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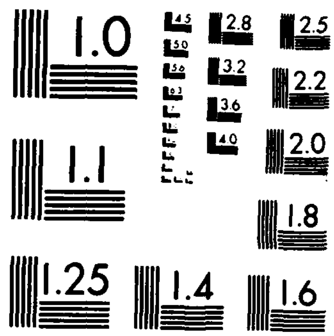


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# NAVAL POSTGRADUATE SCHOOL

## Monterey, California



# THESIS

THE EFFECTS OF COMBINING NAVY SUBSPECIALTIES
ON GRADUATE EDUCATION QUOTAS,
AND QUOTA MODEL ENHANCEMENTS

by

Mary Louise Rainey

June 1987

Thesis Advisor: K. T. Marshall

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This thesis examines the effects of a simplificaton of the U.S. Navy Subspecialty System on determining graduate education quotas. A set of "matching" criteria is introduced bv which Navy fully-funded graduate education curricula are rated for fraction commonality. Subspecialty fields, represented by their supporting curricula, are then aggregated based on various levels of curriculum commonality, and the effect on quotas quantified. Results indicate that reducing the number of subspecialty fields does not significantly alter the number of inputs required to maintain the system. The thesis also advances a model by which U.S. Navy Unrestricted Line graduate eduation quotas may be allocated by primary designators. This model may be used to enhance the capabilities of current models of quota determination.

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# The Effects of Combining Navy Subspecialties on Graduate Education Quotas, and Quota Model Enhancements

by


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Submitted in partial fulfillment of the requirements for the degree of

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ABSTRACT

This thesis examines the effects of a simplification of the U.S. Navy Subspecialty System on determining graduate education quotas. A set of "matching" criteria is introduced by which Navy fully-funded graduate education curricula are rated for fraction commonality. Subspecialty fields, represented by their supporting curricula, are then aggregated based on various levels of curriculum commonality, and the effect on quotas quantified. Results indicate that reducing the number of subspecialty fields does not significantly alter the number of inputs requied to maintain the system. The thesis also advances a model by which U.S. Navy Unrestricted Line graduate education quotas may be allocated by primary designators. This model may be used to enhance the capabilities of current models of quota determination.

TABLE OF CONTENTS

# LIST OF TABLES

LIST OF FIGURES

# I. INTRODUCTION

The U.S. Navy Officer Subspecialty System was conceptualized in 1974 in response to a growing need for officers to possess specialized operational, technical, and managerial education and skills. During the past decade the subspecialty billet base has expanded by about 20 percent. Annual inputs of officers into fully-funded graduate education have also expanded, but persistently remain below requirements Consequently, the capability to maintain subspecialty inventories, particularly in the most critical scientific and technical fields has been affected.

There are basically two corrective measures open to treat the problem. The first is to simply meet the annual required quota. Operational commitments have historically precluded this option, however. The second is to realign personnel management policies to bring system design into sync with the capability to meet quotas.

This thesis addresses the latter alternative. It analyses the impact of simplifying subspecialities on a number of aspects of the Navy full-funded graduate education program.

Chapter II summarizes subspecialty system design, explaining subspecialist and billet coding and mapping subspecialty fields to Navy fully-funded graduate education curricula. Chapter III outlines the simplification methodology used in the analysis and Chapter IV discusses the results of the matching process.

Chapter V further extends the analysis by broaching the concept of adjusting the current model to apportion Unrestricted Line graduate educaton quotas by officer designator instead of the one broad category currently used. Finally, conclusions are presented in Chapter VI.

# II. THE SUBSPECIALTY SYSTEM

## A. BACKGROUND

The Officer Subspecialty System is an integrated manpower and personnel classification and control system which establishes criteria and procedures for identifying officer requirements for advanced educaton, functional training, and significant experience in various fields and disciplines. Similarly, the Subspecialty System is used to identify those officers who acquire these qualifications. In addition to identifying qualitative officer manpower needs, the subspecialty system is used as the basis for generating the Navy's advanced education and training program requirements. [Ref. 1: p. E-1]

### 1. System Design

The U. S. Navy Officer Subspecialty System employs a coding structure which simultaneously identifies billet requirements and officer qualifications. The subspecialty code is applied to billets and officers in specific functional fields where the need for additional education, skill or experience has been identified above and beyond the primary officer specialty.

Subspecialty codes are applied to officers of the Unrestricted Line (URL), the Restricted Line (RL) and the Staff Corps who possess specialized education, experience or skills in Navy-specific functional areas.[1] Limited Duty

[1] Medical and Dental Corps subspecialties will not be included in this thesis.

Officer and Warrant Officer billets and personnel are not included in the subspecialty coding structure. Also, there are no subspecialty billets coded for flag rank officers.

The subspecialty code contains five characters; four numerical and a fifth, alphabetic suffix. Components of the subspecialty code reflect three distinct areas: the first two digits convey the URL "functional field" or Staff Corps identifier; the third and fourth digits identify the discrete educaton/skill field; and the fifth character communicates the education/skill level. Appendix A contains a comprehensive listing of subspecialty coding components. These elements refer to both the qualifications of officer subspecialists and the requirements of specific billets. [Ref. 1: pp. E1-E3]

Subspecialty codes reflecting proven status are conferred on officers by formal Subspecialty Selection Board action. Suffixes denoting educational achievement are awarded upon an officer's completion of a postgraduate degree. A "P" code typically signifies attainment of graduate level education. A Subspecialty Review Board reviews each subspecialty's billet base biennially, validating new requirements and assessing the need to continue billet requirements in fields that have undergone significant change.

The education/skill field component of the coding composite essentially identifies the area of subspecialization. Discrete educational/skill fields are strictly delineated by educational/skill requirements (ESR's). The ESR's are the elements of knowledge or experience an officer must have to gain admittance to a particular subspecialty community.

Graduate education curricula that support the subspecialty system must meet the educational/skill requirements of the subspecialty. Curricula are periodically reviewed to ensure that they meet these criteria. Officers pursuing self-funded graduate education must also meet the education skill requirements of the field they wish to enter.

2. Navy Graduate Programs

Sixty-six subspecialties are supported through Navy fully-funded graduate education programs. Two additional "general" subspecialties, XX00 and XX36, include officers with graduate education but are not maintained through Navy fully-funded study. The general subspecialist typically completes graduate education before commissioning or earns a degree during active service in a field which does not fulfill Navy subspecialty educational/skill requirements.

A primary consultant, or sponsor, monitors ESR's, liaisons with Naval Postgraduate School, Monterey, California (NPS), and generally oversees the health of each subspecialty community. Table I maps the Navy's graduate education

TABLE I

NAVY GRADUATE EDUCATION CURRICULA

| Curriculum | SUBSP | Primary Consultant | School |
|---|---|---|---|
| Operations Analysis (360) | XX42P | OP-91 | NPS |
| Operations Logistics (361) | XX43P | OP-04 | NPS |
| CMD/Control/Communications (365) | XX45P | $JCS/C^3$ | NPS |
| Space Operations (366) | XX76P | OP-943 | NPS |
| Computer Systems Management (367) | XX95P | OP-945 | NPS |
| Computer Science (368) | XX91P | OP-945 | NPS |
| Meteorology (372) | XX48D | OP-006 | NPS |
| Air Ocean Science (373) | XX47P | OP-006 | NPS |
| Operational Oceanography (374) | XX49P | OP-006 | NPS |
| Operational Oceanography (374) | XX49P | OP-006 | CIV |
| Chemistry (382) | XX62P | NAVSEA | CIV |
| Oceanography (440) | XX49D | OP-006 | NPS |
| Ocean Engineering (472) | 1103P | NAVFACENGCOM | CIV |
| Facilities Engineering (47X) | 1101P | NAVFACENGCOM | CIV |
| Naval Construction Eng (510) | XX51P | NAVSEA | CIV |
| Clear Engineering (520) | XX52P | NAVSEA | CIV |
| Nuclear Physics (521) | XX67P | OP-981 | AFIT |
| Antisubmarine Warfare (525) | XX44P | OP-951 | NPS |
| Weapons Systems Engineering (530) | XX61P | NAVSEA | NPS |
| Weapons Systems Science (531) | XX63P | NAVSEA | NPS |

| Curriculum | SUBSP | Primary Consultant | School |
|---|---|---|---|
| Nuclear Physics (532) | XX67P | OP-981 | NPS |
| Underwater Acoustics (535) | XX56P | NAVSEA/SPAWAR | NPS |
| Naval Engineering (570) | XX54P | NAVSEA | NPS |
| Electronics Systems Eng (590) | XX55P | SPAWAR | NPS |
| Space Engineering (591) | XX77P | OP-943 | NPS |
| Electronic Warfare (595) | XX46P | OP-956 | NPS |
| Communication Engineering (600 | XX81P | OP-941 | NPS |
| Aeronautical Engineering (610) | XX71P | NAVAIR | NPS |
| Avionics Engineering (611) | XX72P | NAVAIR | NPS |
| Telecommunications Sys Eng (620) | XX82P | OP-941 | NPS |
| Petroleum Engineering (630) | 1102P | NAVFACENGCOM | CIV |
| NSA Middle East Affairs (681) | XX21P | OP-06 | NPS |
| NSA Far East/SE Asia (682) | XX22P | OP-06 | NPS |
| NSA Europe/USSR (683) | XX24P | OP-06 | NPS |
| NSA Intel Orgs and Negs (684) | XX25P | OP-06 | NPS |
| NSA Western Hemisphere (685) | XX23P | OP-06 | NPS |
| NSA Strat Planning Gen (686) | XX26P | OP-06 | NPS |
| NSA Strat Planning Nuc (687) | XX27P | OP-06 | NPS |
| Material Logistics Mgmt (700) | XX32P | NAVAIR | AFIT |
| Supply Acq Distrib Mgmt (810) | 1301P | NAVSUP | CIV |
| Petroleum Mgmt (811) | 1307P | NAVSUP | CIV |
| Transportation/Logs Mgmt (813) | 1304P | NAVSUP | NPS |
| Transportation Mgmt (814) | XX35P | COMSC | NPS |

| Curriculum | SUBSP | Primary Consultant | School |
|---|---|---|---|
| Acquisition Ctrl Mgmt (815) | 1306P | NAVSUP | NPS |
| Systems Inventory Mgmt (819) | 1302P | NAVSUP | NPS |
| Intelligence (825) | XX17P | NAVINTCOM | NPS |
| Material Log Support Mgmt (827) | XX32P | NAVAIR | NPS |
| Retailing (830) | 1305P | NAVSUP | CIV |
| Financial Mgmt (837) | XX31P | OP-92 | NPS |
| Manpower/Pers/Tra Analysis (847) | XX33P | OP-11 | NPS |
| Subsistence Technology (860) | 1308P | NAVSUP | CIV |
| Education and Tra Mgmt (867) | XX37P | CNET | CIV |
| JAG (88X) | 120XP | NJAG | CIV |
| Public Affairs (920) | XX10P | CHINFO | CIV |
| Religion (97X) | 14X0P | CNET | CIV |
| Joint Intelligence (990) | XX16P | NAVINTCOM | DIC |

Source: [Ref. 1: pp. E10-E13]

curricula to respective subspecialties and primary consultants. It is interesting to note that review of subspecialty literature presents no reference as to why the third and fourth digits of the subspecialty code are used to index and manage subspecialist inventories while a dissimilar numbering schematic refers to subspecialty curricula.

To support its subspecialties educationally, the Navy conducts 36 graduate curricula at Naval Postgraduate School (NPS), Monterey. Two of the curricula offered at NPS are also offered to naval officers on a limited basis at the Air Force Institute of Technology (AFIT). Twenty-four approved graduate curricula are offered to naval officers at civilian universities throughout the nation. [Ref. 2: enclosure 1, p. 1] The courses of instruction offered at civilian universities are directed mainly at the support side of the Navy in technical and managerial education while NPS provides a more "Navy-specific" orientation of operational, technical and managerial disciplines.

Subspecialists must work in their subspecialty field immediately after graduation in a "utilization tour". Department of Defense Guidelines are stringent in this regard. URL officers with warfare designators, however, typically face operational commitments that preclude their subspecialty utilization immediately after graduation. In these cases the utilization requirement is waived until completion of the operational assignment.

The Chief of Naval Operations (CNO) issued a 24 May 1986 policy statement affirming his support for all Navy Graduate Education programs leading to subspecialization. In it, he established a goal for 20% of the Navy Officer Corps to possess a graduate level subspecialty. The CNO also stressed the importance of graduate education as an long-range instrument of adapting to the changing technical environment and not just "training" for the next assignment. [Ref. 3: p. 5]

3. Subspecialty Design Literature

Written material on the subject of subspecialty system design is scarce. The Navy Graduate Education Status Report for 1984, compiled by the NPS Programs Office, proposed combining captain and commander ranks into broad subspecialization categories to improve utilization [Ref. 4: p. 37]. Despite the report's recommendation there appears to have been no subsequent analysis published on the subject.

There is reference, however, to the desirability of altering system design in the 1984 Department of Defense Audit on Graduate Education. The audit specifically addressed the subject of estimating fully-funded graduate quotas by considering closely associated, but not identical, graduate programs a fulfilling authorized billet specifications. It stated:

We recommend that the Assistant Secretary of the Army (Manpower and Reserve Affairs), Assistant Secretary of the Navy (Manpower and Reserve Affairs), Assistant Secretary of the Air Force (Manpower, Reserve Affairs and Installations) and the Commandant of the Marine Corps compute graduate educaton program requirements by including all officers who have either the exact graduate education degrees or closely related degrees that the services determine will qualify the officers to serve in the validated positions. [Ref. 5: p. 11]

During the course of the audit, 51 naval activities to which fully-funded graduates were assigned were reviewed. The auditors noted in their findings:

Included in 5 of te 51 activities were 1,768 validated billets requiring graduate education, representing 32% of all Navy validated billets of this type. Although there were 1,621 officers with graduate degrees assigned to the 51 activities, we determined that 779 (48%) were not filling validated billets. Only 271 officers (17%) were in billets that required their education. The remaining 571 officers (35%) were assigned to billets that did not require their degrees. Nevertheless, the Navy considered that these officers held degrees that were sufficiently related to the education required for the billets and counted the 571 degree holders as assigned to the validated billets. [Ref. 5: p. 12]

The results of an interview conducted with NMPC-440E, Navy Subspecialty Utilization Coordinator, indicate that the Navy details graduates to related subspecialty fields [Ref. 6]. One of the most formidable challenges facing subspecialty managers is the incongruence between billet availability and the individual officer's assignment window. While the Navy aims for a "perfect match" between officers and subspecialty billets, there are instances in which officers must be cross-assigned to an associated field.

Detailers routinely assign subspecialists to similar subspecialty fields when billets are not available at reassignment. There is no programming option in current models, however, to determine graduate education quotas using a "related field" concept. To date, no written criteria exist that delineate what consitutes a related field.

The purpose of the following chapter is to present a well-defined methodology for "matching", or comparing, subspecialties. Although the 1984 Department of Defense audit indicated that forecasting graduate education quotas based on related fields would indicate lower requirements, to date, there has been no analysis that validates this opinion. The next chapter delineates specific criteria for matching subspecialties and attempts to implement a scientific approach in determining graduate education quotas.

# III. SUBSPECIALTY MATCHING

## A. INTRODUCTION

A methodology for matching related subspecialties is now presented. The matching is based on the similarity of the curricula that support subspecialties.

Three levels of "relatedness" are developed. Subspecialties are matched at an 80 percent level of similarity; second, a 60 percent level of similarity; and, the most simplistic of all cases, all subspecialties, including those not offered at NPS, are considered as one large category. This last case is used only to show the maximum possible effect that combining subspecialties can have on quota determination.

NPS curricula are used exclusively in the matching procedure as currcula matrices were not readily obtained from civilian universities that support Navy graduate education. Each subspecialty code is equated to the individual NPS curriculum number as only one subspecialty was supported by each. An example of a NPS curriculum matrix can be seen in Figure 1.

A comprehensive review of each NPS curriculum matrix and its course descriptions was conducted. The 36 NPS curricula were then evaluated, by pairs, based on the following six criteria of similarity:

ANTISUBMARINE WARFARE CURRICULUM (#525)
COURSE MATRIX

| QTR | | | | | |
|---|---|---|---|---|---|
| 1 | MA 1112 2-2 Calculus Review / MA 2129 2-1 ODE, Laplace | MA 1112 2-2 Calculus Review / MA 2181 2-1 Vector Calculus | OC 2120 4-0 Survey of Oceanography | OS 2210 4-1 Introduction to Computer Programming | |
| 2 | MA 3139 4-0 Fourier Analysis & Partial Diff. Eqns. | OS 2103 4-1 Applied Probability | NS 2000 3-0 Military History | PH 2119 4-1 Oscillations & Waves | |
| 3 | OS 3303 4-1 Computer Simulation | OS 3604 4-0 Decision & Data Analysis | PH 2401 3-0 Sonar Equations | EO 3720 4-1 Signals & Noise | Maritime Strategy |
| 4 | EO 4720 4-1 Signal Processing Systems | OS 3601 4-0 Search Detection & Localization | PH 3402 4-2 Underwater Acoustics | OC 4267 4-3 Ocean Influences & Predictions | |
| 5 | OS 3402 3-1 Human Vigilance Performance | | MR 2413 3-1 Meteorology for ASW | | |
| 5 | EXPERIENCE TOUR | | | | |
| 6 | EC 4450 4-1 Sonar Systems Engineering | PH 3479 3-0 Physics of Underwater Weapons | PH 4403 4-1 Advanced Topics in Underwater Acoustics | Defense Organization | |
| 7 | OS 4601 4-0 Test & Evaluation | OS 3602 4-1 Combat Models & Weapons Effectiveness | PH 3306 4-0 Electromagnetic Wave Propagation | THESIS | |
| 8 | PH 3002 4-0 Non-Acoustic Sensor Systems | Naval Warfare Developments | THESIS | THESIS | |

LEGEND:

| COURSE NUMBER* | CLASS HRS-LAB HRS |
|---|---|
| COURSE TITLE | |

*1000 AND 2000 series courses are undergraduate level.
3000 and 4000 series courses are graduate level.

1 April 1987

Figure 1 Representative NPS Curriculum Matrix

(1) level of math involved in the programs of study.

(2) the Academic Profile Code (APC) required for entrance into the course of study.

(3) the number of math courses in the programs of study.

(4) the number of identical courses.

(5) the number of courses similar ("similar" meaning the same topics but considered from a different perspective ie: Course PH3452 - Underwater Acoustics offerd in the Weapons Engineering Curriculum would be "similar" but not identical to course PH3402 - Underwater Acoustics offered in the Antisubmarine Warfare Curriculum).

(6) the likelihood that electives would be chosen from a like grouping (ie: Administrative Science students from the Financial Management Curriculum would be as likely to choose the same electives as the Transportation Management curriculum).

Five point rating scales were used for criteria (1) through (5) ranging from a score of 1 for "no similarity" to a score of 5 for "high similarity". A 5 point scale for criterion (6) ranged from 1 for "no likelihood" to 5 for a "perfect match".

Weightings were also assigned to each of the six criteria reflecting its importance in the evaluation process.

| Criterion | Weighting Factor |
|---|---|
| (1) | .10 |
| (2) | .05 |
| (3) | .20 |
| (4) | .40 |
| (5) | .20 |
| (6) | .05 |

The score of each pair evaluated was then multipled by the respective weighting factor. The resulting number was then multiplied by .2 and rounded to the first decimal to derive fraction commonality.

An example is given in Table II; Financial Management XX31 curriculum is compared with the Operations Analysis XX42 curriculum resulting in a commonality factor of 0.3.

TABLE II

FRACTION COMMONALITY DERIVED BETWEEN FINANCIAL MANAGEMENT XX31 AND OPERATIONS ANALYSIS XX42 CURRICULA

| CRITERIA | RATING | WEIGHTING | SUBTOTALS |
|---|---|---|---|
| (1) | 2 | .10 | .20 |
| (2) | 2 | .05 | .10 |
| (3) | 2 | .10 | .20 |
| (4) | 1 | .40 | .40 |
| (5) | 1 | .20 | .20 |
| (6) | 1 | .05 | .05 |
| | | TOTAL | 1.15 x .2 = .3 |

1. The Initial Matching Matrix

The evaluation process produced fraction commonality for each pair of curricula. The resulting matrix is shown in Table III.

In the matrix, curricula numbers and APC's are arrayed across the top and curricula numbers down the side. The interior cells of the matrix contain the fraction commonality between two curricula determined during the

TABLE III

THE INITIAL MATCHING MATRIX

| CURRICULUM | 360 | 361 | 365 | 366 | 367 | 368 | 373 | 374 | 525 | 530 | 531 | 532 | 535 | 570 | 590 | 591 | 59 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| APC (ACROSS) | (324) | (324) | (325) | (324) | (335) | (325) | (323) | (323) | (323) | (323) | (323) | (323) | (323) | (323) | (323) | (323) | (32 |
| OPERATIONS ANALYSIS (360) | 1 | 0.9 | 0.5 | 0.5 | 0.2 | 0.2 | 0.2 | 0.2 | 0.5 | 0.3 | 0.2 | 0.2 | 0.3 | 0.2 | 0.2 | 0.1 | |
| OPERATIONAL LOGISTICS (361) | | 1 | 0.5 | 0.5 | 0.2 | 0.2 | 0.2 | 0.2 | 0.5 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | |
| JOINT COMMAND, CONTROL, COMMUNICATIONS (365) | | | 1 | 0.9 | 0.2 | 0.3 | 0.3 | 0.2 | .4 | 0.2 | 0.2 | 0 | 0.2 | 0.1 | 0.3 | 0.3 | |
| SPACE SYSTEMS OPERATIONS (366) | | | | 1 | 0.2 | 0.3 | 0.2 | 0.2 | 0.4 | 0.2 | 0.1 | 0.1 | 0.3 | 0.1 | 0.3 | 0.[illegible] | |
| COMPUTER SYSTEMS MANAGEMENT (367) | | | | | 1 | 0.2 | 0 | 0 | 0.1 | 0.1 | 0 | 0 | 0 | 0 | 0.1 | 0 | |
| COMPUTER SCIENCE (368) | | | | | | 1 | 0 | 0 | 0.1 | 0.2 | 0.2 | 0 | 0.3 | 0 | 0.3 | 0.1 | |
| AIR-OCEAN SCIENCE (373) | | | | | | | 1 | 0.9 | 0.7 | 0.1 | 0 | 0 | 0.6 | 0.2 | 0.1 | 0.1 | |
| OPERATIONAL OCEANOGRAPHY (374) | | | | | | | | 1 | 0.7 | 0.3 | 0.1 | 0.1 | 0.6 | 0.1 | 0.1 | 0.2 | |
| ANITSUBMARINE WARFARE SYSTEMS TECHNOLOGY (525) | | | | | | | | | 1 | 0.3 | 0.2 | 0.2 | 0.7 | 0.1 | 0.2 | 0.1 | |
| WEAPONS SYSTEMS ENGINEERING (530) | | | | | | | | | | 1 | 0.6 | 0.7 | 0.5 | 0.4 | 0.5 | 0.3 | |
| WEAPONS SYSTEMS SCIENCE (531) | | | | | | | | | | | 1 | 0.7 | 0.5 | 0.4 | 0.5 | 0.3 | |
| NUCLEAR PHYSICS WEAPONS & EFFECTS (532) | | | | | | | | | | | | 1 | 0.4 | 0.3 | 0.2 | 0.2 | |
| UNDERWATER ACOUSTICS (535) | | | | | | | | | | | | | 1 | 0.3 | 0.4 | 0.3 | |
| NAVAL ENGINEERING (570) | | | | | | | | | | | | | | 1 | 0.3 | 0.3 | |
| ELECTRONIC SYSTEMS ENGINEERING (590) | | | | | | | | | | | | | | | 1 | 0.5 | |
| SPACE SYSTEMS ENGINEERING (591) | | | | | | | | | | | | | | | | 1 | |
| ELECTRONIC WARFARE SYSTEMS TECHNOLOGY (595) | | | | | | | | | | | | | | | | | |
| COMMUNICATIONS ENGINEERING (600) | | | | | | | | | | | | | | | | | |
| AERONAUTICAL ENGINEERING (610) | | | | | | | | | | | | | | | | | |
| AERONAUTICAL ENGINEERING AVIONICS (611) | | | | | | | | | | | | | | | | | |
| TELECOMMUNICATIONS SYSTEMS MANAGEMENT (620) | | | | | | | | | | | | | | | | | |
| NSA MIDEAST/AFRICA/PACIFIC (681) | | | | | | | | | | | | | | | | | |
| NSA FAR EAST/SE ASIA/PACIFIC (682) | | | | | | | | | | | | | | | | | |
| NSA EUROPE/USSR (683) | | | | | | | | | | | | | | | | | |
| NSA INTERNATIONAL ORGANIZATIONS & NEGOTIATIONS (684) | | | | | | | | | | | | | | | | | |
| NSA WESTERN HEMISPHERE (685) | | | | | | | | | | | | | | | | | |
| NSA STRATEGIC PLANNING (GENERAL) (686) | | | | | | | | | | | | | | | | | |
| NSA STRATEGIC PLANNING (NUCLEAR) (687) | | | | | | | | | | | | | | | | | |
| TRANSPORTATION LOGISTICS MANAGEMENT (813) | | | | | | | | | | | | | | | | | |
| TRANSPORTATION MANAGEMENT (814) | | | | | | | | | | | | | | | | | |
| ACQUISITION & CONTRACT MANAGEMENT (815) | | | | | | | | | | | | | | | | | |
| SYSTEMS INVENTORY MANAGEMENT (819) | | | | | | | | | | | | | | | | | |
| INTELLIGENCE (825) | | | | | | | | | | | | | | | | | |
| MATERIAL LOGISTICS SUPPORT MANAGEMENT (827) | | | | | | | | | | | | | | | | | |
| FIANACIAL MANAGEMENT (837) | | | | | | | | | | | | | | | | | |
| MANPOWER, PERSONNEL & TRAINING ANALYSIS (847) | | | | | | | | | | | | | | | | | |

| 25 | 570 | 590 | 591 | 595 | 600 | 610 | 611 | 620 | 681 | 682 | 683 | 684 | 685 | 686 | 687 | 813 | 814 | 815 | 819 | 825 | 827 | 837 | 847 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3) | (323) | (323) | (323) | (323) | (323) | (323) | (323) | (335) | (365) | (365) | (365) | (365) | (365) | (365) | (365) | (345) | (345) | (345) | (345) | (335) | (345) | (345) | (345) |
| .3 | 0.2 | 0.2 | 0.1 | 0.5 | 0.2 | 0.1 | 0.1 | 0.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0.2 | 0.2 | 0.3 | 0.2 | 0.2 | 0.2 | 0.3 |
| .2 | 0.2 | 0.2 | 0.1 | 0.4 | 0.2 | 0.1 | 0.1 | 0.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.3 | 0.3 | 0.3 | 0.4 | 0.1 | 0.5 | 0.3 | 0.3 |
| .2 | 0.1 | 0.3 | 0.3 | 0.7 | 0.6 | 0.1 | 0.1 | 0.9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.2 | 0.2 | 0.2 |
| .3 | 0.1 | 0.3 | 0.7 | 0.4 | 0.5 | 0.1 | 0.1 | 0.6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| 0 | 0 | 0.1 | 0 | 0.1 | 0.2 | 0 | 0 | 0.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.5 | 0.6 | 0.6 | 0.4 | 0.1 | 0.4 | 0.5 | 0.4 |
| .3 | 0 | 0.3 | 0.1 | 0.3 | 0.2 | 0 | 0 | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| .6 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| .6 | 0.1 | 0.1 | 0.2 | 0.4 | 0.2 | 0.2 | 0.2 | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| .7 | 0.1 | 0.2 | 0.1 | 0.4 | 0.3 | 0.1 | 0.1 | 0.3 | 0 | 0 | 0 | 0 | 0 | 0.1 | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| .5 | 0.4 | 0.5 | 0.3 | 0.3 | 0.4 | 0.2 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| .5 | 0.4 | 0.5 | 0.3 | 0.3 | 0.4 | 0.2 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| .4 | 0.3 | 0.2 | 0.2 | 0.3 | 0.3 | 0.2 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0.3 | 0.4 | 0.3 | 0.3 | 0.4 | 0.2 | 0.2 | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 1 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 1 | 0.5 | 0.3 | 0.8 | 0.3 | 0.3 | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | 1 | 0.3 | 0.3 | 0.3 | 0.3 | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | 1 | 0.3 | 0.3 | 0.3 | 0.1 | 0 | 0 | 0 | 0 | 0 | 0.1 | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | 1 | 0.3 | 0.3 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | 1 | 0.9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.3 | 0.3 | 0.3 | 0.3 | 0.1 | 0.3 | 0.2 | 0.2 |
| | | | | | | | | | 1 | 0.8 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | 1 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | 1 | 0.8 | 0.3 | 0.7 | 0.7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | 1 | 0.3 | 0.3 | 0.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 1 | 0.3 | 0.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | | | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | | | | 1 | 0.8 | 0.7 | 0.8 | 0 | 0.8 | 0.8 | 0.6 |
| | | | | | | | | | | | | | | | | | 1 | 0.8 | 0.8 | 0 | 0.8 | 0.8 | 0.7 |
| | | | | | | | | | | | | | | | | | | 1 | 0.7 | 0 | 0.8 | 0.8 | 0.7 |
| | | | | | | | | | | | | | | | | | | | 1 | 0 | 0.9 | 0.8 | 0.7 |
| | | | | | | | | | | | | | | | | | | | | 1 | 0 | 0 | 0 |
| | | | | | | | | | | | | | | | | | | | | | 1 | 0.7 | 0.7 |
| | | | | | | | | | | | | | | | | | | | | | | 1 | 0.7 |
| | | | | | | | | | | | | | | | | | | | | | | | 1 |

evaluation process. A perfect match is indicated by a 1. The 1's on the diagonal of the matrix indicate the perfect correlation of a curriculum with itself.

2. The High Similarity Matrix

From the initial matching matrix all curricula with at least 0.8 similarity were considered candidates for matching. The resulting "matched" curricula are shown in Table IV. Under this level of matching the number of NPS curricula was reduced from 36 to 22.

TABLE IV

THE HIGH SIMILARITY MATRIX

| CURRICULUM | SUBSPECIALTY | MATCHED SUBSPECIALTIES | | | |
|---|---|---|---|---|---|
| 825 | 17 | | | | |
| 681 | 21 | 22 | | | |
| 683 | 23 | | | | |
| 684 | 24 | | | | |
| 685 | 25 | | | | |
| 686 | 26 | 27 | | | |
| 837 | 31 | 32 | 35 | 1302 | 1304 |
| 360 | 42 | 43 | | | |
| 525 | 44 | | | | |
| 365 | 45 | 76 | 82 | | |
| 595 | 46 | | | | |
| 373 | 47 | 49 | | | |
| 570 | 54 | | | | |
| 590 | 55 | 81 | | | |
| 535 | 56 | | | | |
| 530 | 61 | 63 | | | |
| 532 | 67 | | | | |
| 610 | 71 | 72 | | | |
| 591 | 77 | | | | |
| 368 | 91 | | | | |
| 367 | 95 | | | | |
| 815 | 1306 | | | | |

### 3. The Medium Similarity Matrix

The process just described to produce Table IV was repeated, but matched curricula with at least a 0.6 similarity. This led to a greater degree of matching as the results of Table V show. Under this level of matching, the original 36 NPS curricula are reduced to 16.

TABLE V

THE MEDIUM SIMILARITY MATRIX

| CURRICULUM | SUBSPECIALTY | MATCHED SUBSPECIALTIES | | | | | |
|---|---|---|---|---|---|---|---|
| 825 | 17 | | | | | | |
| 681 | 21 | 22 | | | | | |
| 683 | 23 | 24 | 26 | 27 | | | |
| 685 | 25 | | | | | | |
| 837 | 31 | 32 | 33 | 35 | 1302 | 1304 | 1306 |
| 360 | 42 | 43 | | | | | |
| 525 | 44 | 47 | 49 | 56 | | | |
| 365 | 45 | 76 | 82 | | | | |
| 595 | 46 | | | | | | |
| 570 | 54 | | | | | | |
| 590 | 55 | 81 | | | | | |
| 530 | 61 | 63 | 67 | | | | |
| 610 | 71 | 72 | | | | | |
| 591 | 77 | | | | | | |
| 368 | 91 | | | | | | |
| 367 | 95 | | | | | | |

### 4. The Ultimate Matching Matrix

In order to demonstrate the maximum possible effects of combining subspecialties, all Navy fully-funded graduate curricula offered at NPS or civilian universities were considered as one subspecialty. In other words, any Navy subspecialist could be used to fill any subspecialty billet available within his/her own URL, RL, or Staff Corps community. Although such assumptions are clearly impractical, this was done to obtain a lower bound on the effect of subspecialty matching.

The next chapter analyses the effects of the High and Medium Similarity matrices, and the Ultimate Matching Matrix on determining graduate education quotas. However, Tables III, IV and V should be of direct use in subspecialty detailing since they show the commonality of the various curricula that fulfill the educaton/skill requirements of subspecialties.

# IV. THE EFFECT OF MATCHING ON QUOTAS

## A. GENERAL INFORMATION

The three matrices developed in Chapter III serve as the springboard for analysis of the effects of subspecialty matching when used with 1986 subspecialty data and the computational factors imbedded in the Graduate Education Steady-State Quota Model [Ref. 7].

The Graduate Educaton Steady-State Quota Model is an interactive computer program written in the APL programming language. It is currently used by the Office of the Chief of Naval Operations (OP-114) to project annual input and steady-state inventory requirements for Navy fully-funded graduate education programs. Information about the program can be found in the Graduate Education Steady-State Users Manual. [Ref. 8]

Descriptions of model outputs and computational factors appear in Appendixes B and C respectively. A diagram of model flows can be found in Appendix D and a current listing of computational factors used in the model is presented in Appendix E. Model inputs consist of subspecialty system billet requiements, the current inventory of subspecialists, and the number and grade of lateral entrants.

To apply the matching matrices, the Graduate Education Steady-State Quota Model was necessarily modified. The foremost adjustment was the insertion of a brief APL program to combine NPS curricula identified in Chapter III. The program, titled CURRCOMB, can be found in Appendix F.

## B. RESULTS OF ANALYSIS

### 1. The Status Quo - No Matching

Historically, the manner in which quotas have been determined has not included a programming option for matching subspecialties. Graduate education quotas in each subspecialty and officer community are based on the number of validated billets using the computational factors described in Appendix C and presented in Appendix E.

Appendix G contains the output of the Graduate Education Steady-State Quota Model when no matching is performed. Currently 6182 subspecialty billets require incumbents with graduate education. To fully support these billets, the Navy must maintain a steady-state inventory of 15,295 officers. To accomplish this, the Navy is required to educate 1,505 officers per year: 813 URL, 273 RL and 419 Staff Corps officers. Fifty-four percent of the 1,505 total quota is represented by the URL, 18 percent by the RL and 28 percent by the Staff Corps.

2. The High Similarity Match

Appendix H reveals the outcome of using the High Similarity Matrix in the Graduate Education Steady-State Quota Model at an 80 percent level of matching. The APL program CURRCOMB allowed the data to be entered in matched format. The results are based on the identical 6,182 billets used when there is no matching.

The total unconstrained quota of officers falls only 1 percent, from 1,505 to 1,490, a reduction of 15 subspecialists. It is interesting to note that each officer community is reduced proportionately so that community percentages remain the same.

3. The Medium Similarity Match

Duplicating the process used with the High Similarity Matrix, the Medium Similarity Matrix, which matches subspecialties at a 60 percent level of similarity yields analogous results. The effects can be seen in Appendix I.

The total unconstrained quota was reduced only 3 percent from the no-match procedure, from 1,505 officers to 1,468. As in the 80 percent level of matching, officer community percentages remained at constant levels.

4. The Ultimate Match

The effects of combining all subspecialties into a generic subspecialty are shown in Appendix J. Code 10, the subspecialty seen in the appendix, which accommodates all other subspecialties, has no special significance in terms of identifying an educational/skill field.

The total unconstrained quota to support an assumed single subspecialty is 1,251, a reduction from the no-match level of 17 percent. The URL percentage of the unconstrained quota, however, rises from 54 to 57 percent; the RL from 18 to 19 percent; and the Staff Corps' percentage drops from 28 percent to 26 percent.

It is interesting to note that in combining all subspecialties, quotas are redistributed towards the more junior ranks while very few are allocated to lieutenant commanders and commanders. The model accounts for the fact that, after combining subspecialties, there are more billets in each rank to fill at any one time. Officers, educated at a junior level will have more opportunities to fill billets and serve more than one subspecialty tour due to substitution of subspecialties.

## C. DISCUSSION OF RESULTS

### 1. Unconstrained and Constrained Quotas

The analysis, thus far, has addressed the effects of matching on unconstrained graduate education quotas. The unconstrained quota is the annual number of student inputs to graduate education necessary to maintain a steady-state inventory of subspecialists capable of meeting overall system requirements.

The Navy has never met the unconstrained quota. There are basically two reasons for this: (1) fulfilling operational commitments is considered of primary importance in the assignment of officers; (2) annual congressional authorizations inhibit placement of the required contingent of officers into graduate education.

Instead of striving to meet unattainable unconstrained quotas, the Navy has traditionally set an arbitrary constrained quota. A constrained quota of 850 is targeted for FY 88. This figure is approximately 55 percent of the unconstrained figure.

The results of the matching process illustrate that merging subspecialties brings forth only minimal gains in the ability to reduce graduate education unconstrained quotas. The 80 and 60 percent levels of maching yield unconstrained quotas of 1490 and 1468 respectively, considerably higher than the constrained quota of 850. Perhaps more surprisingly, even at the most extreme level of aggregation, in which all subspecialties are combined into one, an unconstrained quota of 1,251 results, also far surpassing the constrained quota. Figure 2 illustrates the effects of matching on the unconstrained quota at the 80 percent, 60 percent and 100 percent levels.

If actual factors, such as promotion rates and flow points, tour lengths, and average availabilities of officers to serve in subspecialty utilization tours continue to mirror

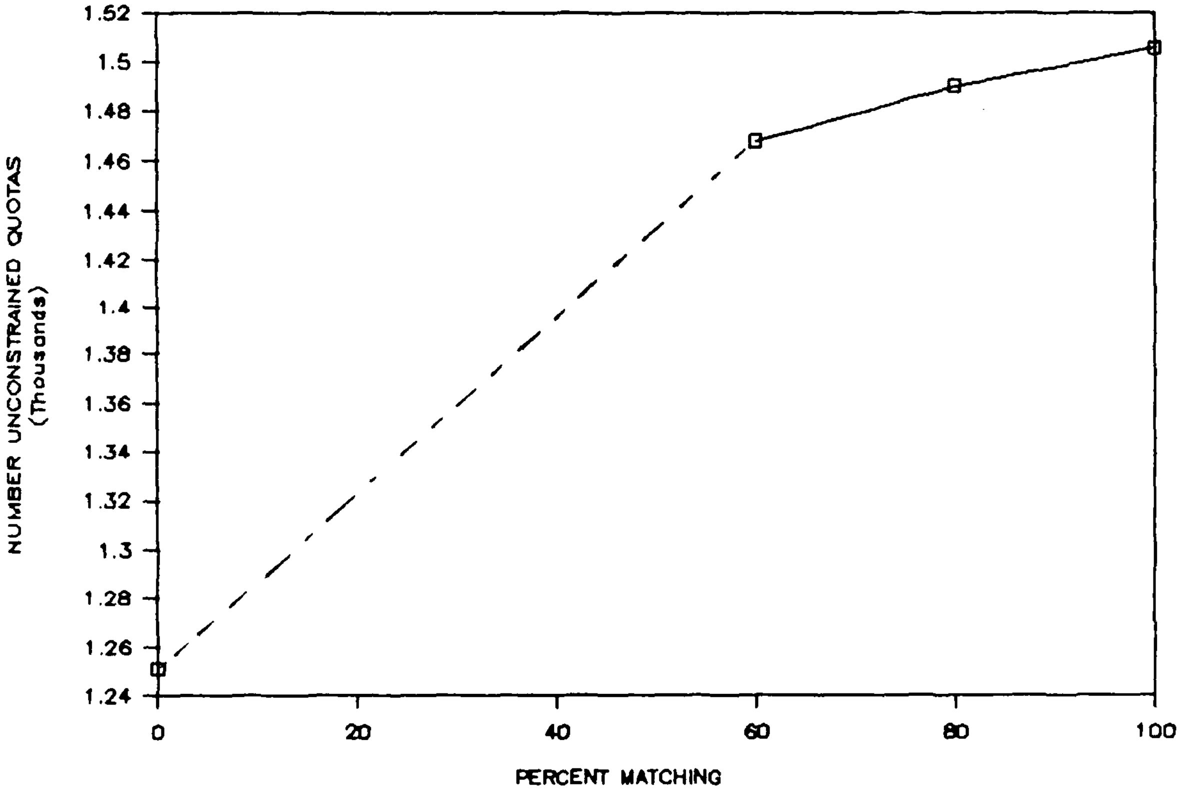



Figure 2 Effects of Matching on Unconstrained Quotas

those included in the Graduate Education Steady-State Quota Model, the process of aggregating subspecialties makes slight difference in the numbers of officers required for steady-state maintenance of th system and no difference in meeting annual constrained quotas. Given the current billet base, it can be safely assumed that the Navy is unlikely to meet its annual unconstrained quota for fully-funded graduate education programs as long as the conditions that contribute to the difficulty in meeting requirements continue.

2. Aggregation and Community Boundaries

Many subspecialties are particular to an officer community. For instance, URL officers cannot serve in any 11XX Civil Engineer Corps, 12XX Legal Corps, 13XX Supply Corps, or 14XX Chaplains Corps subspecialties and Staff Corps officers cannot serve in XX2X National Security Affairs subspecialties.

Subspecialties exist, however, that include combinations of officer communities. Examples include the Anti-Submarine Warfare (XX44) subspecialty comprised of URL and RL officers; and the Financial Management (XX31) subspecialty, which contains URL, RL and Staff Corps officers. Although members of th same subspecialty, officers of a particular community cannot be utilized in another community.

It is interesting to note that at a 60 percent level of aggregation, where six subspecialties were combined (XX31, XX32, XX33, XX35, 1302, 1304, and 1306), the numbers of officers required as input into the aggregated subspecialty decreased by only 9 from a quota of 251 to a quota of 242. Staff Corps required inputs remained at 125, RL inputs decreased from 12 to 9 and URL inputs decreased from 114 to 108.

3. A Response to Audit Claims

The results of the matching methodology clearly demonstrate that the 1984 Department of Defense Graduate Education Audit recommendation of computing graduate educaton program requirements through inclusion of all officers with exact or closely related degrees, would not result in substantial improvements in decreasing total required inputs. The minimal reduction in quotas under all three scenarios also suggests that overall graduate education costs in the Navy would not be substantially lessened under this recommendation.

It must be added that this thesis addresses only the concept of simplifying the subspecialty structure to determine the effects on unconstrained quotas. In no way does it attempt to consider questions surrounding the utilization, or measures of utilization, of subspecialists that were also raised in the audit.

4. The Matching Criteria

There is a lack of documentation on subspecialty system design, particularly in regard to questions of how and why certain management practices came to be. Finding no criteria on which to base subspecialty matching, it became necessary to postulate a set of conditions under which one subspecialty could be compared to another.

The six criteria described in Chapter III were developed to match curricula, and later, subspecialties. The Initial Matching Matrix was then formed, based on the matching results. This thesis attempts to draft assumptions which, heretofore, remained undocumented. These criteria and the Initial Matching Matrix may be of use to subspecialty managers in their efforts to better provide guidance in detailing subspecialists to related fields.

The following Chapter will address the determination of graduate education quotas for URL officer by designator. This is an area of interest to subspecialty system managers as there is no interactive option for detailing by designator in current models.

# V. DETERMINING URL QUOTAS BY DESIGNATOR

## A. THE URL SUBSPECIALIST

Naval warfare and command at sea are the primary objectives of the URL. All URL officers, including subspecialists, must pursue leadership positions within primary specialties to maintain viable career progression. Primary specialties are warfare-related except in the case of 110X General Unrestricted Line (GURL) officers, who are excluded from serving in combat-oriented billets.

The URL is inherently different than the Staff Corps and the Restricted Line. URL promotion flow points, promotion rates, time in grade and tour lengths differ significantly from those of the Staff Corps and Restricted Line, as can be seen in Appendix E.

URL officers are encouraged to pursue graduate education leading to qualification as a subspecialist. Achievement of a graduate degree is widely considered a significant goal for the URL officer. The role of the URL subspecialist, however, is secondary to development of URL leadership experience through combat-related tours of duty. It is warfare experience that enables the URL officer to assume line command.

The URL is composed of several subcommunities, each identified by a 4 digit designator. The groupings include the 110X GURL, 111X Surface Warfare Unrestricted Line, 112X Submarine Warfare Unrestricted Line, 113X Special Warfare Officers (these officers are included with 111X officers for the purpose of determining quotas), and officers of the 13XX Aviation Community.

Graduate education quotas for the URL, as well as the RL and Staff Corps, are determined using the Graduate Education Steady-State Quota Model. [Ref. 7] URL quotas are determined at commander, lieutenant commander, lieutenant and lieutenant junior grade ranks for each subspecialty based on the computational factors resident in the model. The model also produces output on aggregated URL totals in each grade.

No provision exists currently within the model to further delineate quotas at each rank by designator. For instance, if, in the aggregate, 655 URL lieutenant commander quotas are available, it is not possible to determine how many of the 655 may come from a particular URL community.

## B. MODELING URL QUOTAS BY DESIGNATOR

A model for allocating URL quotas by designator is now presented. It produces quotas for officers of five URL officer designators to later fill billets in six URL quota categories. URL quota input is derived from the Graduate Education Steady-State Quota Model using current subspecialty data. [Ref. 7] The number of URL billets, broken down by designator, must also be entered. An algorithmic solution incorporates flow patterns of URL subspecialists into subspecialty billets and distributes quotas based on both the relative size of internal URL communities and a GURL policy variable. The model may be used to allocate quotas in the aggregate or in specific subspecialties.

1. <u>The URL Quota Conundrum</u>

The Officer Subspecialty System contains six categories of URL billets: 1000, 1050, 1100, 1120, 1310, and 1320. Five classifications of URL officers may fill these billets: 110X, 111X, 112X, 131X, and 132X.

Additionally, subspecialists of the officer designators 111X, 112X, 131X, and 132X may be used in billet categories 1000, 1050, and the billet category that corresponds directly to the primary warfare specialty. Officers of the 110X community, however, may fill only 1000 subspeciality billets. Table VI presents a brief description of the six billet categories and the URL officer designators that fill them.

The 1110, 1120, 1310 and 1320 subspecialty billet codes are analogous to the primary officer designator. These billets may only be filled by officers whose designator directly corresponds to subspecialty code. For instance, a subspecialty billet coded with designator 1110 must be filled by a 111X officer. Therefore, officer incumbents to meet these requirements are easily identified. Two important modeling concerns remain, however. First, the proportion of the 1000 coded subspecialty billets to be filled by the 110X community must be determined. Second, the 1000 quotas not

TABLE VI

DESCRIPTION OF URL SUBSPECIALTY BILLET CATEGORIES

| BILLET CATEGORY | WHO MAY FILL BILLET |
|---|---|
| 1000 | Any URL subspecialist may fill a 1000 billet, regardless of designator. |
| 1050 | Any URL subspecialist with a warfare designator may fill 1050 billets. |
| 1110 | Only URL subspecialists with the 111X designator may fill 1110 billets. |
| 1120 | Only URL subspecialists with the 112X designator may fill 1120 billets. |
| 1310 | Only URL subspecialists with the 1310 designator may fill 1310 billets. |
| 1320 | Only URL subspecialists with the 1320 designator may fill 1320 billets. |

filled by 110X officers, and all 1050 billets must be equitably distributed among the 111X, 112X, and 131X and 132X communities.

2. Flows and Variables

Figure 3 illustrates the flows of URL subspecialists into URL billet categories. Each flow is assigned a variable. Variables are also applied to quotas aggregated at a particular grade level, the total number of URL

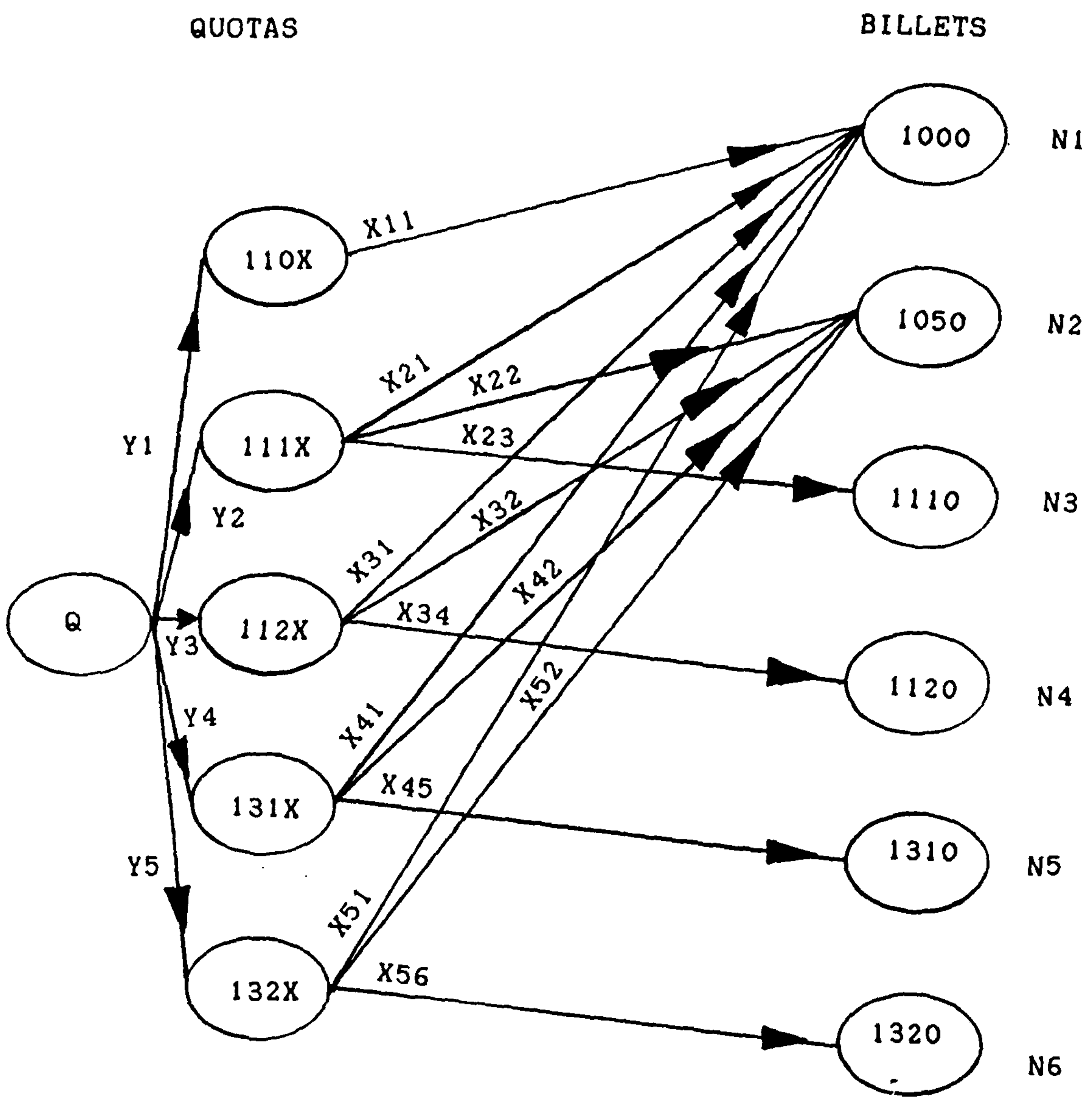



Figure 3 Flows of URL Officers into URL Subspecialty Billets

subspecialty billets, and the number of URL subspecialty billets in the 1000, 1050, 1100, 1120, 1310 and 1320 categories. A description of variables is included in Table VII.

TABLE VII

VARIABLE DESCRIPTIONS USED IN MODELING URL QUOTAS ALLOCATED BY DESIGNATOR

$X_{ij}$=number of officers with designator i who will fill billets with designator j.

| i | Designator | j | Designator |
|---|---|---|---|
| 1 | 110X | 1 | 1000 |
| 2 | 111X | 2 | 1050 |
| 3 | 112X | 3 | 1110 |
| 4 | 131X | 4 | 1120 |
| 5 | 132X | 5 | 1310 |
| | | 6 | 1320 |

Q = the total number of URL quotas available at a given grade. Obtained from Graduate Education Steady State Quota Model output.

Nj = the number of URL subspecialty billets in each URL billet category one officer grade above the grade at which quotas are to be determined. Nj is known.

B = The total number of billets from all URL billet categories (Ni) one rank above that at which quotas will be determined.

$$B = \sum_{j} N_j$$

K = the proportion of quotas at a URL grade to the number of URL billets one rank above that at which quotas will be determined.

P = the fraction of 110X officers that will fill 1000 billets.

### 3. Modeling Assumptions and Relationships

#### a. Billets and Quotas

Let Q be the total URL quotas that must be split between URL designators 110X, 111X, 112X, 131X and 132X (see left-hand side of Figure 3). Also, let Xij be the number of officers with designator i who may fill billets with designator j. The following equation results:

$$X11+X21+X22+X23+X31+X32+X34+X41+X42+X45+X51+X52+X56=Q \quad (1)$$

Quotas for the specific URL designator communities are represented by the flow equations:

$$X11 = Y1, \quad (2)$$

$$X21+X22+X23 = Y2, \quad (3)$$

$$X31+X32+X34 = Y3, \quad (4)$$

$$X41+X42+X45 = Y4, \quad (5)$$

$$X51+X52+X56 = Y5. \quad (6)$$

Also, let K be the number of URL quotas in a particular grade that are required to fill a billet:

$$K = Q/B. \quad (7)$$

#### b. The GURL Policy Variable

Let P be the fraction of 1000 billets that will be filled by 110X subspecialtists. This parameter is an input variable set by the model user.

It is important to set a bound on the fraction of 110X officers to fill 1000 billets for two reasons. First, formation of such a policy would provide justification for the number of 110X officers to educate and later utilize as subspecialists. More importantly, it would also provide a means by which the remainder of 1000 quotas not assigned to the 110X community could be allocated to the URL 111X, 112X, 131X and 132X communities.

Now let Nj be the number of subspecialty billets from the designator corresponding to j (Table VII). Then N1 is the number 1000 subspecialty billets. The quotas required to fill these are KN1. Since a fraction, P, of these are supported by 110X quotas,

$$X11 = PKN1. \tag{8}$$

c. Direct Warfare Designators

As previosly noted, direct warfare designator subspecialty billets are filled only with officers of the corresponding primary designators. Considering this fact and the use of the 110X policy variable, the remaining unassigned quotas, based on 1000 billets and 1050 billets have yet to be assigned. These quotas are distributed based on the weighted average of the number of billets in a specific warfare community to the total number of billets in all warfare communities. Thus,

$$X23 = KN3, \tag{9}$$

$$X34 = KN4, \tag{10}$$

$$X45 = KN5, \tag{11}$$

$$X56 = KN6. \tag{12}$$

are direct warfare quotas. (1-P)KN1 represents the number of 1000 quotas that remain to be allocated. This number is multiplied with the weighted average of each warfare community to derive quotas for 1000 billets. Thus, URL 1000 quotas are distributed in the following manner:

$$X21 = \frac{N3}{N3+N4+N5+N6}(1-P)KN1, \tag{13}$$

$$X31 = \frac{N4}{N3+N4+N5+N6}(1-P)KN1, \tag{14}$$

$$X41 = \frac{N5}{N3+N4+N5+N6}(1-P)KN1, \tag{15}$$

$$X51 = \frac{N6}{N3+N4+N5+N6}(1-P)KN1. \tag{16}$$

Recall that N2 is the number of URL 1050 billets. These require quotas of KN2. These are distributed among the warfare designators in the following manner:

$$X22 = \frac{N3}{N3+N4+N5+N6} KN2, \tag{17}$$

$$X32 = \frac{N4}{N3+N4+N5+N6} KN2, \tag{18}$$

$$X42 = \frac{N5}{N3+N4+N5+N6} KN2, \tag{19}$$

$$X52 = \frac{N6}{N3+N4+N5+N6} KN2. \tag{20}$$

4. Quotas by Designators

After quota and billet inputs have been entered and the 110X policy variable, P, assigned, equations (8) through (20) are solved. Finally equations (2) through (6) are used to obtain designator quotas.

5. An Example

The following example demonstrates the effects the modeling process. Inputs used in the example are not based on actual data. Let Q be 1000 and B equal 1200. In the specific URL billet categories let N1 be 300, N2 be 150, N3 be 300, N4 be 100, N5 be 250 and N6 be 100. Finally, let P be .80.

The system of equations may be solved in this manner. From equation ( 8 ), using equation (7),

$$X1 = PKN1 = (.8)(.8333)(300) = 199.99.$$

From equations (9) through (20),

$$X21=(1-P)KN1\frac{N3}{N3+N4+N5+N6}KN2=\frac{300}{300+100+250+100}(.8333)(150)=49.99,$$

$$X22=\frac{N3}{N3+N4+N5+N6}KN2=\frac{300}{300+100+250+100}(.8333)(150)=49.99,$$

$$X23=KN3=300(.8333)=249.99,$$

$$X31=(1-P)KN1\frac{N4}{N3+N4+N5+N6}=(1-.8)(.8333)(300)\frac{100}{300+100+250+100}$$
$$=6.66.$$

$$X32=\frac{N4}{N3+N4+N5+N6}KN2=\frac{100}{300+100+250+100}(.8333)(150)=16.66,$$

$$X34=KN4=100(.8333)=83.33,$$

$$X41=(1-P)KN1\frac{N5}{N3+N4+N5+N6}=(1-.8)(.8333)(300)\frac{250}{300+100+250+100}$$
$$=16.66$$

$$X42=\frac{N5}{N3+N4+N5+N6}KN2=\frac{250}{300+100+250+100}(.8333)(150)=41.66,$$

$$X45=KN5=250(.8333)=208.32,$$

$$X51=(1-P)KN1\frac{N6}{N3+N4+N5+N6}=(1-.8)(.8333)(300)\frac{100}{300+100+250+100}$$
$$=6.66,$$

$$X52=\frac{N6}{N3+N4+N5+N6}KN2=\frac{100}{300+100+250+100}(.8333)(150)+16.66,$$

$$K56=KN6=100(.8333)=83.33.$$

After adding individual designators' flows, the following designator totals are:

$Y1 = 199.99$,

$Y2 = 319.97$,

$Y3 = 106.65$,

$Y4 = 266.65$,

$Y5 = 106.65$.

Totals may be rounded off to whole numbers.

Appendix K contains a short APL program entitled ASQD that allows inputs to be entered interactively. It provides a means by which subspecialty managers may enter inputs and derive quota outputs for URL quotas by designator, by grade level, either in the aggregate or by subspecialty. Use of this computer-based program allows managers to derive quotas without extensive knowledge of modeling.

## C. FORECASTING WITH THE MODEL

The model put forth to allocate URL quotas by designator is an algorithmic solution to a real-world problem. This model cannot operate, however, without input derived from human decisions based on policy tradeoffs, made prior to its implementation.

The model described in this chapter works on the assumption that specific policy regarding the proportion of

1000 subspecialty billets that will be targeted for 110X subspecialists has been determined. Failure to provide this significant information restricts operation of the model. Producing policy on this issue, however, raises very real implications in the greater operation of the subspecialty system and equity among internal URL communities.

1. An Issue of Fairness

a. The GURL Policy Variable

(1) Implications for the GURL Community. The parameter P enables quotas to be derived based on a clearly understood schematic, which heretofore, has not been the case. It implies that subspecialty managers and GURL community managers will jointly monitor policy objectives to ensure that GURL utilization is in compliance with the predetermined parameter by which quotas are derived.

Determination of the parameter would impart to GURL community managers official validation and clear understanding of the extent of GURL participation in the subspecialty system. It also furnishes a means by which sensitivity analysis can be performed in regard to the impact of varying degrees of GURL participation on the system. A policy of this nature, represented by the parameter, could also provide increased career opportunities to a URL community whose mission and scope continues to evolve.

As 1000 subspecialty billets have traditionally been assigned on a first-come, first-served basis across URL communities, bounding the extent of GURL opportunity to fill 1000 billets presents some special problems for the rest of the URL, however.

(2) <u>URL Warfare Communities</u>. Formation of a policy to delineate the proportion of the 110X community to fill 1000 subspecialty billets also provides a means by which quotas, based on these billets, may be allocated to officers in URL warfare designators.

Various subspecialties are composed of large numbers of 1000 billets while others, mostly supported by curricula of an operational nature, contain very few. For instance, the Financial Management XX31 subspecialty contains 28 lieutenant commander P-coded subspecialty billets. Twenty-three of these are P-coded 1000 billets, available to any qualified URL XX31 subspecialist whose assignment window corresponds the billets' availability. The Anti-submarine Warfare XX44 subspecialty contains 210 P-coded lieutenant commander subspecialty billets, 10 of which are 1000 billets.

This creates a special problem in that various curricula that suport the subspecialty system are more "in demand" than others. For instance, the Financial Management and Computer Science constrained quotas are extremely competitive and tend to be filled as soon as they become available.

Another potential problem exists in that all Navy-educated subspecialists seek to obtain proven subspecialist status represented by the "Q" code. The standing is career enhancing and opens opportunities in significant subspecialty billets at senior ranks. GURL officers, filling a significant portion of 1000 billets, particularly in subspecialties where the majority of the billets are coded 1000, could effectively hamper the ability of officers in URL warfare designators to acquire such status.

Implementation of the model requires careful preplanning to arrive at a GURL policy variable. Use of the parameter, however, allows graduate education quotas to be easily assigned across URL communities in a consistent manner.

# VI. FINDINGS AND CONCLUSIONS

## A. MATCHING CRITERIA

Development of the matching criteria presented in Chapter III presents an initial step in documenting what constitutes related subspecialty fields. This criteria may be of direct use to subspecialty managers and detailers in their efforts to place subspecialists when billet availability and the individual officer's assignment window do not correspond.

## B. THE EFFECTS OF SHRINKING SUBSPECIALTY CATEGORIES

The number of annual fully-funded Navy graduate education quotas required for subspecialty system maintenance is not significantly reduced by decreasing subspecialty categories. Use of the most drastic scenario, in which any fully-funded graduate can fill any P-coded subspecialty billet, still requires inputs of officers far above those which the Navy can currently afford to educate or convince to pursue graduate studies.

## C. SUBSPECIALTY REQUIREMENTS

The number of annual quotas required to maintain the subspecialty system at an optimal level of manning is a matter of fact. Requirements continue to increase due to implementation of weapons systems whose technological framework broadens each year. To maintain the subspecialty system, steady-state subspecialty inventories should exceed subspecialty billets by a factor or 2.4 to 1 (15,295 requirements to 6182 billets). The Navy cannot maintain steady-state requirements so long as the conditions that militate against filling unconstrained quotas exist, namely the lack of funds to educate the necessary numbers of officers; the shortage of officers to fill operational commitments at sea; and the perception of officers that two years spent in graduate study will lessen their competitiveness with peers, thereby inhibiting their desire for full-time graduate study.

## D. MODELING URL QUOTAS BY DESIGNATOR

A URL graduate education quota model based on mathematical algorithms cannot automatically yield optimal solutions. Important policy decisions, to be used as parameters, must be made.

In using the model presented in this thesis the proportion of GURL subspecialists who will fill 1000 subspecialty billets is a crucial input. A policy variable of this nature allows subspecialty managers to derive GURL quotas. It also permits sensitivity analysis on the most efficient proportion of GURL officers to maintain in the system.

# APPENDIX A

## U.S. NAVY SUBSPECIALTY CODING STRUCTURE

### SUBSPECIALTY CODE FUNCTIONAL FIELDS

20XX Public Affairs
30XX Intelligence
40XX Naval Warfare
50XX Command and Control
60XX Plans and Programs
70XX Political-Military/Strategic Planning
80XX Material Support
81XX Logistics
82XX Material Systems
83XX RDT&E
90XX Manpower/Personnel

### EDUCATION/EXPERIENCE SUFFIX

C Ph.D. (level of education) and proven subspecialist*
D Ph.D. (level of education)
M Engineer's Degree and proven subspecialist*
N Engineer's Degree
P Master's Degree
Q Master's Degree and proven subspecialist*

*A proven subspecialist requirement applies to URL officer billets, LCDR and CAPT only. Billets must satisfy criteria for assignment of graduate education level codes as well as establishing need for previous superior performance in billets at the same level of education.

### EDUCATIONAL/SKILL FIELDS

PUBLIC AFFAIRS
XX10 Public Affairs

INTELLIGENCE
XX15 Intelligence
XX16 Joint Intelligence
XX17 Scientific/Technical Intelligence

POLITICO/MIL STRATEGY
XX20 Gen Political Science
XX21 Middle East/Africa/Asia
XX22 Far East/Pacific/Asia
XX23 Western Hemisphere
XX24 Europe
XX25 International Negotiations
XX26 Strategic Planning (General)
XX27 Strategic Planning (Nucl)

MANAGEMENT
XX30 Management (General)
XX31 Financial Management
XX32 Material Management
XX33 Manpower, Personnel Training Analysis
XX34 Logistics Management
XX35 Transportation Management
XX36 Manpower & Personnel
XX37 Education & Training Management
XX38 Human Resource Management

**SUBSPECIALTY CODE FUNCTIONAL FIELDS**

ENVIRONMENTAL SCIENCE
XX47 Geophysics
XX48 Meteorology
XX49 Tactical Environ Support

NAVAL SYSTEMS ENGINEERING
XX50 Nav Systems Eng (General)
XX51 Nav Construction & Eng

XX52 Nuclear Engineering
XX53 Nuclear Propulsion Plant Operatons
XX54 Naval/Mechanical Eng
XX55 Electronic Engineering
XX56 Underwater Acoustics

WEAPONS ENGINEERING
XX60 Weapons Eng (General)
XX61 Weps Systems Eng
XX62 Chemistry
XX63 Weps Systems (Physics)
XX67 Nuclear Physics (Weapons Effects)
XX68 Strategic Weapons (FBM)
XX69 Strategic Navigation (FBM)

AERONAUTICAL SYSTEMS ENG
XX70 Aero Systems Eng (Gen)
XX71 Aeronautical Engineering
XX72 Avionics
XX73 Flight Perf/Test Pilot
XX75 Space Systems (General)
XX76 Space Systems Operations
XX77 Space Systems Engineering

**EDUCATIONAL/SKILL FIELDS**

APPLIED LOGIC
XX40 Applied Logic (Gen)
XX41 Applied Mathematics
XX42 Operations Analysis
XX43 Operations Logistics

OPERATIONS SYSTEM TECH
XX44 Antisubmarine Warfare
XX45 Command, Control, Commun.
XX46 Electronic Warfare

LEGAL
1200 Legal (General)
1201 Miliary Justice (Adv)
1203 International Law
1204 Taxation
1205 Forensic Science
1206 Labor Law
1207 Environmental Law

SUPPLY
1300 Supply Management (Gen)
1301 Supply Acquisition/Distribution
1302 Inventory Control
1304 Material Movement
1305 Retailing
1306 Procurement
1307 Petroleum Management
1308 Subsistence Technology

| <u>SUBSPECIALTY CODE FUNCTIONAL FIELDS</u> | <u>EDUCATIONAL/SKILL FIELDS</u> |
|---|---|
| COMMUNICATIONS | RELIGION |
| XX80 Communications (General) | 1400 Management and Admin |
| XX81 Communications Engineering | 1410 Homiletics, Liturgy & Church Music |
| XX82 Communications Systems Technology | 1420 Religious Education |
| | 1430 Religion in Culture |
| COMPUTER TECHNOLOGY | 1440 Pastoral Counseling |
| XX90 Computer Technology (Gen) | 1450 Ethics |
| XX91 Computer Science | 1460 Training and Education Management |
| XX95 Computer Systems Technology | 1470 Ecclesiastical Communications Management |
| | |
| CIVIL ENGINEERING | |
| 1100 Civil Enginering (Gen) | |
| 1101 Facilities Engineering | |
| 1102 Petroleum Engineering | |
| 1103 Ocean Engineering | |

# APPENDIX B

## DEFINITIONS OF GRADUATE EDUCATION STEADY-STATE QUOTA MODEL OUTPUTS

Subspecialty Billets: Billets validated by Subspecialty Review Board that require incumbents with graduate education in specific subspecialty fields.

Subspecialty Current Inventory: The current inventory of subspecialists entered into the model.

Unconstrained Quota: The annual input of officers to graduate education to maintain the subspecialty system at optimal manning.

Steady-State Inventory: The inventory of postgraduates required to fill all subspecialty billets.

Inventory Constrained Quota: The annual input of officers to graduate education to maintain the steady-state of subspecialists as corrected for inventory shortages and surpluses.

Laterals: Officers who have received a graduate degree leading to subspecialist designation through self-funded study.

Lateral Constrained Quota: The Unconstrained Quota corrected for laterals.

Constrained Quota: The original quota proportionately adjusted down to an arbitrarily set level.

Steady-State Constrained Inventory: Inventory of subspecialists available to meet validated requirements in the steady-state if graduate education quotas continue to be met at the arbitarily set level.

## APPENDIX C

## GRADUATE EDUCATION STEADY-STATE QUOTA MODEL COMPUTATIONAL FACTORS

1. ALPHA. Fraction of officers entering graduate education to meet a future billet requirement in rank i, who are still in the Navy and eligible to meet that requirement when it occurs.

2. BETA. Fraction of those available to serve a P-coded tour in rank i who get to serve such a tour.

3. GAMMA. Fraction of those serving a P-coded billet in rank i who serve in a P-coded tour in rank i+1.

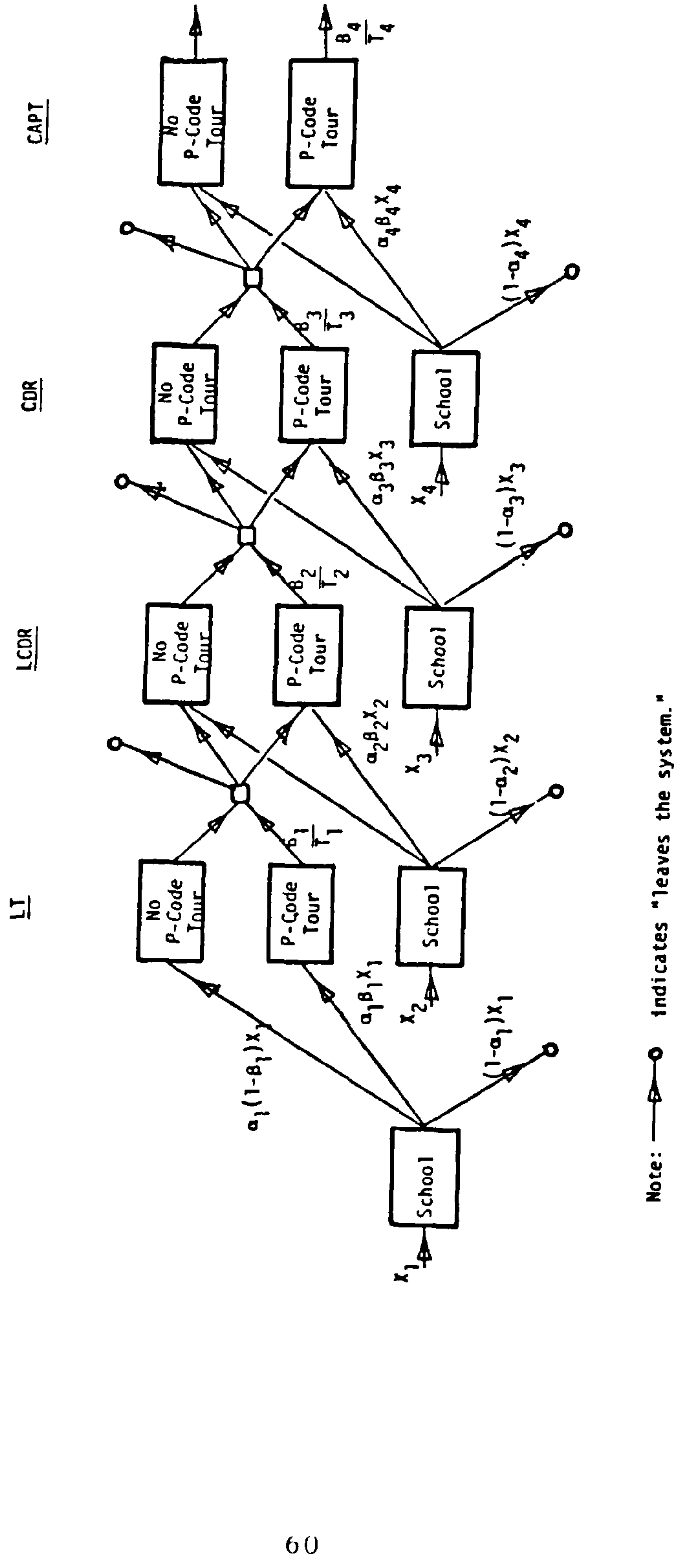
4. Promotion Flow Point. Years of service an officer typically has at promotion to the next highest grade.

5. Promotion Rate. Historical rate of selection by selection boards.

6. Tour Length. Total time spent in all utilization tours in one grade. These times are obtained from typical career patterns which indicate the anticipated timing and frequency of utilization tours.

7. Time in Grade. The time an officer typically spends in each grade. A continuation rate of 100 percent for four years after graduation is assumed due to obligated service of fully-funded subspecialists, then normal continuation rates apply thereafter for "due course officers". [Ref. 7: pp. 1-1, 1-2]

APPENDIX D
GRADUATE EDUCATION STEADY-STATE
QUOTA MODEL FLOW DIAGRAM



# APPENDIX E
# FY 1988 GRADUATE EDUCATION STEADY-STATE QUOTA MODEL FACTORS

| | ALPHA | | | | BETA | | | | GAMMA | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CDR | LCDR | LT | LTJG | CDR | LCDR | LT | LTJG | CDR | LCDR | LT | LTJG |
| URL | .60 | .70 | .80 | .95 | .83 | .74 | .70 | .70 | .30 | .59 | .58 | |
| STAFF | .50 | .60 | .80 | .95 | .98 | .98 | .98 | .90 | .37 | .66 | .88 | |
| RL | .60 | .75 | .85 | .95 | .68 | .96 | .95 | .88 | .40 | .65 | .85 | |

TOUR LENGTH

| | CAPT | CDR | LCDR | LT |
|---|---|---|---|---|
| URL | 3.6 | 2.7 | 2.5 | 2.5 |
| STAFF | 4.5 | 3.8 | 3.7 | 2.0 |
| RL | 5.3 | 5.2 | 4.6 | 4.0 |

TIME IN GRADE

Rank at Graduation

| | | CDR | LCDR | LT | LTJG |
|---|---|---|---|---|---|
| URL | LT | | | 3.0 | 4.9 |
| | LCDR | | 4.0 | 4.8 | 3.5 |
| | CDR | 4.0 | 2.7 | 1.9 | 1.9 |
| | CAPT | 2.2 | 1.1 | .1 | 1.1 |

| | | CDR | LCDR | LT | LTJG |
|---|---|---|---|---|---|
| STAFF | LT | | | 3.0 | 4.7 |
| | LCDR | | 4.0 | 4.4 | 3.65 |
| | CDR | 4.0 | 3.4 | 2.4 | 2.0 |
| | CAPT | 1.7 | 1.0 | 1.0 | 1.0 |

| | | CDR | LCDR | LT | LTJG |
|---|---|---|---|---|---|
| RL | LT | | | 3.0 | 4.7 |
| | LCDR | | 4.0 | 5.2 | 4.3 |
| | CDR | 4.0 | 3.2 | 2.7 | 2.2 |
| | CAPT | 2.0 | 1.0 | 1.0 | 1.0 |

PROMOTION FLOW POINT

| URL | | | | RL | | | | STAFF | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CAPT | CDR | LCDR | LT | CAPT | CDR | LCDR | LT | CAPT | CDR | LCDR | LT |
| 21 | 15 | 10 | 4 | 22 | 16 | 10 | 4 | 22 | 16 | 11 | 4 |

PROMOTION RATE

| URL | | | | RL | | | | STAFF | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CAPT | CDR | LCDR | LT | CAPT | CDR | LCDR | LT | CAPT | CDR | LCDR | LT |
| .50 | .70 | .80 | .95 | .55 | .80 | .85 | .95 | .60 | .75 | .80 | .95 |

# APPENDIX F

## APL MODIFYING CURRCOMB PROGRAM

```
      ∇CURRCOMB[⎕]∇
[0]   CURRCOMB;N;NN;TCV;CTCV;VV
[1]    NN←N←ρTCV←CURRV
[2]    CM←(0,N)ρ0
[3]    CCM←(0,N)ρ0
[4]   L1:'CURR: ',,⍕X←1↑TCV
[5]    VV←Nρ0
[6]    CTCV←NNρ1
[7]    'EQUIVS? '
[8]    VV[CURRV⍳V←,⎕]←1
[9]    CM←CM,[1]VV
[10]   VV←Nρ0
[11]   VV[CURRV⍳X]←1
[12]   CCM←CCM,[1]VV
[13]   CTCV[TCV⍳V]←0
[14]   NN←ρTCV←CTCV/TCV
[15]   →(NN≠0)ρL1
```

# APPENDIX G

## GRADUATE EDUCATION STEADY-STATE QUOTA MODEL
## UNCONSTRAINED QUOTA OUTPUT - NO MATCHING USED

UNCONSTRAINED QUOTA

| CODE | URL | | | | RL | | | | STAFF | | | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CDR | LCDR | LT | LTJG | CDR | LCDR | LT | LTJG | CDR | LCDR | LT | LTJG | |
| 10 | | | | | | 6 | 3 | | | | | | 9 |
| 16 | | | 2 | 2 | | 2 | 2 | 1 | | | | | 9 |
| 17 | | | 8 | 2 | 1 | 1 | 2 | 3 | | | | | 19 |
| 21 | 1 | 2 | 1 | | | | | 1 | | | | | 5 |
| 22 | 2 | 4 | | | | | | | | | | | 6 |
| 23 | 1 | 2 | 2 | | | | | | | | | | 5 |
| 24 | 3 | 2 | 2 | | | 1 | | | | | | | 8 |
| 25 | 2 | 4 | 2 | | | | | | | | | | 8 |
| 26 | 1 | 9 | 4 | | | | | | | | | | 14 |
| 27 | 5 | 1 | 8 | | | | | | | | | | 15 |
| 31 | 9 | 20 | 17 | 2 | 1 | | 2 | | | 19 | 24 | 5 | 99 |
| 32 | | | 4 | | | 5 | 3 | | 3 | | 9 | 1 | 25 |
| 33 | | 14 | 28 | 10 | | 1 | | | | | 3 | 2 | 58 |
| 35 | 5 | 4 | 1 | | | | | | | | | | 10 |
| 37 | 7 | | 22 | 2 | | | 1 | | | | | 2 | 34 |
| 39 | | | 12 | 1 | | | | | | | | | 13 |
| 42 | | 5 | 56 | 6 | | | | 1 | | | 4 | 1 | 73 |
| 43 | | 5 | 6 | | | | | | | | | | 11 |
| 44 | | | 86 | 8 | | | | | | | | | 94 |
| 45 | 1 | | 8 | 2 | | | | | | | | | 11 |
| 46 | | | 15 | 7 | | | 2 | 1 | | | | | 25 |
| 47 | | | | | | | 10 | 23 | | | | | 33 |
| 49 | | | 22 | 13 | | | | | | | | | 35 |
| 51 | | | | | 1 | 10 | 11 | 12 | | | | | 34 |
| 52 | | | | | | | | 8 | | | | | 8 |
| 54 | | | 34 | 1 | | | 22 | 16 | | | | | 73 |
| 55 | | | 31 | 1 | 7 | 5 | 15 | 7 | | | | | 66 |
| 56 | 6 | 4 | 7 | 1 | 1 | 1 | 2 | 1 | | | | | 23 |
| 61 | 2 | | 31 | | | | 9 | 5 | | | | | 47 |
| 62 | | | 3 | 2 | 3 | 1 | 1 | | | | | | 10 |
| 63 | 3 | | 4 | 4 | | 1 | 1 | | | | | | 13 |
| 67 | 12 | 7 | 8 | 3 | | | 1 | | | | | | 31 |
| 71 | 5 | 1 | 18 | 2 | 1 | 11 | 11 | 1 | | | | | 50 |
| 72 | | | 19 | 1 | | 2 | 10 | | | | | | 32 |
| 76 | 1 | | 7 | 1 | | | | 1 | | | | | 10 |
| 77 | 1 | | 4 | 1 | | | 4 | 2 | | | | | 12 |
| 81 | 7 | 5 | 3 | 1 | | | 3 | 1 | | | | | 20 |
| 82 | 1 | | 21 | | | | | 1 | | | | | 23 |
| 91 | | | 23 | 3 | | | 2 | 4 | | | | | 32 |
| 95 | | 1 | 35 | 15 | | | 2 | 3 | | 3 | 2 | 10 | 71 |
| 1101 | | | | | | | | | | | 37 | 41 | 78 |
| 1102 | | | | | | | | | 42 | | | 1 | 43 |
| 1103 | | | | | | | | | | 10 | | 4 | 14 |

| | CDR | LCDR | LT | LTJG | CDR | LCDR | LT | LTJG | CDR | LCDR | LT | LTJG | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1201 | | | | | | | | | | 10 | | 4 | 14 |
| 1203 | | | | | | | | | 2 | 10 | 4 | 1 | 17 |
| 1204 | | | | | | | | | | 4 | 3 | 1 | 8 |
| 1205 | | | | | | | | | | 1 | 5 | 1 | 7 |
| 1206 | | | | | | | | | | | 5 | | 5 |
| 1207 | | | | | | | | | | | 2 | | 2 |
| 1301 | | | | | | | | | 4 | 14 | 5 | 2 | 25 |
| 1302 | | | | | | | | | | 3 | 7 | 1 | 11 |
| 1304 | | | | | | | | | | 6 | 3 | | 9 |
| 1305 | | | | | | | | | 1 | 13 | | | 14 |
| 1306 | | | | | | | | | 1 | 22 | 14 | 5 | 42 |
| 1307 | | | | | | | | | | 4 | 2 | 2 | 8 |
| 1308 | | | | | | | | | | | 1 | | 1 |
| 1400 | | | | | | | | | | | | 1 | 1 |
| 1410 | | | | | | | | | | | 9 | | 9 |
| 1420 | | | | | | | | | | | | 9 | 9 |
| 1430 | | | | | | | | | | | 1 | 2 | 3 |
| 1440 | | | | | | | | | | | | 19 | 19 |
| 1450 | | | | | | | | | | 3 | | 1 | 4 |
| 1460 | | | | | | | | | | 1 | | | 1 |
| 1470 | | | | | | | | | | | | 1 | 1 |
| TOT | 77 | 99 | 554 | 92 | 15 | 47 | 119 | 92 | 53 | 113 | 140 | 113 | 1505 |

# APPENDIX H
## GRADUATE EDUCATION STEADY-STATE QUOTA MODEL UNCONSTRAINED QUOTA OUTPUT USING THE HIGH SIMILARITY MATCHING MATRIX

| UNCONSTRAINED QUOTA CODE | URL CDR | URL LCDR | URL LT | URL LTJG | RL CDR | RL LCDR | RL LT | RL LTJG | STAFF CDR | STAFF LCDR | STAFF LT | STAFF LTJG | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | | | | | | 6 | 3 | | | | | | 9 |
| 16 | | | 2 | 2 | | 2 | 2 | 1 | | | | | 9 |
| 17 | 2 | | 8 | 2 | 1 | 1 | 2 | 3 | | | | | 19 |
| 21 | 2 | 6 | 1 | | | | | 1 | | | | | 10 |
| 23 | 1 | 2 | 2 | | | | | | | | | | 5 |
| 24 | 3 | 2 | 2 | | | 1 | | | | | | | 8 |
| 25 | 2 | 4 | 2 | | | | | | | | | | 8 |
| 26 | 6 | 10 | 12 | 1 | | | | | | | | | 29 |
| 31 | 15 | 22 | 22 | 2 | 1 | 3 | 5 | | | 28 | 43 | 7 | 148 |
| 33 | | 14 | 28 | 10 | | 1 | | | | | 3 | 2 | 58 |
| 37 | 7 | | 22 | 2 | | | 1 | | | | | 2 | 34 |
| 39 | | | 12 | 1 | | | | | | | | | 13 |
| 42 | | 10 | 62 | 6 | | | | 1 | | | 4 | 1 | 84 |
| 44 | | | 86 | 8 | | | | | | | | | 94 |
| 45 | 3 | | 36 | 3 | | | | 3 | | | | | 45 |
| 46 | | | 15 | 7 | | | 2 | 1 | | | | | 25 |
| 47 | | | 22 | 13 | | | 10 | 23 | | | | | 68 |
| 51 | | | | | 1 | 10 | 11 | 12 | | | | | 34 |
| 52 | | | | | | | | 8 | | | | | 8 |
| 54 | | | 34 | 1 | | | 22 | 16 | | | | | 73 |
| 55 | 6 | 1 | 34 | 2 | 7 | 4 | 17 | 8 | | | | | 79 |
| 56 | 6 | 4 | 7 | 1 | 1 | 1 | 2 | 1 | | | | | 23 |
| 61 | 5 | | 35 | 4 | | | 11 | 5 | | | | | 60 |
| 62 | | | 3 | 2 | 3 | 1 | 1 | | | | | | 10 |
| 63 | 3 | | 4 | 4 | | 1 | 1 | | | | | | 13 |
| 67 | 12 | 7 | 8 | 3 | | | 1 | | | | | | 31 |
| 71 | 4 | | 38 | 3 | 1 | 12 | 21 | 1 | | | | | 80 |
| 77 | 1 | | 4 | 1 | | | 4 | 2 | | | | | 12 |
| 91 | | | 23 | 3 | | | 2 | 4 | | | | | 32 |
| 95 | | 1 | 35 | 15 | | | 2 | 3 | | 3 | 2 | 10 | 71 |
| 1101 | | | | | | | | | | | 37 | 41 | 78 |
| 1102 | | | | | | | | | 42 | | | 1 | 43 |
| 1103 | | | | | | | | | | 10 | | 4 | 14 |
| 1201 | | | | | | | | | 2 | 10 | 4 | 1 | 17 |
| 1203 | | | | | | | | | | 4 | 3 | 1 | 8 |
| 1204 | | | | | | | | | | | | | |
| 1205 | | | | | | | | | | 1 | 5 | 1 | 7 |
| 1206 | | | | | | | | | | | 5 | | 5 |
| 1207 | | | | | | | | | | | 2 | | 2 |
| 1301 | | | | | | | | | 4 | 14 | 5 | 2 | 25 |
| 1305 | | | | | | | | | 1 | 13 | | | 14 |
| 1306 | | | | | | | | | 1 | 22 | 14 | 5 | 42 |
| 1307 | | | | | | | | | | 4 | 2 | 2 | 8 |
| 1308 | | | | | | | | | | | 1 | | 1 |

| | CDR | LCDR | LT | LTJG | CDR | LCDR | LT | LTJG | CDR | LCDR | LT | LTJG | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1400 | | | | | | | | | | | | 1 | 1 |
| 1410 | | | | | | | | | | | 9 | | 9 |
| 1420 | | | | | | | | | | | | 9 | 9 |
| 1430 | | | | | | | | | | | 1 | 2 | 3 |
| 1440 | | | | | | | | | | | | 19 | 19 |
| 1450 | | | | | | | | | | 3 | | 1 | 4 |
| 1460 | | | | | | | | | | 1 | | | 1 |
| 1470 | 75 | 83 | 555 | 92 | 15 | 47 | 119 | 93 | 50 | 113 | 140 | 113 | 1490 |

APPENDIX I

GRADUATE EDUCATION STEADY-STATE QUOTA MODEL UNCONSTRAINED QUOTA OUTPUT
USING THE MEDIUM SIMILARITY MATCHING MARIX

UNCONSTRAINED QUOTA

| CODE | URL | | | | RL | | | | STAFF | | | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CDR | LCDR | LT | LTJG | CDR | LCDR | LT | LTJG | CDR | LCDR | LT | LTJG | |
| 10 | | | | | | 6 | 3 | | | | | | 9 |
| 16 | | | 2 | 2 | | 2 | 2 | 1 | | | | | 9 |
| 17 | 2 | | 8 | 2 | 1 | 1 | 2 | 3 | | | | | 19 |
| 21 | 2 | 6 | 1 | | | | | 1 | | | | | 10 |
| 23 | 9 | 14 | 17 | 1 | | 1 | | | | | | | 42 |
| 25 | 2 | 4 | 2 | | | | | | | | | | 8 |
| 31 | 11 | 36 | 50 | 11 | | 4 | 5 | | | 50 | 60 | 15 | 242 |
| 37 | 7 | | 22 | 2 | | | 1 | | | | | 2 | 34 |
| 39 | | | 12 | 1 | | | | | | | | | 13 |
| 42 | | 10 | 62 | 6 | | | | 1 | | | 4 | 1 | 84 |
| 44 | | | 114 | 22 | | | 12 | 24 | | | | | 172 |
| 45 | 3 | | 36 | 3 | | | | 3 | | | | | 45 |
| 46 | | | 15 | 7 | | | 2 | 1 | | | | | 25 |
| 51 | | | | | 1 | 10 | 11 | 12 | | | | | 34 |
| 52 | | | | | | | | 8 | | | | | 8 |
| 54 | | | 34 | 1 | | | 22 | 16 | | | | | 73 |
| 55 | 6 | 1 | 34 | 2 | 7 | 4 | 17 | 8 | | | | | 79 |
| 61 | 20 | | 43 | 7 | | | 12 | 6 | | | | | 88 |
| 62 | | | 3 | 2 | 3 | 1 | 1 | | | | | | 10 |
| 71 | 4 | | 38 | 3 | 1 | 12 | 21 | 2 | | | | | 80 |
| 77 | 1 | 4 | 1 | | | | 4 | 2 | | | | | 12 |
| 91 | | | 23 | 3 | | | 2 | 4 | | | | | 32 |
| 95 | | 1 | 35 | 15 | | | 2 | 3 | | 3 | 2 | 10 | 71 |
| 1101 | | | | | | | | | | | 32 | 41 | 78 |
| 1102 | | | | | | | | | 42 | | | 1 | 43 |
| 1103 | | | | | | | | | | 10 | | 4 | 14 |
| 1201 | | | | | | | | | 2 | 10 | 4 | 1 | 17 |
| 1203 | | | | | | | | | | 4 | 3 | 1 | 8 |
| 1204 | | | | | | | | | | | | | |
| 1205 | | | | | | | | | | 1 | 5 | 1 | 7 |
| 1206 | | | | | | | | | | | 5 | | 5 |
| 1207 | | | | | | | | | | | 2 | | 2 |
| 1301 | | | | | | | | | 4 | 14 | 5 | 2 | 25 |
| 1305 | | | | | | | | | 1 | 13 | | | 14 |
| 1307 | | | | | | | | | | 4 | 2 | 2 | 8 |
| 1308 | | | | | | | | | | | 1 | | 1 |
| 1400 | | | | | | | | | | | | 1 | 1 |
| 1410 | | | | | | | | | | | 9 | | 9 |
| 1420 | | | | | | | | | | | | 9 | 9 |
| 1430 | | | | | | | | | | | 1 | 2 | 3 |
| 1440 | | | | | | | | | | | | 10 | 10 |
| 1450 | | | | | | | | | | 3 | | 1 | 4 |

| | CDR | LCDR | LT | LTJG | CDR | LCDR | LT | LTJG | CDR | LCDR | LT | LTJG | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1460 | | | | | | | | | | 1 | | | 1 |
| 1470 | | | | | | | | | | | | 1 | 1 |
| TOT | 67 | 72 | 555 | 91 | 13 | 41 | 119 | 94 | 49 | 113 | 140 | 113 | 1468 |

## APPENDIX J

GRADUATE EDUCATION STEADY-STATE QUOTA MODEL
UNCONSTRAINED QUOTA OUTPUT
USING THE ULTIMATE MATCHING MATRIX

NONCONSTRAINED QUOTA

| CODE | URL | | | | RL | | | | STAFF | | | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CDR | LCDR | LT | LTJG | CDR | LCDR | LT | LTJG | CDR | LCDR | LT | LTJG | |
| [illegible] | | | 774 | 96 | 8 | 18 | 118 | 93 | | 86 | 122 | 122 | 1251 |

# APPENDIX K

## APL PROGRAM ASQD USED TO ALLOCATE URL GRADUATE EDUCATION QUOTAS BY DESIGNATOR

```
      ∇ASQD[⎕]∇
[0]   ASQD
[1]   'GREETINGS'
[2]   'ENTER THE NUMBER OF BILLETS (ONE RANK ABOVE THAT IN WHICH QUOTAS WILL'
[3]   'BE DETERMINED) IN THE FOLLOWING CATEGORIES:'
[4]   '1000 1050 1110 1120 1310 1320'
[5]   BV←⎕
[6]   'ENTER THE TOTAL UNCONSTRAINED QUOTA IN THE URL RANK BEING ASSIGNED'
[7]   'QUOTAS BY DESIGNATOR:'
[8]   Q←⎕
[9]   B←+/BV
[10]  K←Q÷B
[11]  'ENTER THE FRACTION OF 1000 BILLETS TO BE FILLED BY 1100 COMMUNITY'
[12]  F←⎕
[13]  X1←P×K×BV[1]
[14]  X21←((1-P)×(K×BV[1]))×(BV[3]÷+/BV[3 4 5 6])
[15]  X22←(K×BV[2])×(BV[3]÷+/BV[3 4 5 6])
[16]  X23←K×BV[3]
[17]  X31←((1-P)×(K×BV[1]))×(BV[4]÷+/BV[3 4 5 6])
[18]  X32←(K×BV[2])×(BV[4]÷+/BV[3 4 5 6])
[19]  X34←K×BV[4]
[20]  X41←((1-P)×(K×BV[1]))×(BV[5]÷+/BV[3 4 5 6])
[21]  X42←(K×BV[2])×(BV[5]÷+/BV[3 4 5 6])
[22]  X45←K×BV[5]
[23]  X51←((1-P)×(K×BV[1]))×(BV[6]÷+/BV[3 4 5 6])
[24]  X52←(K×BV[2])×(BV[6]÷+/BV[3 4 5 6])
[25]  X56←K×BV[6]
[26]  Q1110←X21+X23+X22
[27]  Q1120←X31+X32+X34
[28]  Q1310←X41+X42+X45
[29]  Q1320←X51+X52+X56
[30]  'QUOTAS:'
[31]  'DESIGNATOR 1100'
[32]  X1
[33]  'DESIGNATOR 1110'
[34]  Q1110
[35]  'DESIGNATOR 1120'
[36]  Q1120
[37]  'DESIGNATOR 1310'
[38]  Q1310
[39]  'DESIGNATOR 1320'
[40]  Q1320
```

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