TARPS: A Prototype Expert Database System For Training and Administration of Reserves Officer Placement

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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 paper describes the design and implementation of a prototype expert database system that will enhance 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.

1. INTRODUCTION

The placement officer's primary responsibility is to select the best possible assignment for officers who are transferring out of their current assignments. The four placement officers who serve at the Training and Administration of Reserves (TAR) branch of the Naval Military Personnel Command (NMPC-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 takes the officers input for where they want to go. Second he 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 further is 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 OAIS database contains officer information. This information includes: Name, Rank, Social Security Number (SSN), Designator, Homeport, Billet Title, Planned Rotation Date (PRD), Subspecialty, and Additional Qualification Designator (AQD).

The ODIS database contains billet information. This information includes: Unit Identification Code (UIC), Billet

Sequence Code (BSC), Billet Title, Activity, Homeport, Rank, Designator, PRD, Subspecialty and Additional Qualification Designator (AQD). UIC specifies the Naval activity and the BSC identifies the specific billet in that command. Rank and Designator are specific qualifications. PRD determines if a timely match can be made. Homeport is the number one priority for most officers when requesting a billet. AQD 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 a single structured instruction. Training and transition for a new placement officer requires a minimum of two to three months of overlap with an experienced placement officer before he is ready to make placement decisions. Subsequently, the officer in training, accesses the databases for information on officers and billets and applies his expert knowledge to make a selection.

At the Naval Military Personnel Command there are several branches that have similar responsibilities covering all the officers in the U.S. Navy. A study of all these branches show that the billet selection process is nearly the same everywhere but no advanced computer system is being designed to help the placement officers.

There have been attempts to produce computer based systems to enhance the decision process. 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 officers for the Greek Navy. Alston (1987) designed an expert system based on PROLOG to assign enlisted personnel to maintenance billets in aviation squadrons. Although interesting, none of the above approaches seem to be well suited to the placement officer's decision process. Rapp's linear programming model produces only one billet for each officer. It does not allow placement officer interaction to share expertise and additional knowledge that may be important, nor does it consider the wishes of the transferring officer on where or what type of billet he wants. 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.

Because the process of officer placement uses expert knowledge, an expert system is a good choice for implementation (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 meets the general requirements for an expert system as specified by Turban and Waterman (Turban 1990):

1. The task requires only cognitive skills.
2. At least one genuine expert, who is willing to cooperate, exists.
3. The experts involved can articulate their methods of problem solving.
4. The task is not too difficult.
5. The task is well understood, and is defined clearly.
6. The solution to the problem has a high payoff. (The task is important).
7. The Expert System can preserve scarce human expertise.
8. The expertise will improve performance and/or quality.
9. 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). In a loosely coupled architecture, both subsystems retain their original structure and appearance. A loosely coupled architecture is best suited for the officer placement application. The expert systems component uses it's rule base, placement officer input, and access to the two databases to propose a selection while the databases could be manipulated independently.

This paper presents the design and implementation of a prototype expert database system for placing TAR officers in their upcoming duty assignments. The organization of the paper is as follows. Section 2 explains the domain of expertise needed for the expert system. Section 3 develops a rule base. Section 4 details the design of the expert system and its interface with both databases and the expert user. Finally, Section 5 draws some conclusions and states objectives for future research.

2. 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 one of the authors of this paper, Zolla, has served as a TAR placement officer, he is a domain expert. Having an expert readily available greatly enhanced the process of building and testing this system.

Placing an officer into an available billet can be perceived in two different ways. 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 wishes or career requirements. If, on the other hand, we view the problem from the officers perspective, the solution would be to find the exact billet that fills his needs and desires. In most branches of NMPC there are two officers working on officer placement, one who works with the officer being reassigned and one who works with the commands that are trying to fill their billets. Each of these officers is an expert, one queries the officer database to find the best qualified officer for the billets and the other queries the billet database to find the best possible billet for the officer.

In NMPC-4417, the placement officer manages both the billets and the officers. He can choose to prioritize either one. This paper will choose the approach that prioritizes the officer's wishes. It will attempt 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 need and he must be qualified to fill that need.

The first step used by the placement officer is to retrieve the transferring officer's record from the NMPC database and review his qualifications. The following officer information will be required for this simple prototype: 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 beneficial to put a pilot in a billet that has a pilot designator code and it would be beneficial to place 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 attributes 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 very long and complicated query to produce a list of billets in the requested geographic area that match the officer's qualifications. However, the placement officer still wouldn't 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. Similarly, other rules are used by the expert to determine the allowable Additional Qualification Code (AQD) and Subspecialty Codes.

The following simplistic cases with fictitious names are provided to clarify the assignment process:

CASE 1. Lt Nickerson makes a morning telephone call and schedules a meeting with the placement officer at NMPC-4417 on 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 NMPC-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 Lt 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 Lt Wood's third choice. Reviewing the commands located at Dallas reveals a 1300 Lt billet open in July 1991. Lt Wood accepts the billet.

To summarize the current process: First the officer's qualifications and desires are retrieved from OAIS. Next, the placement officer applies a set of rules to the officer's qualifications to determine what billets he is qualified to fill. Finally, the placement officer manually queries all the billets at the requested homeport to find any billets that are expected to be open 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. Automating the process would provide the placement officer with more time to communicate with transferring officers and to consider placement options resulting in improved decision making.

3. RULE BASE

To transform the processes that are currently in use to an expert system, a collection of IF THEN rules (Hayes-Roth 1985) needs to be developed. These rules will be 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 officer database. There are three main areas that use rules: Officer Rank, Officer Designator and Officer PRD. For this simple prototype, the placement officer will manually enter the officer's request for homeport. Manual insertion of the requested homeport was chosen because in most cases the officers do not make their final decision for homeport preference until the last possible moment making the homeport preference in the database outdated.

The first set of rules will determine billet ranks available to the officer. If the officer's rank is LCDR, he would be 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
```

The second 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
```

The third area that needs a rule base is officer Planned Rotation Date (PRD). The system should be able to pick billets that have a PRD window close to the officer's PRD, but not necessarily an exact match. An exact match would be too restrictive and too narrowly limit the billet choices. In practice, the placement officer often looks at an entire calendar year when beginning his search for billet matches. Looking at an officer with a PRD of 9107, the placement officer would initially look at all billets with incumbent PRDs of 9101 through 9112. This rule would look like this:

```
IF      OFFICER_PRD >= 9101 AND
        OFFICER_PRD <= 9112
THEN    BILLET_PRD  =  91**
```

** = any integer between 1 and 12

The final rule base is for homeport preference. There are several 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. The homeport rule for Washington, D.C. is written as:

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

The billet rank, designator, PRD and homeport generated by the rule base would then be used to query the billet database for matches. Figure 1 illustrates the architecture of the rule base (Mockler 1989).

4. SYSTEM DESIGN

As indicated earlier, the TAR officer Placement System (TARPS) is designed as an expert database system that couples the officer and billet databases to an expert system (Brodie and Mylopoulos 1986). The placement officer interacts with the system by providing officer information. The required officer attributes are then retrieved from the officer database, and passed to the rule base where it is processed by an inference engine to produce a list of query criteria. These query criteria plus officer input is passed to the billet database to produce a list of billets that match officer qualifications, billet requirements and the officer request. Figure 2 is a diagram showing the interaction of the system (Harmon and King 1985).

Since OAIS is composed of information on tens of thousands of officers and ODIS has information on ten of thousands of billets it is expected that performance will be negatively affected. To improve the efficiency of the expert system without affecting it's functionality, the OAIS and ODIS databases were filtered into smaller databases that included only TAR officers and TAR billets. These smaller databases are then downloaded to and accessed by the expert system.

An expert system shell was selected to couple the knowledge base and the databases because it has the ability to interface with the user and has an inference engine built in to process the rule base. The VP expert system shell was selected because of it's additional capability to query databases and ability to be implemented on microcomputers. The rule base for the prototype is expected to be about 200 rules.

5. CONCLUSIONS AND FUTURE RESEARCH

This paper addressed the feasibility of developing an expert system for placing TAR officers in their upcoming duty assignments.

It also addressed the capability 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 was 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 extremely beneficial for training new placement officers.

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

Filtering the billets by only four criteria: rank, designator, PRD and homeport quickly trimmed the quantity of acceptable billets down to a reasonable number. These billets consistently proved to be a very good starting point for the placement officer. In addition, the ability to rerun the system with different homeports was an effective way of quickly looking for available billets at several geographic locations.

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.

A comprehensive system is currently being developed that will provide additional officer qualification information in the database and allow more domain expertise information to be incorporated in the knowledge base. This effort includes the addition of the promotion status attribute in the officer database to provide information that is helpful in determining the optimum billet rank. It also includes the addition of the Additional Qualification Designator (AQD). This code specifically defines the ship or aircraft where the officer qualification has been attained. Billets also have AQDs that define the type of equipment that the qualification must be in. This precludes a helicopter pilot from being considered for an F-14 squadron. Finally, the addition of a subspecialty code attribute for officers and billets will enable the new system to match officer educational background with billet educational requirements.

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