICER_DESIGNATOR =1317
THEN BILLET_AQD=DJ3
BILLET_AQD=DJ4

RULE 42A
IF OFFICER_AQD=DJ3
THEN BILLET_AQD=DJ4

RULE 42B
IF OFFICER_AQD=DJ4
THEN BILLET_AQD=DJ3

RULE 43
IF OFFICER_AQD=DL1 OR
OFFICER_AQD=DL2 OR
OFFICER_AQD=DL3
THEN BILLET_AQD=DL0

RULE 44
IF OFFICER_AQD=DL2
THEN BILLET_AQD=DL3

RULE 45
IF OFFICER_AQD=DL3
THEN BILLET_AQD=DL2

RULE 46
IF OFFICER_AQD=DM0 AND
OFFICER_DESIGNATOR=1317
THEN BILLET_AQD=DJ3
BILLET_AQD=DJ4

RULE 47
IF OFFICER_DESIGNATOR=1317
THEN BILLET_AQD=DP1
BILLET_AQD=DT0

RULE 48
IF OFFICER_AQD=DE3
THEN BILLET_AQD=DQ2

RULE 49
IF OFFICER_AQD=DQ2 OR
OFFICER_AQD=DQ3 OR
OFFICER_AQD=DQ4
THEN BILLET_AQD=DQ0

RULE 50
IF OFFICER_AQD=DR4
THEN BILLET_AQD=DR0

RULE 51
IF OFFICER_AQD=DS2
THEN BILLET_AQD=DS3

RULE 52
IF OFFICER_AQD=DV1 OR
OFFICER_AQD=DV2 OR
OFFICER_AQD=DV3 OR
OFFICER_AQD=DV4
THEN BILLET_AQD=DV0

RULE 53
IF OFFICER_AQD=DW1 OR
OFFICER_AQD=DW2 OR
OFFICER_AQD=DW3 OR
OFFICER_AQD=DW4 OR
OFFICER_AQD=DW5 OR
OFFICER_AQD=DW6 OR
OFFICER_AQD=DW7 OR
OFFICER_AQD=DW8
THEN BILLET_AQD=DW0

RULE 54
IF OFFICER_AQD=DW7 OR
OFFICER_AQD=DW8
THEN BILLET_AQD=DW6

RULE 55

IF OFFICER_AQD=DV1 OR
OFFICER_AQD=DV2 OR
OFFICER_AQD=DV3 OR
OFFICER_AQD=DV4 OR
OFFICER_AQD=DW1 OR
OFFICER_AQD=DW2 OR
OFFICER_AQD=DW3 OR
OFFICER_AQD=DW4 OR
OFFICER_AQD=DW5 OR
OFFICER_AQD=DW6 OR
OFFICER_AQD=DW7 OR
OFFICER_AQD=DW8 OR
OFFICER_AQD=DY3 OR
OFFICER_AQD=DY5
THEN BILLET_AQD=DY0

RULE 56

IF OFFICER_DESIGNATOR=1317 OR
OFFICER_DESIGNATOR=1327
THEN BILLET_AQD=DZ0
BILLET_AQD=DZ2
BILLET_AQD=DT0
BILLET_AQD=DZ3

RULE 57

IF OFFICER_DESIGNATOR=1317 AND
OFFICER_AQD=DA4
THEN BILLET_AQD=EB4
BILLET_AQD=ED4

RULE 58

IF OFFICER_DESIGNATOR=1317 AND
OFFICER_AQD=DF2 OR
OFFICER_AQD=DF3
THEN BILLET_AQD=EBF

RULE 59

IF OFFICER_DESIGNATOR=1317 AND
OFFICER_AQD=DL2 OR
OFFICER_AQD=DL3 OR
OFFICER_AQD=DS2
THEN BILLET_AQD=EC8

RULE 60
 IF OFFICER_DESIGNATOR=1317 AND
 OFFICER_AQD=DA4 OR
 OFFICER_AQD=DD2 OR
 OFFICER_AQD=DB4 OR
 OFFICER_AQD=DC4 OR
 OFFICER_AQD=DB6 OR
 OFFICER_AQD=DA7 OR
 OFFICER_AQD=DA2
 THEN BILLET_AQD=ECK

RULE 61
 IF OFFICER_DESIGNATOR=1317 AND
 OFFICER_AQD=DB4 OR
 OFFICER_AQD=DC4
 THEN BILLET_AQD=EDD

RULE 62
 IF OFFICER_AQD=BN1 OR
 OFFICER_AQD=BN2 OR
 OFFICER_AQD=BN3
 THEN BILLET_AQD=BN*

RULE 63
 IF OFFICER_RANK=LTJG OR
 OFFICER_RANK=LT OR
 OFFICER_RANK=LCDR AND
 OFFICER_DESIGNATOR NOT EQUAL TO 3107 OR
 OFFICER_DESIGNATOR NOT EQUAL TO 1637
 THEN BILLET_AQD=CA*

RULE 64
 IF OFFICER_RANK=LT OR
 OFFICER_RANK=LCDR OR
 OFFICER_RANK=CDR AND
 OFFICER_DESIGNATOR NOT EQUAL TO 3107 OR
 OFFICER_DESIGNATOR NOT EQUAL TO 1637
 THEN BILLET_AQD=CB3
 BILLET_AQD=CB4
 BILLET_AQD=CB5

RULE 65
 IF OFFICER_RANK=LCDR OR
 OFFICER_RANK=CDR AND
 OFFICER_DESIGNATOR NOT EQUAL TO 3107 OR
 OFFICER_DESIGNATOR NOT EQUAL TO 1637
 THEN BILLET_AQD=CC4
 BILLET_AQD=CC5

RULE 66
IF OFFICER_RANK=CAPT AND
OFFICER_DESIGNATOR NOT EQUAL TO 3107 OR
OFFICER_DESIGNATOR NOT EQUAL TO 1637
THEN OFFICER_AQD=CE6

RULE 67
IF OFFICER_AQD=JS1 OR
OFFICER_AQD=JS2 OR
OFFICER_AQD=JS5
THEN BILLET_AQD=JD1

RULE 68
IF OFFICER_DESIGNATOR=1117 AND
OFFICER_AQD=KM1
THEN BILLET_AQD=KM2

RULE 69
IF OFFICER_AQD=LM2 OR
OFFICER_AQD=LN1 OR
OFFICER_AQD=LN2
THEN BILLET_AQD=LM1
BILLET_AQD=(OFFICER_AQD)
BILLET_AQD=(BLANK)
ELSE BILLET_AQD=(OFFICER_AQD)
BILLET_AQD=(BLANK)

8. The rules to determine Naval Postgraduate School eligibility and payback information are:

RULE 70 !OFFICER HAS ALREADY BEEN TO
NAVY FUNDED EDUCATION
IF OFFICER_PB=X OR
OFFICER_PB=Y OR
OFFICER_PB=Z OR
OFFICER_PB=A
THEN PG=NO

RULE 70A
IF OFFICER_RANK=RDMU OR
OFFICER_RANK=RDML OR
OFFICER_RANK=CAPT
THEN PG=NO
DISPLAY "Officer is too senior for NPGS"

RULE 70B
IF OFFICER_PROMSTAT=F1 OR
OFFICER_PROMSTAT=F01
THEN PG=NO1
DISPLAY "Officer has been passed over for promotion
and is therefore ineligible for NPGS."


```

RULE 70C
IF      OFFICER_APC>345
THEN    PG=NO2
        DISPLAY "Officer's APC is too high for NPGS"

RULE 71
IF      OFFICER_APC<=345 AND
        OFFICER_APC>335
THEN    PG=CAT3
        DISPLAY "Officer is qualified for FM only at NPGS."

RULE 72
IF      OFFICER_APC=335
THEN    PG=CAT2
        DISPLAY "Officer is qualified for FM and CSM only at
                NPGS."

RULE 73
IF      OFFICER_APC<335
THEN    PG=CAT1
        DISPLAY "Officer is qualified for FM, CSM, CS and OA
                at NPGS."
ELSE    PG=CAT0
        DISPLAY "Officer APC is inaccurate or missing"

RULE 74
IF      OFFICER_PB=X
THEN    PAYBACK=YES
        DISPLAY "OFFICER HAS PAID BACK NAVY FUNDED
                EDUCATION"

RULE 74A
IF      OFFICER_PB=Y
THEN    PAYBACK=NO
        DISPLAY "OFFICER HAS NOT PAID BACK NAVY FUNDED
                EDUCATION 1 TOUR";

RULE 74B
IF      OFFICER_PB=Z
THEN    PAYBACK=NO
        DISPLAY "OFFICER HAS NOT PAID BACK NAVY FUNDED
                EDUCATION 2 TOURS";

RULE 74C
IF      OFFICER_PB=A
THEN    PAYBACK=NO
        DISPLAY "OFFICER HAS NOT PAID BACK NAVY FUNDED
                EDUCATION 3 OR MORE TOURS."

```

APPENDIX H

A SESSION WITH TARPS

WELCOME TO TARPS - THE TAR OFFICER PLACEMENT SYSTEM

Enter Officer's SSN: 012345678

SSN	NAME	RANK	YRG	DESIG	SUBSP	APC	PRM	AQD	PRD
012345678	NICKERSON GUY D.	LT	800	1317		345		DB4	9106

UIC	BSC	ACTIVITY	HOMEPORT	BILLET	AVEND	RPTD
63102	01100	NAVAIRES NORVA	NORVA	AV FLIGHT PROGRAMS	951001	890605

Enter Transfer Date (System will check +- 3 months of this date): 9106

MAT NOT REQUIRED FOR THIS PRD
OFFICER IS UNDER AVIATION CONTINUATION BONUS UNTIL 951001.

Officer is qualified for FM only at NPGS.

ENTER COG: ANY-*, WASH-41, AIR-51, SURFACE-65
51 < 41 *
65

Enter officer's requested homeport: SD

DESIG	RANK	ACTIVITY	HPORT	BILLET TITLE	SUBS	UEDA	PRD
1000	LT	NARU NASNISNARCM	MIRAMA	ADMIN		9109	
1000	LT	NAVAIRES SDIEGO	NORTI	PUBLIC AFFAIRS			
1000	LT	NAVAIRES SDIEGO	NORTI	ADMIN/LEGAL		9105	
1300	LCDR	NAVAIRES SDIEGO	NORTI	PERS/MPWR MGMT			9106
1300	CDR	CNARF PAC REP	SDGO	MOB SUPPT PLANS OFF		9107	9109
1302	CDR	NAVAIRES SDIEGO	NORTI	TRAINING/RESERVE PROG D		9107	9107
1312	LCDR	VF-302	MIRAMA	NATOPS			9108
1322	LT	NARU NASNISNARCM	MIRAMA	TRAINING		9110	9109

SEARCH COMPLETE! <F3> TO ENTER A DIFFERENT HOMEPORT, PRD OR COG.

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Thesis
Z6535 Zolla
c.1 TARPS.



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