SAILOR 21:

A Research Vision to Attract, Retain, and Utilize the 21st Century Sailor

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The Challenging Environment

As a nation we have high expectations for our Armed services. We expect our forces to be the best and brightest—to be well trained, motivated, properly cared for and, above all, preeminent in warfighting. But, achieving these world-class expectations requires world-class preparation—a corps of quality people working in superb organizations, with state of the art processes, knowledge, and technology. Joint Vision (JV) 2010 acknowledges that to achieve the evolution of our Armed Forces the first priority must be recruiting and retaining high quality people.

As the Navy prepares for the next century, extraordinary challenges to sustained high levels of combat readiness loom ahead. A strong economy and lagging compensation are making it increasingly difficult to recruit the people we need. Expanding missions are increasing operating tempos and time away from home. Retention of highly skilled Sailors and officers will continue to suffer. Thirty percent crew turnover per year cripples the ability of the Fleet to train and deploy as cohesive units. Key billets often go unfilled or remain gapped for months. Stove-piped, antiquated, and often inefficient personnel management processes make responsiveness to all these problems piecemeal and difficult.

Many in Congress, the Department of Defense, and the Navy believe that if we have newer, bigger, more high-tech weapons systems, we don't need to worry about people. These new technologies may require fewer people, but those same people must be more capable, able to learn more, faster, and perform a much broader range of tasks. And while JV 2010 "recognizes that, regardless of how sophisticated technology becomes, the individual warfighter's judgement, creativity and adaptability (are key)," the Navy's ability to attract, retain, and prepare the 21st century Sailor is in doubt. Just as we need new hardware technologies to meet the challenges of the future, we must improve our manpower and personnel technologies to ensure total force readiness.

Can Science and Technology Help?

Chief of Naval Personnel (CNP) VADM Dan Oliver's Manpower and Personnel Science and Technology Vision of the Future provides a strong mandate for science and technology to help alleviate many of the current and future challenges, and provide significant, measurable contributions to personnel performance and management. The recent 1998 N091-sponsored Technology Investment Game (TIG), which focused on human resources, supplied another powerful endorsement of people-related research.[1] And while both provided compelling validation of the need for this research, neither was the right venue to lay out a comprehensive research agenda. As the Navy's manpower and personnel research laboratory, Navy Personnel Research and Development Center (NPRDC) has developed the research agenda—presented here in this SAILOR 21 document—to achieve that vision.

[1]Complete results of the Technology Investment Game (TIG) can be found on the Web at www.hq.navy.mil/n091/tigsplash.htm

A number of visionary documents are shaping defense thinking, policies, and even R&D. Documents such as JV 2010, Forward…from the Sea, and the DD-21, CVX and NSSN programs all maintain the importance of quality people in future operations. While SAILOR 21 provides a vision consistent and supportive of these broad initiatives, it also provides a comprehensive and unique view of Navy personnel in the future.

Adding to the mix is the profound change NPRDC is going through as we transition from San Diego to Millington, Tennessee, and become the Navy Personnel Research, Studies and Technology (NPRST) organization. The move and the accompanying organizational renewal have caused us to rethink every element of our business, but none more than our future research agenda. The result of our thinking is SAILOR 21—a more comprehensive, although not exhaustive—science and technology vision for "Navy people." It is, in essence, our own "Revolution in Military and Business Affairs" regarding Navy personnel. We build on the mandate of JV 2010 and the momentum created by the CNP and TIG initiatives but provide a more detailed picture of what can be realized in the future and how we can get there through a sustained, well organized, and properly resourced research program.

SAILOR 21 is organized around NPRDC's six Core Programs:

- Recruiting
- Selection and Classification
- Personnel Planning and Policy Analysis
- Distribution and Assignment
- Knowledge Management Systems
- Personnel Surveys and Program Evaluation

Our Core Programs represent areas of considerable expertise and experience in conducting research, areas of critical functional importance to the Navy, and areas rich in research opportunities. The following table illustrates the types of products or research found historically in each Core Program and contrasts them to the evolutionary or sometimes-revolutionary outcomes we expect from SAILOR 21.

Core Program	Historical Outcomes	SAILOR 21
Recruiting	**HQ Planning Models**	**Field Level Technologies**
Selection and Classification	**CAT-ASVAB**	**Multi-dimensional Classification**
Personnel Planning and Policy Analysis	**Inventory and Retention Forecasting Models**	**Personnel Battlefield Simulation**
Distribution and Assignment	**Person-Job Matching Algorithms**	**Intelligent Distribution Software Agents**
Knowledge Management Systems	**Information Delivery Systems; Decision Support Systems**	**Knowledge Management Library**
Personnel Surveys and Program Evaluation	**Paper & Pencil Surveys**	**Web-based Evaluation Tools**

The SAILOR 21 Document

In each of the six sections of SAILOR 21, we begin with the **vision** we have for that area. The vision lays down what we believe the Navy would look like in that area five to ten years from now as a result of successful R&D. After a discussion of **technical and operational challenges facing the area and emerging technologies** supporting it, the remainder of the section focuses on an **integrated research program** we think will realize the vision.

Unlike many "vision" documents that are produced with great fanfare and then lie fallow, we intend for SAILOR 21 to be an evolving, and truly "living" document. We hope that it will be the **nexus of discussion and debate for manpower and personnel research** among sponsors, customers, and scientists. We also intend for it to be a **charter or agenda** for defining and guiding manpower and personnel research for the next five to ten years. Finally, we hope SAILOR 21 will produce greater understanding of, broad advocacy for, and commitment to our program and yield the resources essential to carry it out.

We hope you will find SAILOR 21 thought-provoking and far-reaching. It represents a blend of extensive functional experience with cutting-edge knowledge of technological possibilities. To achieve the successes we anticipate, we need your support and especially your input. Please take the time to read and reflect on our vision and research agenda. Then, we would appreciate hearing your thoughts and reactions. Feel free to contact us at the numbers or addresses below.

Very Respectfully,

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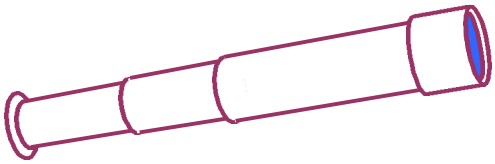
Recruiting

Vision



It's January 2009 and EM1 Jones has just reported aboard Navy Recruiting District San Diego as a Navy field recruiter. He's working face-to face with young prospects. His best friend from USS KENNEDY went to recruiting duty as well, but he's assigned to the headquarters recruiting pool in Millington. His buddy uses a sophisticated Web-based application to interact with applicants and members of the Delayed Entry Program (DEP). To be selected for the coveted and highly rewarded job of Navy recruiter, both Sailors passed rigorous personality screens and assessments of their recruiting strengths and weaknesses. Then, they attended personalized and highly interactive training courses oriented to their specific assignment and location and geared toward overcoming their weaknesses, identified during selection. Finally, they both spent time on site in Millington at the new Recruiting Training Lab, practicing their specific assignments.

Like his predecessors in field recruiting, EM1 Jones' job is to use his extroverted personality, solid sales skills, and enormous pride in the Navy to persuade young people to enlist in the Navy. Only today he is supported by an extensive array of Internet-based information services and an integrated support team. Gone is the "bag carrying" recruiter operating alone. Today, recruiters carry lightweight computers that provide a gateway to an extensive source of information useful in prospecting, sales, screening, and shipping recruits. The Recruiting Network also provides access to an extensive, experienced virtual recruiting team that offers coaching, training, and administration.

During a typical week, Jones visits several high schools, community colleges, and trade schools, as well as meeting with prospects at their homes. Using the Recruiting Network, Jones has produced on-line, customized presentations for each of his prospects. Using sophisticated financial tools he's able to make meaningful pay and benefits comparisons for specific Navy and civilian careers. As he meets with prospects he can instantaneously retrieve additional information on Navy jobs and careers and produce tailor-made electronic packages that he sends to prospects via e-mail or by posting on individual Web sites. To cap off his presentation to a new prospect, Jones plugs special virtual reality glasses into his computer and gives the prospect a "realistic job preview". The prospect gets immersed in the excitement and tension of the Combat Information Center, gets to feel and hear the pulse of an aircraft carrier flight deck, or work along side a doctor in a Navy hospital.

All prospect information, contact notes, screening results, and interests are captured in the Recruiting Network. Prospecting information is updated daily from powerful databases using data mining technology to identify quality prospective candidates. "Cold calling" has become a thing of the past.

This afternoon, Jones will visit a prospect at his home. He's met with the candidate before and generated an interest. Today, he's administering a brief intelligence assessment test online and conducting a search for criminal violations. Within seconds, he is able to qualify the candidate. Then, he uses the Recruit Network to prepare a contract and assign a reporting date for boot camp.

Jones completes his day by using the Recruiting Network to access the Recruiting Training Lab. He works through some advanced sales skill lessons and then consults with a "mentor" via video connection on how to handle a resistant prospect.

Meanwhile, back at headquarters, Jones' friend interacts by video with prospects who visit the Navy recruiting site. Other members of his team develop highly individualized advertising packages to be sent electronically to specific prospects.

An Introduction to Navy Recruiting

The primary mission of the Navy Recruiting Command is to enlist high quality young men and women into the Navy. Approximately 4,000 Navy recruiters recruit 45,000-55,000 young people to join the active duty Navy each year.

The recruiting process encompasses all activities from generating initial interest in the Navy to sending a recruit off to boot camp. However, most emphasis is placed on the recruiter's initial contact with a prospect and getting the prospect to sign an enlistment contract. In between, recruiters generate leads and contact potential applicants, select and classify prospects, and process the applicant into a recruit.

Like large sales organizations, recruiting requires a certain amount of management and support. But, the most important asset is the salesperson who generates business. In recruiting, the field recruiter is the salesman and his sales goal is to produce a certain number of qualified enlistees.

Currently, 60 percent of recruiters volunteer for recruiting duty. Enlisted persons can volunteer for recruiting duty or be recruited by the Commander, Navy Recruiting Command (CNRC) Recruiter Screening Team. Sailors who volunteer for recruiting duty are given a duty station preference and, if available, are guaranteed recruiting duty in their location of choice. If there are not sufficient volunteers, E-4s and above who are up for orders are made available for recruiting duty and are detailed where CNRC needs recruiters. Potential recruiters are screened for body fat, financial problems, and family issues (e.g., special needs children) and their service records are evaluated for moral or criminal transgressions (e.g. driving under the influence violations).

Prospective recruiters spend four weeks in the Enlisted Naval Recruiting Orientation (ENRO) curriculum. Here, recruiters review Navy core values (Honor, Courage, and Commitment) and are taught basic sales skills. Recruiters are also given laptop computers and basic computer orientation/RTOOLS (the CNRC legacy prospecting software) training. When a recruiter reports to his recruiting station, he or she is supposed to work with the other recruiters as a team to achieve the station goal. However, team recruiting is a relatively new concept that is slowly being integrated into the process.

The current incentive system for recruiters is a mix of individual and team incentives. The primary team incentive is an award (Navy and Marine Corps Achievement Medal, Navy Commendation Medal) for station production. Advancement awards (promotion to the next pay grade) are given at the individual level and are based on individual performance and

contribution to station production (but are very limited). CNRC advocates other incentives such as 24-hour liberty or lunch with the Admiral for team success.

The Current Recruiting Environment

Recruiting qualified young people to join the Navy has been particularly difficult recently. Strong economic growth and low unemployment nationwide coupled with an increasing propensity for young people to attend college have resulted in failure to make accession goals. A strong economy also reduces retention at all rates and ranks, exacerbating the recruiting problem.

When recruiting is more difficult, recruiters have to work longer hours under more stressful conditions to meet their objectives. Consequently, their quality of life suffers. With many recruiters coming from the Fleet to “shore duty”, the long hours and stressful work environment pose a significant morale problem.

In addition, FY99 brings another challenge to CNRC with the relocation of the headquarters command to Millington, TN; the loss of corporate knowledge; and a major restructuring of the command. While the accession mission may not increase significantly, the focus on recruit quality, rebuilding the headquarters command, and favorable economic conditions will assure continued challenges for CNRC and the Navy into the next century.

Technological Advances in Support of Research

Improvements in Computing and Visual Display

Increases in computing capacity and reductions in the cost of computer hardware have made the use of computers by all members of CNRC feasible. The computers can support more sophisticated software programs to assist in recruiter selection as well as with prospecting, selecting, processing, and classifying applicants. Advances in computer audio-visual capabilities, specifically the new DVD drives that can store and display several hours of motion-picture quality video and audio data, have the potential to provide recruits with more realistic view of the Navy, boot camp, and jobs. Streaming video over the Internet provides additional audio-visual capability and does not require special drives or multiple copies of large video files.

Internet and World Wide Web

The Internet and the World Wide Web provide a unique environment for the Navy to reach its target market and recruiters. An interested young person can access detailed information on the Navy at any time in a non-threatening environment, interact with a recruiter at the headquarters recruiting pool, and apply to join the Navy—all from one location. The CNRC Web site can also include policy and training information for recruiters as well as information and training materials for recruits in the Delayed Entry Program.

Virtual Environments

Advances in computing, programming software, and audio-visual equipment have enabled the development of realistic virtual environments. One of the simplest virtual environments results from the use of 3D glasses (such as Crystal Eyes) with computer generated environments. Depending on the method used to develop the environment, users can either see a 360-degree view of the environment or actually move through the environment. A more complex virtual environment is a room-sized, high-resolution, 3D video and audio theater called a CAVE (Cave Automatic Virtual Environment). In a CAVE, the viewer is immersed in the sights and sounds of the environment. More portable, CAVE-like environments are currently being developed, but the software costs are prohibitively expensive.

For the Navy, the first type of environment would enable an applicant to view the cockpit of an airplane or the engine room on a ship. In a CAVE, the applicant would be able to fly with the aircraft or get underway with a ship. Later in the classification phase, virtual environments would enable very realistic job previews for recruits.

New Advertising Media

The proliferation of cable TV, the Internet, and changes in telephone and computer technology may create a very different environment for making contact with young people in the future. One benefit of these new advertising media is that the demographics of the users are well known, enabling CNRC to focus on the media that reach its target market.

Database Applications

Improvements in database software and advances in computing have made the development and maintenance of very large, complex databases manageable on a PC. CNRC maintains a considerable amount of data related to recruiting on production, markets, and advertising. In addition, detailed data are becoming more readily available and easier to organize, manipulate, and analyze. This data can be used to improve the recruiting process by improving market research or filtering out unqualified applicants before a lot of time and energy has been expended by recruiters.

Challenges to Overcome

Recruiter Selection, Development, and Teams

Recruiters are one of CNRC's most important resources, yet very little is known about what makes a successful recruiter. Identifying factors that contribute to recruiter performance is a challenging first step in determining who will be a successful recruiter. One way to predict recruiting success is psychological screening tests. Another is to select relevant characteristics or evaluation factors contained in a sailor's service record. However, both of these assume that the success factors can be captured by a skill assessment and/or some other measure. Finally, we must design a training environment that is flexible and enables the development of individualized training programs based on recruiter needs and weaknesses.

The ability of the Navy to accomplish its recruiting mission is dependent, in part, on teams. While teams are widely argued to be the most effective and innovative approach

to business in an increasingly complex and competitive environment, systematic controlled laboratory research on team variables has never been performed. A formal analysis of or experiment with teams in the recruiting environment has also never been performed. Finally, the recruiting team of the future is likely to consist of a recruiter in the field and a recruiter at the headquarters recruiter pool. The importance of co-location to team cohesiveness and performance should be included in any analysis of teams for recruiting.

Recruiter Incentives

CNRC is limited in what it can offer recruiters as incentives for production. Currently the command rewards successful recruiters with time off, lunch with the Admiral, awards (medals), and promotions -- anything but money. While these are all meaningful types of recognition, the incentives are very different from the rewards offered to salespeople in the private sector. For recruiting, the challenge is to identify incentives that are appropriate for recruiters or teams of recruiters (i.e., encourages performance without compromising ethics). Then, we must select and test a package of incentives that appear to have the greatest impact on productivity. If the results of experiments show that financial incentives improve recruiter and recruiting team production, the Navy would have scientific evidence to support seeking congressional approval to offer monetary incentives to recruiters.

Virtual Navy Environments in the Recruiting Process

Several technical challenges exist for the design of a realistic virtual Navy environment. The audio and visual technology is currently expensive and software development costs are high. Fidelity, spatial orientation, and motion sickness are all problems in a virtual environment. Finally, the role that a realistic job environment preview (virtual environment) plays in an individual's decision to join the Navy is unknown.

New Advertising Media and Advertising Effectiveness

Advertising is a large, visible, and important part of recruiting. The technology revolution has created many new advertising media, including cable TV, mobile kiosks, and the World Wide Web. The Navy must keep pace with technological advances and effectively utilize advertising and marketing funds. With the rapidly changing advertising environment, CNRC must be able to identify and assess emerging media, adapt the Navy's ad campaign to the media, and measure the advertising effectiveness.

CNRC Strategic Plan for Information Technology (IT) and Use of Emerging Technology

One important factor underlying the vision of recruiting is the development, funding, and execution of a CNRC strategic plan for information technology. With the increasing importance of computers and centralized electronic processing of applicants, CNRC must have a cohesive plan for hardware, software, data transfer, support, and training commensurate with existing technology and requirements for integration between widely disbursed team members. The strategic plan should pay particular attention to the Web, which will be the central site for Navy information

available to the public, applicant processing, and recruiting data. In addition, CNRC should include knowledge management systems in the strategic plan in order to preserve, catalogue, and disseminate corporate knowledge among employees.

Data Management

Two types of data are of particular interest. First, support data are collected, maintained, and used by the headquarters staff for market research, analysis, and goal-setting. Second, the headquarters recruiter pool maintains operational data. Since all processing for applicants and recruits will be done electronically (via the Internet), a system for managing recruit information in a centralized database is critical to the vision of recruiting and must be developed.

Recruiting Training Lab

In the current recruiting environment, there is no means to ease the transition of recruiters from training to recruiting duty. Having recruiters spend time at a recruiting lab after training and before reporting for recruiting duty would provide an opportunity for recruiters to ease into recruiting in a controlled environment.

In addition, it is very difficult to test new recruiting procedures or tools in the field. Since management's top priority is production, it is often difficult to field test new procedures which might be perceived as having an adverse impact on it. If experimenting with new technologies, policies, and procedures is an integral part of future research, a recruiting training lab could be a realistic way to simulate the recruiting process while retaining the focus of the majority of recruiters.

Integrated Research Agenda

Recruiter Selection, Development, Incentive System, and Teams

Basic Science Foundation

- Determine the general skills and characteristics that make a successful recruiter. Determine the desirable skills and characteristics for field recruiters and headquarters recruiters.
- Evaluate existing recruiter screening and skill assessment tools.
- Investigate the way that sales and/or human resource organizations select and train their employees and determine what, if any, corporate selection and training methods are appropriate in the Navy recruiting environment.
- Gather existing research on incentive systems for individuals and teams, in particular incentive systems in sales organizations, and determine which have had the greatest impact on productivity. Decide what mix of incentives for recruiters and/or recruiting teams is appropriate for Navy recruiting.
- Construct a series of increasingly complex experiments that examine individual preferences for team structure, dependence, and reward systems and determine how individuals are affected by these factors. Experimental subjects will also be asked to complete a short questionnaire to determine the extent to which they felt comfortable with the team configuration to which they were exposed. This survey could provide valuable information

concerning the team member's preference for team configuration.

Exploratory Development

- Using the results of the above research and knowledge of Navy recruiting, design a skill assessment tool for potential recruiters. If appropriate, design a skill assessment tool for field recruiters and another skill assessment tool for headquarters recruiters.
- Develop training regimes for relevant recruiting skills identified in the skill assessment research.
- Evaluate the selection and training methods determined to be appropriate to Navy recruiting in previous research for inclusion in a Navy recruiting selection and training process. Areas of training to be considered include sales techniques, computer instruction, and training exercises.
- Using the information obtained in prior research for successful sales organization as a baseline, design a survey that asks Navy recruiters about their incentive system preferences.
- Design the structure for a Recruiter Database that would include information on a recruiter's background, whether he or she volunteered, scores on skill assessments or psychological tests, training classes, and training performance.
- Use the above research to determine staffing preferences of individuals and the way that appropriate incentives can induce individuals to work efficiently in prescribed staffing schemes.

Advanced Development

- Using the skill assessment tool(s) for potential recruiters developed previously, design an experiment to begin administering skill assessment tool(s) as part of the recruiter selection and assignment process. Determine the usefulness, if any, of using skill assessment tools in recruiter selection.
- Develop a procedure for developing a personalized training regime for each recruiter based on the results of his or her skill assessment. Utilize training regimes for relevant recruiting skills developed in previous research to address a recruiter's deficiencies or weaknesses.
- Administer the incentive system survey designed in the above research to a small group of present and former Navy recruiters.
- Expand the Recruiter Database by combining the data elements from the previous research with field data describing the nature of assignments and information on performance. Use the database to develop screening instruments for recruiter selection. Also, determine a procedure for updating the Recruiter Database.
- Develop a prototype version of the Web-based Recruiting Network.

Recruiting Over the Internet

Basic Science Foundation

- Investigate the relationship between a recruiter and a prospect. Determine which interactions between a recruiter

and prospect must take place face to face and which interactions can occur electronically (over the Internet). Consider using an Internet camera to replace a face to face meeting.

Exploratory Development

- If previous research supports the concept, design a primarily electronic recruiting process that takes advantage of the Internet.

Advanced Development

- Test the prototype electronic recruiting process developed in previous research. Determine the effectiveness of performing recruiting tasks electronically (over the Internet).

Virtual Navy Environment

Basic Science Foundation

- Research the fidelity of virtual reality needed to depict Navy life during a recruiting session.

Exploratory Development

- Identify virtual reality applications developed for training that could be used by recruiters to show applicants what life is like in the Navy. Determine where virtual reality fits in the recruiting process.

Advanced Development

- Test the use of virtual environments that depict Navy life in the recruiting process. Determine what impact, if any, this has on a prospect's decision to join the Navy.

New Advertising Media and Advertising Effectiveness

Basic Science Foundation

- Research emerging trends in advertising, advertising costs, and measures of effectiveness. Determine which of these media might be appropriate for the audience Navy recruiting is trying to reach with its advertising.

- Determine which media, if any, are an effective vehicle for a message intended to get a "consumer" to take an action (rather than simply generating awareness).

Exploratory Development

- Using the results of the above research, select advertising media with which CNRC can experiment and develop evaluation techniques appropriate to the media. Work with an ad agency to develop a prototype advertising campaign for the selected media.

- Contract with an ad agency to develop an advertising campaign that emphasizes the Navy recruiting Web site.

Advanced Development

- Test the prototype ad campaign developed in the previous research, collect data, and determine the effectiveness. Develop a system that provides CNRC with immediate feedback on the effectiveness of advertising campaigns.

- Run the Web site ad campaign in selected markets while closely monitoring Web site hits. Determine if

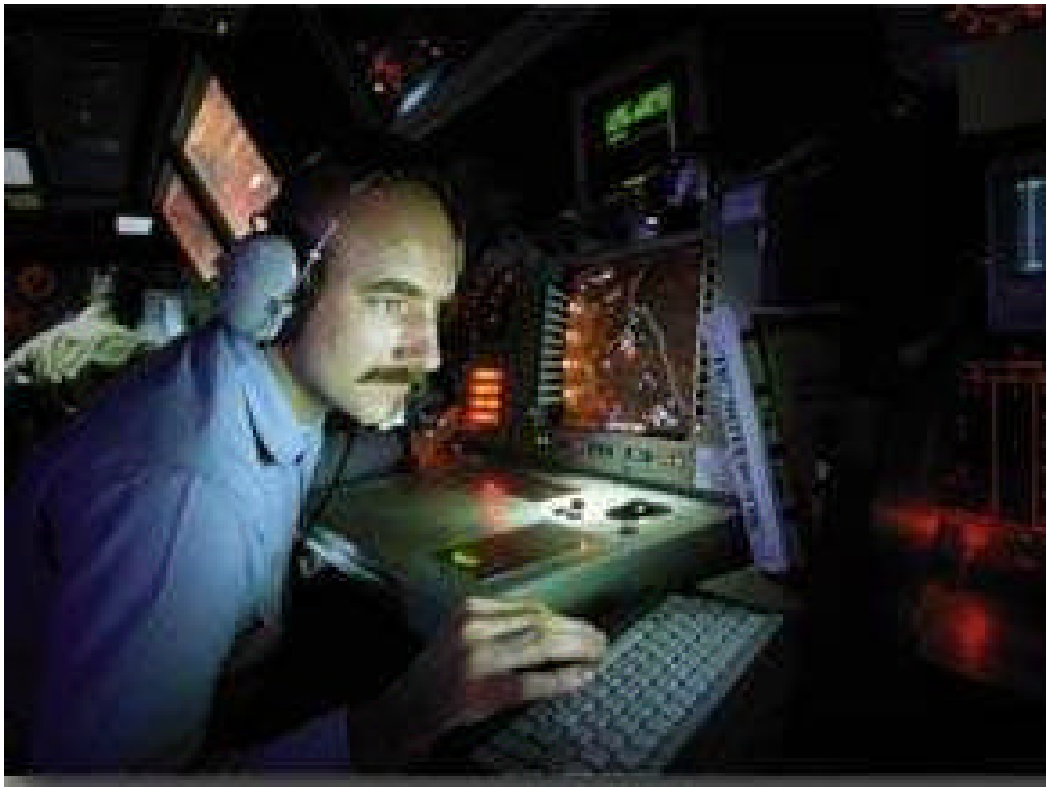
there is a change in Web site activity that is directly related to the ad campaign.

Anticipated Benefits for Navy Recruiting

An integrated research plan that targets the important components of the vision for recruiting has the potential to provide significant benefits to CNRC in the future. Improved selection and development of recruiters will produce more satisfied and productive recruiters. A recruiting training lab will ease the transition of new recruiters into recruiting duty. It will also enable testing of new recruiting practices in an environment that is independent of production and political pressures that could adversely impact an actual experiment.

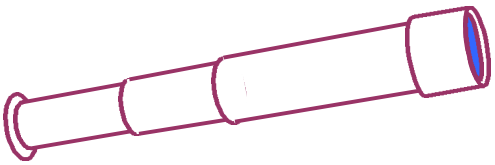
A team recruiting scenario that includes a mix of field recruiters in the communities and recruiters at a central location performing administrative functions electronically has the potential to significantly decrease the number of recruiters and recruiting stations. Advances in video will enable face-to-face contact between an applicant and a recruiter, regardless of the time and distance between them. Recruiters spend less time driving and are able to use their time more efficiently. Enhanced incentives that support this desired team structure will encourage productivity.

By using new media and technology, the Navy has the opportunity to provide more—and more realistic—information to potential recruits, thus enabling young people to make an informed choice about joining the Navy. The split team approach to recruiting will benefit applicants as they are able to glean experience and job knowledge from more than one recruiter while having access to a recruiter 24 hours a day. All of these areas working in concert will improve the applicant experience and the image of recruiting within the Navy.



Navy Personnel
Selection and Classification

Vision



To begin a Navy enlisted career today, an applicant must take a battery of tests, known as the Armed Forces Vocational Aptitude Battery or ASVAB, that covers four content domains: verbal, numerical, technical, and perceptual speed. By adding scores across tests, an applicant is qualified for service, assigned to a technical school, and enlisted into an entire Navy career—potentially in under 3 hours. This is an ideal process for recruiters; it is rapid and may require only a single contact. However, people are more complex and multidimensional than the ASVAB. People have other aptitudes, skills, and knowledge. They also have preferences, interests, and personalities. Not only are people more complex, but the schools they attend, the jobs they perform, and the organizational culture of the Navy, all require more than the modest intellectual competency currently measured.

In the 21st Century, the Navy will have fewer Sailors, each of whom will need to be more capable and better trained, will need to perform more tasks, will operate in more complex and rapidly changing environments, and under a broad variety of mission objectives. To meet manpower requirements in the 21st Century, the Navy will give applicants a brief general intelligence test and then send them to basic training where a complete personnel assessment will be performed. This more complete assessment will test for achievement, complex reasoning, spatial ability, and job specific skills, while also measuring interest, social understanding, conscientiousness, motivation, leadership, and emotional stability. The Navy will use this rich "whole person" profile to match people along a multitude of dimensions into the best-fitting Navy job available. Importantly, "best-fitting" will no longer mean the limited outcome of completing technical training. Instead, best-fitting will reflect all of the outcomes important to Sailors and the Navy. It will mean that the applicant will likely perform well in both classroom and laboratory training, will likely be proficient on the job, be reliable, work well in groups, be satisfied with the job, be promoted, and be likely to reenlist. This new, complete assessment and initial assignment system will produce an optimal match between the person and available jobs, so the Navy will end up with the type of Sailor needed to assure efficiency and readiness in the 21st Century.

Introduction to Navy Personnel Selection and Classification

The *selection* and *classification* of military personnel refers to a segment of the overall process of transforming a civilian applicant into an assignable military asset. *Recruiting* is another part of the process which encompasses the collection of activities associated with making the initial contact with a "prospect," plugging them into the qualification (or selection) process, and if qualified, having them sign an enlistment contract. *Selection* refers to the formal stage of qualifying an individual for military service. In the narrowest sense, selection refers to the intellectual qualification of an applicant (determined through cognitive tests). More generally, selection or "screening" refers to the entire qualification evaluation, including, assessing intellectual competence, and performing educational, criminal, and moral checks. (Medical screening for drug abuse, disease,

morphological integrity, adequate vision, etc., is also part of the qualification process but outside of our scope.) While the terms "selection and classification" are typically bound, they refer to logically separable processes. *Classification* is shorthand for "job classification" and refers to the collection of decisions about an applicant's job or career path after he has qualified for service. Job assignment decisions are based on information about the individual (e.g., aptitudes, skills, preferences, and experiences) in conjunction with manpower needs and training availability (typically a prioritized list of positions that need to be filled). Historically, selection was separate from classification, often using different instruments and data, and the decisions were made on distinct timelines and in different locations. For a host of reasons, selection and classification have been temporally combined, yet the processes differentially emphasize information from the same pool. When both processes perform well for the Navy, only individuals at least minimally capable of succeeding are selected, and they are assigned only to jobs where they are statistically likely to succeed. If selection is done poorly, attrition rates are high and disciplinary problems and staffing shortages often result. When classification is done poorly, the consequences are more costly and complex. School attrition is elevated; school seats are underutilized; job incumbents perform poorly, which directly affects unit and fleet readiness; and job satisfaction is low, further degrading performance while substantially reducing retention.

The primary instrument for selection and classification is the ASVAB or its computer delivered equivalent, the Computer Adaptive Test version of the ASVAB (CAT-ASVAB). All applicants for the Navy's enlisted ranks must take the ASVAB in a single session, lasting three hours (for the paper-and-pencil version, one to three hours for the computer-based version). The ASVAB test battery consists of ten[1] subtests representing four abilities or psychometric factors: Verbal Ability, Mathematical Ability, Technical Knowledge, and Perceptual Speed. Verbal ability is measured primarily by Word Knowledge (WK) and Paragraph Comprehension (PC). Mathematical Ability is measured by Arithmetic Reasoning (AR) and Mathematics Knowledge (MK), which is a good mixture of computational and problem solving. Technical Knowledge is measured by a combination of Mechanical Comprehension (MC) – pulleys, levers, gears, and the like – Automotive and Shop Information (AS), and specific Electronics Information (EI). The General Science (GS) test actually measures two constructs, Verbal and Technical Ability. Perceptual Speed is measured by Coding Speed (CS), an arbitrary number-word translation task, and Numerical Operations (NO), which is a rapid, simple computation test.

The ASVAB is used for both intellectual qualification and job classification. Four subtests (Paragraph Comprehension, Word Knowledge, Arithmetic Reasoning, and Math Knowledge) are combined and rescaled into the Armed Forces Qualification Test (AFQT). AFQT is expressed as a cumulative percentile score (1 to 99) tied to a 1980 nationally representative sample of non-institutionalized youths (ages 16-23). Congress sets the minimum AFQT qualification score. Following qualification,

[1]To be accurate, there are actually ten subtests in the paper and pencil ASVAB but eleven in CAT-ASVAB. For technical reasons, Automotive and Shop Information are separate tests in CAT-ASVAB, although the two tests are statistically combined to produce only ten subtest scores.

classification takes place by combining the individual ASVAB test scores in dozens of ways to determine in which jobs an applicant should be successful. For example, the Navy uses the sum of Numerical Operations, Coding Speed, Paragraph Comprehension, and Word Knowledge to determine if an individual has the basic skills required for clerical jobs; if the sum is above a certain level the person is statistically likely to perform well in clerical job training, otherwise they are not.

Selection and Classification Research

The majority of our recent selection and classification research has surrounded the ASVAB. We focused on qualifying the best military applicants while keeping early attrition low and statistically classifying recruits into jobs where they are most likely to succeed—all within the constraints of Navy manpower requirements and policy. Our work has had two broad thrusts. One thrust has been to improve the ASVAB. We conduct research to improve the tests or the measurement of constructs in the ASVAB, develop tests of intellectual abilities and skills not represented in the test battery, and perform research on non-intellectual measures of personality, interest, and personal history and experience to supplement the ASVAB content and improve its functioning. In this vein, we also conduct research to support the operational ASVAB and CAT-ASVAB, including field testing new items, new scoring methods, and the impact of new administration techniques, media, or equipment. Another large thrust in our work is to make full use of the information from the ASVAB. We do this by working with schools and enlisted communities to determine the combination of ASVAB tests (or "composites") most likely to predict success in training and on the job, and the minimum score (or qualifying "cut score") that should be set for composites to assure success in training.

While these research thrusts remain, we are in the midst of some profound changes in the Navy force structure. Technological modernization of the Navy in the 21st Century will only accelerate these changes. For example, the next generation Navy surface combatant (DD-21) is expected to use fewer than half the number of crewmembers deployed on current destroyers. Such a dramatic reduction in the number of personnel will radically alter the task requirements for any one Sailor and by implication, alter the content and scope of the jobs defined by current classification models. At the very least, each Sailor will be required to perform a broader range of tasks, have more sophisticated technological knowledge and skills, and will operate more independently with fewer coworkers and a truncated chain of command. This implies that current jobs will have to be redefined in light of the new requirements, and that the aptitudes, skills, and training requirements in support of these jobs will have to be reviewed to update selection and classification composites. Jobs that are largely mechanical in nature may become more electronic in the future, and thus the classification composite may need to be altered to include electronic or mathematics knowledge. Jobs with small scopes may be broadened, dramatically increasing the cognitive complexity of the position such that a generally more able Sailor will be required to minimally succeed. Jobs that now allow individuals to work in isolation, say on the internal communication system of a ship, may be recast to cover all shipboard communications, requiring the individual to work more closely with other electronics, information, and communications ratings,

and have a much broader knowledge of electronic and power systems. In general, far fewer men and women will execute a ship's mission and each one will have a much broader scope of job responsibilities, will operate in very complex information-intensive environments, make substantially more independent decisions, work better on teams for process goals, and be technologically more sophisticated than today's service members. The instruments and methods we use to identify and assign these new Sailors will have to be modified, improved, or developed from "scratch." This requirement represents our mandate and challenge for the future.

Operational Issues Affecting Selection and Classification

Two primary operational problems frustrate our advances in selection and classification research and its implementation: (1) the diffused responsibility for the selection and classification process and (2) the structure of the recruiting process. Additional operational issues are discussed following these.

Diffused responsibility for accession, selection, and classification policies

Congress sets broad constraints on the number and minimum quality of new recruits across the military and the Department of Defense (DoD) sets further policy regarding recruiting, entrance standards, and compensation. Within the Navy, the Chief of Naval Personnel (CNP) sets both constraints and accession goals, while the Commander, Navy Recruiting Command (CNRC) dictates the methods and pacing of recruiting activities. The US Military Entrance Processing Command (MEPCOM) controls the actual qualification testing, including the tests to be used; when, how, and where tests will be administered; and to some extent who can be tested and under what circumstances. DoD's Defense Manpower Data Center (DMDC) has operational and maintenance responsibility for the ASVAB and thus has a say in its content, structure, and implementation. The Office of the Under Secretary of Defense for Personnel and Readiness and several of its committees (e.g., Manpower Accession Policy Working Group and Steering Committee) also have responsibility for the make-up of the ASVAB and the content of applicant screening measures. The Chief of Naval Education and Training (CNET), in support of the CNP, sets classification and A-school qualification standards, schedules classes, and allocates placement resources. Additionally, the Navy Personnel Command (NPC) and several of its subcomponents, and the individual Fleet Commanders in Chief (CINCs) who allocate sea and shore billets, all have input and thus impact on selection and classification policies and resources. These entities often produce conflicting policies and make resource allocation decisions that complicate throughput planning and standard setting. This diffused responsibility makes it difficult to implement any change.

Although the cross-service use of the ASVAB requires DoD involvement, ideally, the Navy would have a single "czar" or organization responsible for recruiting, selecting, and classifying Sailors. This would eliminate duplicated effort, diffused responsibility, and conflicting policies, while identifying a single office that could be targeted with our efforts to implement the products of selection and classification

research. This organizational unification and reengineering is critical to the success of our research program and its expected benefits.

Fixed and limited structural model for recruiting, selection, and classification

A second major impediment to progressive change in selection and classification is the structure of the recruiting, selection, and classification processes. Current accessioning practices have been driven by recruiting goals and product-sales models, which dictate that nearly all decisions about an applicant must be made at the time of initial contact. That is, recruiters want to have people under contract as soon after meeting them as possible. With little supporting evidence, this belief has successfully limited the amount of information collected about an applicant's past behavior, personality, interests, knowledge, and intellectual capacity. Moreover, this same belief has led the military to "sell" a candidate a particular job and associated training seat at the time of qualification—a point in time so far removed from actual placement that current manpower planning systems may be inaccurate. In the extreme, based on as little as three hours of contact with a prospect, a person is qualified for service, classified into a job (potentially, an entire career path), assigned a reporting date for basic training, and guaranteed a seat in a technical training school (that may not actually be available); yet, the military entrance date may be 12 months hence.

In contrast, our goal is to evaluate the benefits of separating selection from classification decisions. We will investigate the impact of qualifying individuals for the military, perhaps assigning them to broad occupational groups, while delaying actual job assignment decisions until midway recruit training. Such a procedure would: (1) allow additional time to collect more background information (e.g., medical, driving, arrest, financial, and scholastic records) for further screening of recruits before classification decisions, (2) delay the classification decision until a point when progress in basic training could inform the decision process, and (3) allow the Navy to perform further psychological testing (e.g., emotional stability, interest, intellectual, and job/skill specific testing) to increase the amount of information available to support assignment decisions. Moreover, these assignment decisions would be made at a point in time when (a) the recruit is very likely to successfully complete basic training and (b) very accurate information would be available for assigning recruits to existing jobs and training seats.

Environmental Changes Affecting Selection and Classification

The military force structure is expected to change rapidly during the technological modernization for the 21st Century. In some cases, it is estimated that less than one-half the number of crewmembers will be required on similar platforms in the future. Such a dramatic reduction in the number of personnel will radically alter the task requirements for any one Sailor, and each Sailor will have to operate in a more complex, information-rich, technologically sophisticated environment. The new Sailor will have to be process-oriented and less task-oriented. Where in the past, a Sailor might take and relay telemetry readings, he will now take the telemetry readings, verify them against targeting information, determine whether the projectile is ready by

checking with other fire-control team members, and release it. This shift away from isolated task performance will by implication, alter the content and scope of the jobs defined by current classification models. In the past, the Navy was able to select individuals based on isolated, component abilities, so it was sufficient to select a person who could read, perform arithmetic, and identify common electronic devices. In the future, a Sailor will need to be able to read, process, and act upon the numerical output from several electronic monitoring systems, and have the ability to coordinate the information toward a goal. This flexible coordination of information will likely be a more critical ability than competence in the isolated skills. Currently, we have good selection and classification tools for the component skills but we have no instruments designed to measure competency in the flexible use of multiple sources of information.

At the very least, each Sailor will be required to perform a broader range of tasks, have more sophisticated technological knowledge and skills, and will operate more independently with fewer coworkers, and in a flatter command structure. Jobs will become more complex, require more mathematical and electronic knowledge, have very broad scopes, and demand greater flexibility. This implies that current jobs will have to be redefined in light of the new requirements, and that the aptitudes, skills, and training requirements for the new jobs will have to be evaluated to develop appropriate selection and classification composites. It is very likely we will find that for many of the jobs in the future, we will not have instruments that measure the underlying skills, and they will have to be developed.

Currently, virtually all predictive validation work has focused on finishing basic training, successful completion of A-school, or, more rarely, job performance in the first-term of enlistment. Because the cost of finding and training a 21st Century Sailor will be much higher than today, we will also have to focus more of our effort to identify individuals who will not only complete training, but be successful on the job, and, importantly, be likely to stay in the Navy beyond the initial contract. The prediction of such long-term behavior as reenlistment and promotion rates will require the use of new sets of predictor variables such as measures of personality, motivation, and interest. To effectively use the variables to predict long-term performance, we will have to gain a better understanding of the work context for the future Navy, including the environmental, social, and group structural characteristics. Combining the personal and organizational characteristics may allow us to augment personnel selection models based on theories of person-organization (P-O) fit, which go beyond the usual vocational and aptitude relations. Our most difficult challenge will not be to identify measures of personality, motivation, and interest that predict long-term behavior, but to develop objective instruments for measuring these constructs that are insulated from faking, coaching, and easy misrepresentation.

Technological advances impacting selection and classification

Operational Computer Adaptive Test version of the Armed Services Vocational Aptitude Battery (CAT-ASVAB)

As of now, and after more than 15 years of effort, CAT-ASVAB is operational in all 65 Military Entrance Processing Stations (MEPS). CAT-ASVAB provides a ready computational platform for new tests to augment the ASVAB. In the past, the usual argument against the implementation of new intellectual tests has been that there was no operational computer-based system for their inclusion and the additional printing costs for paper and pencil versions (if feasibly delivered this way) were prohibitive. Moreover, the operational computer systems are being upgraded with additional RAM memory, storage capacity, and better video cards.

Computer costs, CPU power, and interconnectivity

Dramatic reductions in the cost of computer hardware effectively catapulted the CAT-ASVAB program from a research effort to an operational system. The continued reduction in costs associated with increases in computing power will allow CAT-ASVAB to expand testing from the 65 fixed MEPS locations to the more than 600 transitory Mobile Examinee Testing Sites (METS).[2] Importantly, this expanded use will eventually eliminate the need to maintain a paper-and-pencil ASVAB and thus undercut arguments against new selection and classification tests that often can only be computer delivered. Moreover, the ever increasing power of computers makes the delivery of adaptive, complex, and CPU intensive tests feasible, again undermining arguments against using new selection and classification tests. Computer interconnectivity options continue to expand, making it possible to share data and information from virtually any location almost instantly. Although unrelated to whether new or different tests are used, these interconnectivity options should have a profound influence on selection and classification efficiency. If the recruiter can obtain operational test scores instantly, by transmitting data to the central repository for verification,[3] then a great deal of time and energy can be saved and no break in the applicant-recruiter transaction will be necessary. Just as importantly though, the recruiter, or classifier at a Recruit Training Center (RTC), would have access to precise, up-to-date information on jobs and school assignments available and the ship dates for these positions. Logistically, more accurate assignments could then be made. Additionally, more sophisticated,

[2] Mobile Examinee Testing Sites are transitory ASVAB administration locations used from one to several times a year; typically, they are rented hotel meeting rooms.

Since CAT-ASVAB is currently administered on desktop class computers, it is logistically difficult to have a single OPM test administrator transport, setup, and breakdown a network of 30 or more computers for a single testing session. With the increased power and reduced cost of laptop computers, it will become cost effective to use laptops which will minimize the logistic problems for CAT-ASVAB administration in METS.

[3] All test scores given to applicants and/or recruiters at the time of testing are treated as provisional until they are transmitted to MEPCOM headquarters and verified. This is usually done overnight but may take several days. In either case, the applicant must return, or the recruiter must visit the applicant, to receive verified scores and continue with the recruiting process.

multivariate person-job match algorithms could also be utilized, yet still make them immediately available to the recruiter and/or classifier at their location.

Storage capacity, video-audio capabilities

Coincidental to the decreases in computer cost and increases in CPU power, data storage capacity, video-audio access speed, and video-audio capabilities continue to grow. A particularly promising advance is the advent of new DVD drives which are capable of storing several hours of motion-picture quality video and audio data, with the ability to display the data in an uninterrupted, seamless stream, even under random access search requirements. This presents an entire new vista of opportunities for realistic-job previews, complex situational judgement tasks, and extended, multi-option, problem-solving environments.

Changes in psychological theory

We are experiencing an exciting and challenging expansion of thought and theory in personnel psychology. Evidence has mounted making it clear that we can substantially improve personnel selection and assignment by expanding our view of the predictor and criterion space. An expansion of the predictor space includes expanding the abilities and skills we assess in the ASVAB to cover new abilities, skills, and knowledge areas (e.g., time-sharing, psychomotor, and computer literacy). The ASVAB does an exemplary job of measuring traditional academic knowledge and achievement domains, such as vocabulary and arithmetic reasoning, and adequately measures technical knowledge, such as tool use and mechanical operations. However, the ASVAB does not measure some critical areas of intellectual functioning, such as spatial ability, content-free reasoning, complex time-sharing abilities, skilled performance, or some knowledge domains that are critical to the next generation Sailor (e.g., computer knowledge).

Just as importantly, we now know that we can reliably measure personality, motivational and interest facets of human behavior and that under certain conditions these can add substantially to our ability to predict attrition, retention, and school and job performance. For example, measures of "conscientiousness" predict ratings of job reliability, and emotional stability measures predict early attrition and long-term adaptability to the workplace. Motivational measures of "can-do" or "will-do" orientations have very successfully predicted teamwork activity, peer ratings of social fit, and supervisory ratings of organizational fit. Social intelligence measures have predicted successful supervisory and peer ratings, managerial performance, customer service evaluations, and promotion rates. Interest measures have predicted job satisfaction and long-term retention. We must begin evaluating the utility of these measures in the military.

Large-scale research has demonstrated the value of differentiating the outcome criteria we are trying to predict. Historically, outcome measures for successful selection and classification efforts have been global measures of training success (pass or fail the entire curriculum) or short-term job performance (most recent supervisor performance ratings). When aggregate measures of short-term performance are used, evidence shows that the single best predictor of training or job performance will

be general intelligence. If we differentiate the outcome measures (e.g., job reliability from proficiency), or include longer-term performance or job tenure, we find a much richer web of interrelationships between selection and classification measures and outcome variables. Noticeably, personality and motivational indices become increasingly predictive. We must begin to use a more complex set of differentiated school and job performance metrics, particularly those that may be associated with longer-term performance indices such as tenure, promotion rates, multiple supervisory ratings, and retention. Retention is already too low in many jobs and the cost of losing highly trained Sailors will become more expensive in the future.

Technical Challenges in Selection and Classification

Several technical issues are associated with moving from single-stage testing for both selection and classification toward multistage or two-stage testing, separating selection or qualification from classification. Since it is unlikely that applicants will enlist with no knowledge of the occupations to which they are to be assigned, we need research on this issue. First, we need to determine the minimal assignment specificity necessary to attract recruits. That is, how much (or how little) information is required by the recruit about the job to which they are likely to be assigned before they are enticed to sign an enlistment contract. The best model we currently have available would be recruiting into broad occupational categories, such as mechanical, electronics, nuclear field, administrative, etc., perhaps crossed with major warfare community, such as aviation, submarine, and surface. Not only do we need to know what is acceptable to recruits, but we need to know what makes technical sense for the Navy and what the occupational categories should be to best map onto current job and rating structures, technical school curricula, and other existing organizational constraints. Finally, we have to develop the classification standards for these occupational fields based on ASVAB enlistment performance.

Determine the aptitude, knowledge, skill, and social requirements needed by the next generation Sailor

A major technical and intellectual challenge for the immediate future is to develop descriptions of the force structure, requirements for jobs, environmental contexts, and organizational and command structures for the next generation Navy. As we ascertain more information about the nature of the future Navy (from SYSCOMS and N-8 staffs), we can begin developing aptitude, knowledge, skill, personality, and social requirements for successful Sailors. We can map these requirements onto the current selection and classification instruments, and see what we are not measuring or are measuring poorly. This knowledge would allow us to focus our research efforts in developing new measures to select and classify applicants into future jobs.

Operationalize personality and volitional measures

Recent evidence, and frankly, colloquial knowledge, argues for the inclusion of personal characteristics information into the selection and classification system. Certain personal characteristics ameliorate adapting to military life while others clash with it.

Some personality characteristics make team and group work attractive while others make it difficult. Similarly, some personality, personal history, or volitional factors spawn beneficial "can-do" and "will-do" motivations that facilitate integration into military units and life; others undermine it. Although we might agree that knowledge of these personality or motivational predispositions would improve selection and classification, most also agree that contemporary versions of these measures are easily faked and people can be coached to respond in ways that will improve the selection probability. For example, typical items such as "I work well in groups", "I always do my best", "I like a structured `world", "I am very conscientious in my work" reveal personality predispositions beneficial in the Navy, yet their meaning is transparent. With little effort a person could be suborned or coached to endorse items that would increase the likelihood of being selected—or excluded under the threat of conscription. To mitigate these problems, we need to undertake an extensive research regime to develop less transparent, ideally objective, tests that measure desirable personality and motivational predispositions for service in the Navy.

Utilize interest measures

An extensive vocational counseling literature attests to the benefits of matching an incumbent's interests to his job requirements, and that the enhancement goes beyond that obtained from job classification based on pre-existing abilities and knowledge. The benefits are often obscured when organizational assessment does not include indices of job satisfaction. Instead, organizations see the results of poor fit or low satisfaction, in indirect effectiveness measures such as turnover rates and absenteeism, and ultimately decreased readiness. Room exists in the classification process to include measures of a person's interests and proclivities. Indeed, when a person is intellectually qualified for a host of jobs, the evidence suggests that the best assignment for long-term retention is the one that fits an individual's interests and not just the organization's manpower needs. We need to conduct research to determine which interest measures are best suited for use by the Navy and how the results of these measures can be utilized in the classification process to optimally assign the individual within the scope of manpower requirements.

Differentiate performance outcome measures and incorporate longer-term success criteria

Historically, the military has measured the effectiveness of selection and classification against short-term outcomes such as 6- or 12-month attrition, completing technical training or initial supervisory evaluations. This focus has resulted in an accession system that optimally minimizes early loss to the detriment of later—and more expensive—loss at reenlistment. Research has demonstrated that short-term global performance criteria, particularly overall school grades, are best predicted by general intelligence while longer term, more differentiated criteria such as retention and promotion rates are better predicted by other measures, including personality, interest, and motivation instruments. We need to begin a program of research to look at the relationship between short-term and long-term loss, the measures that predict or may predict them, and develop an integrated selection and classification model that is optimal for both temporally near and longer-term criteria. As part of this research, we

need to collect more specific measures of job performance, such as job reliability, proficiency, and team-effort, as well as more specific measures of training success, such as academic, hands-on, and group activities. With these differentiated outcome measures we could develop a model that maps the multivariate performance space onto a multivariate predictor space (tests, personality, personal history, and interests). These complex mappings could then be used to select and classify individuals and optimally maximize both short- and long-term outcome measures using sound economic metrics.

Grow the skill base for NPRST and access to military research subjects

At NPRDC, we have several "technical" challenges to overcome during the next year as we reconstitute ourselves as the Navy Personnel Research, Studies, and Technology (NPRST) Department. We need to replace staff lost because of our geographic relocation, particularly those with expertise in personality theory, classification theory and methods, mathematical statistics, and psychometrics. We have coverage in all these domains but we need more strength. We also need some staff-based computer programming support, someone who can mock up new tests, provide insight into producing functional specifications for programming projects, and offer oversight to programming products from contractors. We are developing the necessary skill base through new hires, an excellent and mutually beneficial set of relations with the University of Mississippi, the University of Memphis and their associated institutes. We are also putting together a strong contractor base with classification, economic, and programming staff. Additionally, we are forging new and stronger relationships with other research and development groups such as the Defense Manpower Data Center (DMDC) and the Naval Health Research Center (NHRC). Lastly, we need to develop a mechanism for ready access to military research subjects. For some projects, contracting data collection will suffice. However, for continued development and refinement cycles, as well as for initial evaluation, we need a source for military research subjects. We will approach RTC Great Lakes to establish a research and testing laboratory similar to the one we had at RTC San Diego.

Integrated Research Agenda

The overarching requirement for implementation of this research agenda is the modification of the structural constraints of the current single-stage-testing model that dictates that all selection and classification testing occur in a single, short session prior to service qualification. The guiding principle for this agenda is that to improve personnel selection and classification, for the immediate future and the 21st Century, we must expand both the predictor and criteria space beyond the current boundaries. That is, we must expand the scope of the measures used to qualify and assign personnel, and we must differentiate and amplify the range of outcome criteria against which these measures are evaluated. Finally, we must put these predictors and outcome measures together in an integrated selection and classification model that optimally selects and assigns personnel. A number of initiatives within this broad principle are described below.

Basic Science Foundation

Cognitive Measures

Spatial Ability: Psychologists almost uniformly agree that spatial information processing is fundamental to human intellectual performance and while a great deal has been learned over the last two decades, much more research is needed. Dr. Anne Treisman at Princeton University has conducted some remarkable experimental work on visual memory that may hold the key to understanding individual differences in spatial information processing and representational integrity. Her analytic framework focuses only on group differences as a function of experimental manipulations yet she reports sweepingly large between subject error terms; the statistical manifestation of individual differences. She has reported evidence that nonsensical, complex shapes can be presented only once in the context of dozens of similar shapes, yet a visual memory can persist for the target shape across several hundred intervening trials and across long periods of time (up to one month; DeSchepper & Treisman, 1996[4]). It seems very likely that the instantiation of this visual memory, or "object file" representation, may be fundamental to spatial information processing, and if there are large, stable, individual differences in the production and durability of the representation, then these individual differences may be fundamental to more complex spatial problem solving. If they do predict individual differences in more complex spatial tasks, then this would be key to understanding and predicting spatial problem solving and direct us in how to measure the essential component of this critical aspect of intellectual functioning.

Time-Sharing Ability: For nearly 100 years psychometricans have postulated a general time-sharing ability separate from other intellectual competencies. Unfortunately, nearly every effort to identify this ability has failed. Since we believe this ability may be critical in future Navy working environments, we need to investigate the phenomena further. One reasonable explanation for failing to identify the construct may lie in the common factor statistical models that have been used to test for the ability. If a general-time sharing ability is actually present in only a small percentage of the population with the remainder having only a task specific time-sharing ability, then the common factor model would fail. We will undertake research to elucidate under what distributional conditions and with which statistical models a time-sharing factor can be recovered from correlational data. The results of this simulation research will direct later empirical exploratory development research.

Non-cognitive measures

Personality Research: While there is extensive research supporting the use of personality constructs such as W. T. Norman's "Big Five," current instantiations of personality tests require endorsements of fairly transparent items ("I am a conscientious worker") and thus are subject to faking and coaching to manipulate selection and classification decisions. Before such constructs could be actively utilized for personnel decisions, we must have more objective and/or less transparent test items. We will try to develop objective measures of the constructs. A good example comes from

[4]DeSchepper, B. & Treisman, A. (1996). Visual memory for novel shapes: Implicit coding without attention. *Journal of Experimental Psychology: Learning memory and Cognition*, **22**(1), 27-47.

work by Gerald E. Larson where he devised a behavioral measure of the personality construct of conscientiousness. In essence, he presents a long list of tedious yet simple instructions that, individually, anyone can follow. The hypothesis, though, is that only "conscientious" individuals will consistently succeed at the task. Indeed, there are several existing psychological measures, such as Stroop tests, response inhibition tests, and susceptibility to influence tests, that superficially have nothing to do with the personality construct they measure; these need to be investigated as starting points in the development of other objective personality measures. In addition, a psychological projection technique will be explored by presenting individuals with social scenarios or work vignettes describing desirable and undesirable personality traits, with mutually exclusive alternatives that individuals must choose between or rate, which may reveal personality traits (e.g., "Which person would be a better coworker?"). The efficacy of these measures, their relationship to established personality tests, and their susceptibility to response manipulation will have to be explored.

Selection and Classification Models

Selection and Classification Modeling: Virtually all selection and classification research and their resulting cut-scores are based on simple linear regression, utilizing a single outcome measure regressed on a limited set of predictor variables. Indeed, once the regression models have been identified, further simplifying assumptions are made, discarding the optimal regression weights in favor of simple sums of test scores for use in operational composites. Historically, there were practical limits on the computational complexity of models that could be considered for selection and classification, but these limitations are no longer valid. As noted in earlier discussion, there is now substantial evidence demonstrating that if traditional aggregate evaluation measures (e.g., early attrition, final technical school grades) are differentiated to reflect finer grained outcomes (e.g., reasons for early attrition, laboratory performance in school) or long-term criteria (e.g., reenlistment, promotion rate) then a more complex set of relations exist between predictors and criteria. The critical point is the aggregate outcomes will likely be best predicted by aggregate intellectual and behavioral measures. If we could only apply simple univariate/bivariate models, then these would be the best. However, we have much more sophisticated multivariate classification models available to us, ones that can identify and utilize hierarchical relationships between sets of predictors and outcomes and identify best fitting models under a host of assumptions and constraints. We will conduct some small research to develop multivariate classification models and explore their advantages and practical limits, what form, and theoretical basis should be employed.

Exploratory Development

Cognitive Measures

Spatial Ability: The most glaring weakness of the ASVAB is that it does not include any measure of spatial (figural) problem solving. This deficit has been repeatedly pointed out and there is substantial military and non-military research demonstrating that a spatial test could greatly improve the validity of the ASVAB. The Military Accession Policy group has agreed that a spatial test should be included in the ASVAB. However, the test

that was chosen ("Assembling Objects") was selected not because it was the best test, but rather because it could be administered in a paper-and-pencil format. Setting aside the tests weaknesses, the fact is that it will likely be included in future editions of the ASVAB and if there is to be a spatial test in the ASVAB, we need to assure that it is the best possible test. We plan to undertake a series of research and analytic studies to better understand the content and cognitive processing demands of Assembling Objects, how the test is related to other spatial tests and cognitive tasks, and how we can improve the content and measurement properties of the test.

Perceptual Speed Ability: The ASVAB currently contains two tests historically classified as "Clerical/Perceptual Speed" tests (Numerical Operations and Coding Speed). Numerical Operations is used in very few selection composites and will likely be dropped from future editions of the ASVAB. Coding Speed produces important incremental validity in a few jobs and is used in several classification composites by the Navy and Army. The Air Force and DMDC have suggested that it be dropped from the next edition of the ASVAB for a host of reasons, including the fact that it is not used for many jobs, it is not used by all of the services, and performance on the test is very volatile, suffering from huge ranges in mean performance following subtle changes in answer sheets (for paper-and-pencil tests), screen luminescence and font size (computer-based versions), or items (any version). The volatile nature of the test requires that a costly equating study be conducted whenever anything about the test's items, their rendering, or the equipment used to administer the test, changes. Since the test has value to the Navy, we need to begin research to salvage its predictive value. We need to better understand what it is measuring, determine what facet of performance underpins the predictive value to the Navy, and what the communality is in the Navy jobs for which the test is predictive. Based on this more fundamental understanding of the test, and utilizing the extensive cognitive literature on perceptual speed and visual search models, it should be possible to develop a new and better perceptual speed test that will also be predictive of performance, yet less susceptible to unimportant changes in the administration of the test.

Diagnostic Test Use: Research needs to be conducted that could lead to the diagnostic use of test performance. Specifically, the goal of "diagnostic testing" is to try to wring out additional information from a person's performance on a test, either for the purpose of improving the psychometric properties of the test or for gaining more detailed information about a person's strengths and weaknesses. In the latter case, the additional information might be that a person understands arithmetic concept A but not arithmetic concept B. This diagnostic information could potentially be used to prescribe the course of future training or remedial training. If any information beyond whether a person "passed or failed" and scored in the X-percentile can be gleaned from test performance, then we would have made better use of the test. Such information can also be used as feedback to test item writers in their development of future editions of the test. Diagnostic testing has a huge potential in the context of having to accept recruits with lower educational attainment to meet basic manning requirements. Even still, there may be applications of the same principles wherever tests are used in the Navy, such as A-school progress tests or even career advancement exams.

Non-cognitive measures

Personality Research: Based on input from basic science efforts, a collection of published and new personality measures, social intelligence and ability measures will be aggregated into a battery and utilized in a study to ferret out the interrelationships among the tests, their measurement and psychometric properties. Additionally, we need to gain estimates for racial, ethnic, gender, and other group differences in personality measures among incoming recruit populations and look for differences in intercorrelation and latent trait models among these groups. Unlike aptitude measures, little research has been done with personality measures in recruit populations, and we have few expectations for the distributional characteristics and latent model structure of these measures, singly or in conjunction with intellectual ability measures. This critical step must be undertaken before serious consideration can be given to the use of personality and motivational measures.

Social Intelligence: Social intelligence is a generally accepted facet of theoretical models of human intelligence yet its measurement, description, and relationship to other aptitudes and personality constructs are poorly understood. The potential value of measuring social intelligence among military applicants is that it may be predictive of adaptability to military life, likelihood of performing effectively in work teams, response tendencies in confrontational situations, and potential for leadership. We have conducted some data collection to understand the relationship between social intelligence and other individual difference constructs, and this must be analyzed and interpreted. We have also developed some sample vignettes that have Navy workplace content yet reflect social intellectual reasoning. We will continue to develop and refine these test "items," develop both logical and empirical scoring keys, and assess their relationship to other social intelligence and personality constructs.

Classification models

Criteria Differentiation: Efforts need to be undertaken to identify information currently available in automated personnel systems, A-schools, etc., that may supplement the aggregate outcome measures generally in use. Along with this, we need to begin looking at the processes involved in evaluating performance in recruit training, technical school training, and supervisory evaluations to look for opportunities to supplement current outcome measures with finer-grained indices of meaningful personnel outcomes. This needs to be done in light of the body of psychological research revealing criteria that are meaningful for both short-term and longer-term performance and retention. This is essential if we are to develop the input necessary for more sophisticated and valid selection and classification models.

Classification Models: Once promising new predictors, criteria, and prediction models have been evaluated, research needs to begin to determine the form of the interrelationships and models that best integrate selection and assignment decisions into an overall accession process. For example, we need to determine whether hierarchical or simultaneous equations best characterize the relationship between short-term and long-term retention and between cognitive and non-cognitive measures. Similarly, we need to evaluate how Navy policy, such as minority and gender representation, should be included in the models.

Contextual Research

Future Navy Work Environments: We need to begin collecting information describing in detail the job environments for the Navy personnel of the future. There have been a number of weapons platform specifications produced and other endeavors describing the environments and operational requirements for systems going on-line in the future. We need to digest this information and determine what it means in terms of the aptitude, knowledge, skill, and personality characteristics for the next generation Sailor. We can then use these characteristics to guide future research.

Selection Process Evaluation: Research needs to be undertaken to capture recruit and applicant reactions to the selection and classification process. When people perceive the selection/classification process to be open, fair, and considerate of their interests and preferences, they are more likely to join the organization and be satisfied with their initial work assignments. We have little information regarding how the process is perceived by people contacting it, what their expectations and understandings are about the process and how it operates, thus we do not know what could be done to make the process seem fair and considerate. This is a person's first interaction with the Navy and the negative or positive evaluation of this contact will have an impact on the person's decision to join the service and how they feel about the service when they enter training.

Long-Term Retention: We need to conduct research to determine the factors associated with the decisions to leave or remain in the service. It is standard practice in industry to conduct exit-interviews to garner whatever information the person is willing to impart about their experience and decision to separate. The Navy assumes that most people leave service because of family separation, quality of life issues, leadership, pay issues and/or an inability to adjust to the rigors of service. This is likely true, yet, there is undoubtedly valuable information that can be obtained from details in the reasons people are leaving; how much more money would they need to remain in service, do they fully understand their entire compensation package, do they know they have educational and other opportunities that would allow them to change jobs? To improve long-term retention, a first step must be to understand exactly what information people are using to make their separation decisions.

Advanced Development

Validation Studies

Integrated Evaluation: We need to employ only the most promising cognitive and non-cognitive measures developed and refined in exploratory development research and utilize new and variegated outcome measures in large-scale, multiple-job, validation research to assess the magnitude of validity coefficients and their increments over the ASVAB. These studies are complex and difficult to execute, and it may take several years for the outcome measures of real interest (job proficiency, promotion, and retention) to mature sufficiently to evaluate. Following the evaluation of the validity relative to the ASVAB, the results must be subjected to economic analyses to determine their viability and the cost/benefit consequences for the Navy.

Assignment Studies

Integrated Evaluation: While basic and exploratory research will determine the predictor and criterion relationships and how

multiple models should be integrated to capture both short- and long-term performance, additional research, particularly simulations, will be required to integrate this information into an overall assignment system and compare it with the present assignment system. Work will also be required to develop the interface of a new assignment system with existing and necessary data sources, equipment, and the operators.

Outcomes, payoffs, and benefits to Navy

Improving the current recruiting, selection, and classification processes will:

1. Position us to recruit for the skills needed in the 21st Century Navy,
2. Reduce the cost associated with early attrition,
3. Improve the quality of new recruits,
4. Reduce the cost associated with over-enlistment "safety margins" to ensure end-strength,
5. Reduce the costs associated with under utilization of Navy and Marine Corps training schools (currently only 80% utilized),
6. Better meet manpower requirements,
7. Improve job-satisfaction by making better job assignments,
8. Increase reenlistment rates, and
9. Improve fleet readiness.

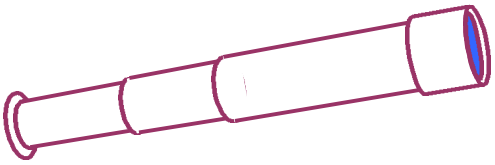
Many of the benefits from improving the predictor space, criterion space, and classification system have been described. While it is difficult to attach a price to many of the benefits, some research has made inroads. For example, Schmidt, Hunter, and Dunn (1987) estimated that by adding a spatial and/or psychomotor test, the ASVAB's average predictive validity could be improved by 3%, and that this improvement would produce performance increases worth $83 million annually to the Navy. Researchers focusing on classification efficiency (Alf and Abrahams, 1996; Scholarios, Johnson, and Zeidner, 1994; Zeidner and Johnson, 1994) have estimated that mean predicted performance could be increased by 23-46% resulting in productivity gains valued at several hundred million dollars annually. Note that each research group only looked at the minimum gain from altering a part of selection and classification (adding a spatial test or improving classification efficiency) while leaving the other components intact. We have proposed substantially broadening the predictor space to include not only spatial tests, but also working memory, time-sharing, job specific tests, and improved perceptual speed tests, as well as personality, biographical, social intelligence, and interest measures. With such a broad assessment of human performance, we are likely to improve the ASVAB's validity more than 3%. The addition of these new predictors may also allow us to qualify additional applicants for service and thus reduce recruiting costs. Classification efficiency will improve simply by adding new predictor measures that are relatively uncorrelated with the other measures; personality, biographical, social intelligence, and interest measures are statistically unique from the cognitive measures. Further, the shear scope of the proposed predictor measures provides substantially more information upon which to base classification decisions which further improves classification efficiency. More importantly though, we propose improving the measurement of the criterion space, that is, the meaning and breadth of the outcome

measures to include differentiated school performance, job knowledge, job proficiency, job reliability, job satisfaction, and promotion and reenlistment rates. This expansion of the criterion space will improve the monetary value of the outcome measures over that in prior research (mean performance) and thus increase the economic benefits. Additionally, we propose delaying classification decisions until recruit training so that more precise training availability data will be available. This will allow us to improve the utilization rate of school seats from the current 80% which will provide further economic benefits.

The above discussion focused on the tangible economic gains that can be expected from small changes in selection and classification; however, the interactions among these changes and their long-term effects are not captured by the prior economic research. For example, while a small boost in the ASVAB's validity reaps great gains in productivity, what happens when you improve the ASVAB further, improve the value of the outcome measure, and improve classification efficiency at the same time? The answer is that the gains become greatly magnified. Moreover, no economic value has been associated with the expected longer-term benefits of better selection and classification. There will be lowered recruiting costs, decreased attrition, and reduced accession safety margins which reduce expenditures and waste. Less tangible, though, are the benefits that will accrue from a more accurate assignment system that incorporates the interests, preferences, and extended abilities of the recruit. These improved assignments will increase job satisfaction, improve morale, improve promotion rates and increase reenlistment rates. Critically, elevating job satisfaction and retention directly improves fleet readiness, the penultimate outcome for the Navy. The estimated economic gains from improving selection and classification are huge (hundreds of millions of dollars), even based on very restricted scenarios, but the probable cumulative and intangible gains are even larger.

Personnel Planning and Policy Analysis

Vision



23 October 2008, 1900 hours: The Navy's officer strength planner has a congressional "tasker" for information on trends in the proportion of married officers over the last ten years, for each officer designator. She accesses the Data Warehouse and easily selects the exact information she is looking for, pastes it into an email, and sends it off, thinking that in the 'old days' it would have taken several days to get the information by submitting a data processing request, and then the data would not be exactly right. Forward thinking programs such as IT-21 have also benefited personnel planners allowing them, like warfighters, to use and exploit information in more efficient ways. Then a red light begins flashing on her display screen. She clicks the 'Alert' icon, and the program informs her that aviator resignations have exceeded expectations for the second month in a row. She clicks on the 'Analysis' icon, and views easily digestible graphs showing historical aviator retention trends, a projected aviator shortage in twelve months if the recent behavior continues, and the likely effect on fleet readiness. The Analysis display also points out that airline salaries and hiring have significantly increased in the last three months. She clicks on the 'Options' icon, and the intelligent system recommends a specific combination of accession and retention bonuses to address the problem. She browses the extensive supporting information provided by the system and uses it to assemble a briefing to justify her request to fund this option and avoid the aviator shortfall.

A battle group (BG) commander relies on computer systems that simultaneously monitor and evaluate multiple air, surface, and subsurface threats, "friendlies" and unknowns, as well as BG platforms and weapon system status to give clear, timely warnings of changes in battle conditions. Similarly, a personnel manager must be able to quickly identify threatening or advantageous changes to various key personnel system indicators. The ability of the personnel force to perform its mission depends on maintaining the appropriate number of trained and deployable personnel. This mix is achieved by monitoring, evaluating, and responding to changes in many interrelated indicators, including levels of losses, accessions, inventories, billets, skill manning percentage, promotions, laterals, demographics (gender, race/ethnic), skill acquisition, and costs. Like the BGcommander, failure to correctly anticipate possibilities and take quick, proactive steps jeopardizes the force's ability to act effectively now and in the future. If the information conveyed is not timely, is not well understood in the context of the current situation, is not analyzed for future significance, or is in error, the probability of catastrophic events and unexpected costs increases.

Introduction to Personnel Planning and Policy Analysis

The Personnel Policy and Career Progression (N-13) division of the Bureau of Naval Personnel (BUPERS) develops and issues military personnel plans and policies, monitors to ensure attainment of fiscal and end strength objectives, and plans and directs the career management and progression of Regular Navy personnel. They must ensure that the personnel force maintains the appropriate rank and skill composition to meet operational objectives, while staying within budgetary constraints.

The Navy enlisted force is managed by the Enlisted Community Managers (ECMs) and the Enlisted Strength Planners. The ECMs manage skill level school accessions, training, advancements, rotation policy, retention and separations to ensure that the skill is adequately manned to meet Navy operational goals. The Enlisted Strength Planners closely monitor and manage the monthly enlisted force strength by paygrade to ensure execution of Navy enlisted strength objectives within fiscal constraints. This includes sending the signal to the Navy's recruiters on how many new Sailors need to be recruited each year and determining the need for force-shaping tools to bring enlisted endstrength within congressional and budgetary controls. Navy force-shaping tools include its Early Out program, separation incentive programs, and Temporary Early Retirement Authorization (TERA). The Enlisted Strength Planners also determine Navy-wide advancement opportunities by paygrade and promulgate policy for each enlisted advancement cycle.

The Navy officer force is managed by the Officer Community Managers (OCMs), the Officer Strength Planners, Officer Accession Planners, and Officer Promotion Planners. Like their enlisted counterparts, the OCMs ensure that each officer skill category is adequately staffed, but the OCMs pay particular attention to career progression so that enough officers are available to fill required department head, executive officer, and commanding officer positions. The Officer Strength Planners generate officer strength targets by paygrade, monitor losses and accessions, and implement policies required to meet congressionally mandated strength and fiscal targets. The Officer Accession Planners develop plans to meet officer accession requirements for each available accession source, including the Naval Academy, Officer Candidate School, Naval Reserve Officer Training Corps (NROTC), and the Seaman to Admiral enlisted commissioning program. The Officer Promotion Planners determine Officer promotion targets for each skill, as well as promotion zones, timing, Selective Early Retirement (SER), TERA, and frocking policies to achieve the desired officer paygrade structure within congressional guidelines.

Previous Personnel Planning and Policy Analysis Work

Developing technologies that improve N-13’s ability to perform personnel planning and policy analysis functions has been the primary responsibility of the Force Management Division of NPRDC, which has assumed cognizance over the corresponding Core Program: Personnel Planning and Policy Analysis. Over the course of this relationship, NPRDC has focused on developing models of personnel processes to enable force mangers to project

the size and composition of the force under varying scenarios.

Models developed by NPRDC include SKIPPER, an enlisted inventory projection model for the purpose of accession planning; SKIPPER II, which added advancement planning to SKIPPER; COURTNEY, an enlisted inventory projection model for sea/shore tour length planning; SPAN, an extensive suite of models for enlisted strength planning to ensure that monthly and annual strength targets are met; and STRAPO, an officer inventory projection model for planning and analysis of accession, retention, and promotion policies. NPRDC has also developed other information delivery systems for N-13, including TARGET, which delivers current officer and enlisted personnel and billet data for ad hoc queries, and OPIS, which delivers historical officer data. This experience in working with N-13 has given NPRDC a unique depth of insight into the personnel planning and policy analysis business, and the research problems and possibilities associated with it.

Operational Goal

Problem/Opportunity Identification

With currently available tools it is often impossible for personnel managers to recognize a developing personnel force management problem until it has done its damage. Personnel managers need tools that quickly assess the current status of the force, provide in-depth information on all potential ramifications of the current situation, and identify emerging problems. We call this capability a **Personnel Battlefield Simulator**. All relevant force information would be available in the system, but the system would intelligently prioritize displays so that potentially emerging problems or opportunities would be evident.

Facilitating Understanding

Personnel managers need to have the earliest possible warning of changes in any personnel system indicator of the condition of the force, but ultimately they need to make good decisions in response to the changes. In addition to ability, training, and experience, an essential element of making good decisions is a thorough **understanding** of the situation and possible consequences of the decision. A computer system cannot create understanding, but also understanding cannot occur without a complete set of relevant information. Computer systems are the only practical hope of organizing and presenting the volume of complex information required to understand a personnel force problem/opportunity in its current and historical context, and to understand the potential implications of decisions.

In addition to identifying potential problems and opportunities, the Personnel Battlefield Simulator will provide relevant contextual information and facilitate evaluation of alternative courses of action.

Currently, Navy personnel managers are struggling with retention and recruiting problems, skill shortages, increased demand to justify their allocation of resources, increased operating tempos, decreased readiness ratings, and demands for better Quality of Life (QOL), to name a few issues. The envisioned system would help personnel managers understand the relationships between these problems, and their options for dealing with them. But, it would not be limited to current problems, which may fade in importance due to

changing economic conditions, or other external factors. It would be designed to help manage the current issues, while simultaneously identifying emerging issues so that they can be understood and addressed in the early stages.

Creating the synergy between the computer system and the personnel manager that leads to understanding is a tremendously complex and challenging task. The Personnel Battlefield Simulator concept is built on a suite of contributing research efforts, each of which will improve Navy personnel management capabilities. Each component presents interesting, challenging, and worthwhile research opportunities. The integration of these components will produce a tool that enables Navy personnel managers to understand current and planned personnel force behavior and respond to emerging problems/opportunities quickly and appropriately.

Simulator Components

Building to Understanding

Effective personnel planners and policy analysts make good decisions. Therefore, research and development (R&D) in this area should be directed toward enabling good decision-making. Good decision-making begins with quality **data**, but the existence of sufficient data alone does not ensure good decision-making. To be useful, data must be transformed. The process of converting data to good decisions includes:

1) organizing and presenting the data so that it can be recognized as meaningful **information**,

2) interpreting the information in context so that the analyst absorbs meaning and it becomes part of the analyst's **knowledge**, and

3) teaching general principles and interrelationships so that the knowledge can be applied to making decisions with confidence that the decision maker will have a complete **understanding** of the personnel environment and the potential effects of the decision.

So, effective planning and policy decisions depend on the ability to understand the manpower and personnel environment. This understanding is predicated upon knowledge of relevant information about the environment. Information is the useful organization of data.

We find it useful to frame the R&D enterprise in terms of these four pre-requisites to effective decision-making (data, information, knowledge, and understanding). Each step along the way is challenging in its own right and, in fact, each step presents increasingly interesting and complex research opportunities. But, from a practical standpoint, each step is also completely dependent on the success of the previous steps. For example, an excellent technique for transforming information into knowledge would be a great research achievement but would be of diminished practical use if the original information were corrupted. Indeed, in such a case, it would be difficult to establish the effectiveness of the technique because evaluation would likely depend on the faulty information.

Data Quality

For this reason, data are the foundation upon which research in all these aspects of decision-making stands or falls. Data are the raw material upon which all decisions are

based, and are the means by which researchers establish the merit of their hypotheses. Current Navy personnel data does not adequately support the needs of the analyst or the researcher.

The primary sources of Navy personnel data are the Enlisted Master File (EMF) and the Officer Master File (OMF). These databases are updated daily and contain detailed career history and biographical information on each active duty member. While these files contain considerable data, they are not without deficiencies:

1) The rate of errors in these files is thought to be very high.

2) Although the files provide current information, they do not give an indication of historical information or trends.

3) The files provide no context for the data that might help with analysis.

The first deficiency will be addressed in this section of the chapter, and the other two in subsequent sections.

Other data are available in a variety of databases. For example, the Defense Finance and Accounting Service (DFAS) maintains their own personnel data for payroll accounting purposes. While the DFAS data could be useful as a source for data not available in the EMF/OMF, it undermines confidence in the EMF/OMF data because DFAS often reports different counts for the same data element.

The EMF/OMF error rate is unknown. But, strength planners who work closely with the data report that the number of errors is unacceptable, and that they spend too much time manually correcting errors. Effects of undiscovered errors are also unknown. The effects are potentially huge because all decisions are based upon analyses which presume the accuracy of supporting data, but their effects will never be known until a systematic approach to evaluation of data quality is developed.

Considerable research on data quality is underway. The Total Data Quality Management program directed by Richard Wang and Stuart Madnick of the Massachusetts Institute of Technology has fostered much of the work:

> The use of information systems in organizations is restricted by the quality of data that appears in these systems. Correctness, completeness, precision, timeliness, and usability are important dimensions in the assessment of the level of data quality that exists. Three approaches to incorporating and improving data quality are… 1) building semantically rich data models; 2) reinforcing databases with a large number of database constraints; and 3) restricting the use of data to predefined processes…Future research will investigate and demonstrate how to take advantage of these approaches for improving the quality of organizational databases. (Orman, Storey, Wang)

Research suggests that organizational databases are likely to have enough errors to be costly, and that development of automated procedures for detection and correction of errors is not a straightforward task:

> There is strong evidence that data items stored in organizational databases have a significant rate of errors. If undetected in use, those

> errors in stored data may significantly affect business outcomes… Even with skilled error detection algorithm designers and functional experts who know the data, it is hard to anticipate all errors that might occur. (Klein, Goodhue, Davis)

The first step toward improvement and measurement of data quality is R&D of a **data quality facility** which would use new techniques to identify and correct errors in the data. Data quality measures should be reported regularly to monitor reliability of the data and provide feedback to data collection sites. Development of sophisticated data quality metrics will also facilitate research into improving source data collection.

Transforming Data to Information

Although much historical data exists in the form of monthly EMF/OMF "snapshots", these data do not represent information to the planners and analysts because there is minimal ability to compare data from multiple snapshots to study behavior over time. Answers to questions as simple as, "How has the average number of dependents in the force changed over the last ten years?" require considerable effort. Planners and analysts need a tool that transforms data representing current personnel conditions and behavior into information that tells them what is currently happening. Then, the tool would transform that information into knowledge of how the current behavior fits into an historical and projected context and why these events are occurring.

When NPRDC's Manpower and Personnel Vision of the Future project brought together Navy personnel managers to brainstorm on new directions personnel management might take in the 21st century, the primary themes that emerged included: (1) seamless access to information, (2) a fully integrated manpower, personnel, and training (MPT) information system, and (3) the ability to simulate plans and policies across the entire MPT spectrum. A major conclusion of the project report was that, "Navy MPT systems suffer from a lack of compatibility and availability of the data stored in the numerous data bases currently in use." (Myers, et al) The report goes on to:

> …recommend that the development of a prototype for an integrated, manpower and personnel system that is based on a single, verified source of data be undertaken. The system should be based on large-scale data warehousing techniques for data storage and retrieval, include complex data mining capabilities including neural networks, decision trees, multivariate statistical techniques, and provide coherent, clear input and output capabilities.

Under the auspices of the same project, NCR Corporation undertook an extensive Business Discovery investigation of BUPERS' business processes and concluded that BUPERS needed:

> …an Enterprise wide data warehouse… to provide 'a single version of the truth' providing detail and historical data (not readily available with the current 'snapshot in time' legacy systems)…Such a warehouse would provide the Navy with the information it needs to 'run

> the business' and to do trending and forecasting in order to set future strategic directions. The information would be readily available, easy to access, and much simpler to maintain than out-of-date, multiple stove-pipes. (NCR)

Personnel managers demand good information and expect it to be readily available. Let's use retention policy as an example of this principle. The Chief of Naval Personnel (CNP) perceives a shortage of aviators. The conventional approach is to offer larger financial incentives to aviators to remain in the Navy. CNP must now justify his 'knowledge' of the aviator situation with information that supports the Navy claims. That information depends on the availability of relevant data. Navy planners, managers, and analysts are increasingly being tasked with justification of routine expenditures in addition to extraordinary ones, as the Congress becomes more determined to trim budgets. This creates a demand for higher quality information, including increased demand for timeliness and accessibility. In turn, these demands draw attention to corresponding deficiencies in the available data.

The job of officer and enlisted planners, managers, and analysts has always been to ensure that the force is adequately manned, taking into consideration overall size requirements; specific skill and paygrade requirements; specific deployment and mission requirements; and accession, training, rotation, demographic, geographic, and QOL constraints. This is an extremely complex task, given the size and multi-dimensional diversity of the force. Associated with the job has always been some degree of accountability to the Office of Management and Budget, Inspector General, Navy Audit Service, Secretary of the Navy (Manpower and Reserve Affairs), various Department of Defense agencies, Congress, and the press. In recent years, the level of scrutiny has increased while the staffing level of the people doing the job has decreased. The result has been an increase in the proportion of time answering inquiries, with a commensurate decrease in the proportion of time spent planning, managing, and analyzing the force. As a result, managers spend more and more time scrambling for information. And, while in the past the types of information required by these people tended to be consistent over time, the queries coming in now are more unpredictable.

In most cases the requested information is not readily available, and it is a labor-intensive process to derive. Often, the response supplied is no better than a "best guess" or "ballpark estimate" because of constraints on time and availability of the data. It would be useful to know how much the volume of queries has increased, the amount of time spent answering specific questions, and the confidence level of the responses; but this information is unknown because there is no systematic documentation of the management processes. As NCR observed, "BUPERS has to invest in developing metrics to measure its own efficiency and cost-effectiveness. Without these measures it is impossible to know whether improvement efforts are making things better or worse." The personnel managers, who are already overwhelmed with work, do not have the time to document their processes.

Unavailability of quality data is detrimental not only to the personnel management process, but also to the personnel research enterprise. Much of personnel research concerns proposing a process that will lead to "better"

management of personnel, and by "better" we often mean more cost efficient. The key to evaluating whether a particular process is "better" than the status quo is measurement. We must be able to measure the difference evoked by using the experimental process. Given the current state of personnel data collection and storage, the scientific process is hobbled by imprecise and inaccurate baseline data. If we cannot include the means to collect, store, and access reliable personnel information as part of our personnel research program, then we will be unable to reliably substantiate the research that is done.

One source of comprehensive personnel data for the whole Navy, a **data warehouse,** would provide the volume of information required, including the breadth of potentially useful information and the depth into the past. It would reconcile data derived from different functional entities, solving the problem of conflicting data and lack of confidence in information systems that use derived data. Thus, it would be a fully integrated MPT information system providing seamless access to information across different functional areas. It would organize all available historical data into all forms of information that are useful to the Navy to facilitate placing current behavior into historical context. It would quickly assimilate current data into the system, so managers would have the earliest possible opportunity to identify emerging situations. In addition, it would provide contextual information about the data, including general economic conditions, major policies in effect, and significant concurrent events, so that these important elements of the personnel environment would not be lost when future personnel managers attempt to analyze today's personnel behavior and decisions.

Research would be conducted to enhance the data warehouse system beyond features provided in a typical business setting to address Navy personnel management concerns and to adapt the data warehouse as a resource for researchers. The data warehouse system would also be adapted to automatically monitor details of how the system is used to obtain metrics for Navy personnel business processes. Other major innovative features of this data warehouse would include enhanced accessibility (via the Internet), ease of use (through user interface technology research), and facilitated understanding of results (through visual information filtering research). The proposed data quality facility should be integrated with the data warehouse. Most importantly, from a research standpoint, this enhanced data warehouse would serve as a building block for a tool that will help to turn information into knowledge, as described in the next section.

Transforming Information to Knowledge

Planners and analysts could use the proposed data warehouse to analyze specific trends of interest, but it would be impossible for them to monitor all personnel trends to identify undesirable behavior that must be corrected before becoming a costly management problem, and conditions which indicate opportunities that can be exploited. It would be more useful to automate trend tracking and analysis of data relationships. Current force management tools lack any automated trend or data relationship analysis. The harmful effects of recent problems such as the MPN shortfall (a result of unanticipated effects of an aging force) and the pilot exodus (a result of slow response to increased airline market

competition) demonstrate the consequences of failure to quickly recognize significant trends. The *San Diego Union-Tribune* reports that the Navy is now losing Surface Warfare Officers and Submariners in "unsustainable numbers," but the ability to analyze the loss data to quickly discern significant patterns does not exist.

So, although personnel managers would have access to the information they need to perform effectively, they would still have great difficulty turning that information into the knowledge that can be derived from the information about significant changes in the behavior of the force. To remedy this, research would be conducted to develop **intelligent software agents to monitor personnel conditions** and draw attention to deviations from expected behavior.

This **personnel force information monitoring facility** would require a wealth of clean, organized data, which would be provided by the data quality facility/data warehouse. In addition to identifying interesting personnel force events, it would provide the means for contextual analysis by personnel managers. Human-computer interaction research would be required to find the best ways to facilitate the contextual analysis. Providing this capability would be a difficult and meaningful research achievement, but it would still leave the more difficult next step of helping the personnel manager to formulate the appropriate response to the emerging situation.

Transforming Knowledge to Understanding

Existing and future models should be integrated with this data analysis facility to enable more sophisticated analysis, leading to deciding on a course of action when potential problems or opportunities are discovered.

Recent research has concentrated on modeling personnel force processes for the purpose of anticipating the size and composition of the future force under different policy scenarios. Using this approach, NPRDC has produced SKIPPER, COURTNEY, STRAPO, and SPAN, all of which project the size and composition of the officer or enlisted force in the near or long term. The implementations of SKIPPER and SPAN have been particularly successful, and enlisted force managers and planners now rely upon these tools. From our experience with these models, we have learned that force managers do not want a proliferation of different modeling tools, and we are currently combining the capabilities of SKIPPER and COURTNEY into one model, SKIPPER III, which will have the flexibility to expand and contract modeling dimensions according to the needs of the user. The prototype for SKIPPER III will begin testing near the end of FY99.

There are currently several concerns in the modeling area which should be addressed through future research: 1) data conflicts in different models; 2) difficulty learning to use models; 3) ongoing tracking and validation of models; 4) lack of effective modeling of cost tradeoffs; 5) improvement of modeling techniques; and 6) lack of user understanding/confidence in modeling processes.

Eliminating model input data inconsistencies in the data warehousing process will help to satisfy the concern with data conflicts, but conflicts in model results must be addressed through **integration of models**, including reconciliation of

modeling processes and outputs. This is a difficult research issue because modeling differences demanded by differing model objectives need to be reconciled with a user's expectation that good models will give the same answer to the same question. Model integration will also help to reduce the cumulative difficulty in learning to use models by reducing the number of models (and interfaces) users must learn. Continued human-computer interaction research into **user interface techniques**, such as that performed by NPRDC in a recent exploratory development project, is also necessary to make the models as user-friendly and intelligent as possible for personnel force managers who must learn to effectively use the models quickly because of general lack of experience with such tools and relatively short tours of duty as force managers (MacMillan, et al). Research into **visual information filtering** techniques will also facilitate effective model usage.

The tracking and validation of model outputs should be performed routinely as part of the general tracking and evaluation of all aspects of the personnel management business. It is extremely difficult to justify and evaluate the effectiveness of new prototype systems when there is no repository of metrics on the current systems for comparison. The data warehouse would be adapted to accommodate this **model tracking and validation facility**.

Current models available to planners and analysts have extremely limited ability to link personnel decisions to cost factors. Planners and analysts are increasingly being asked to use financial incentives to correct force structure problems. Yet, they have no tool that reliably evaluates alternative courses of action, including the estimated effects of proposed bonuses or separation incentives on accessions and retention in the force. Although a standard methodology exists for estimating the effect of varying compensation on Navy stay/leave decisions (the ACOL model), this model has not been integrated into analytic tools available to planners and analysts and has not been validated in an operational setting. ACOL-based decisions should be continually tracked and validated so that the actual performance of this methodology is known. Current standard **costing methods should be integrated into planning and analysis models** so that personnel behavior and proposed personnel policies can be evaluated by cost, and improved costing techniques should be researched. Ultimately, an effective method for evaluating tradeoffs between cost and readiness should be available as part of a comprehensive personnel information management system.

Increasing competition for personnel resources causes the Navy to consider more flexible approaches to compensation, including pay table revisions that reward performance more than longevity, revamping the retirement package, and adjusting various QOL benefits. The Navy must also be concerned with countering the negative retention effect of increased operating tempos and the increased number of working spouses of Navy members. **Innovative econometric techniques need to be developed** to evaluate these possibilities, and these techniques need to be integrated into models that allow planners and analysts to evaluate cost tradeoffs between different scenarios. More extensive econometric research needs to be conducted in order to develop effective models for accession and retention behavior which include the impact of QOL.

The improvement of modeling techniques has been hampered by many of the deficiencies already mentioned but will

proceed more effectively once these impediments are removed. Nevertheless, a major hindrance to improved modeling that has not yet been discussed is the difficulty of getting personnel managers to accept models they do not understand. Thus far, the most successful models have been the simplest, although they may not be the most accurate. More thorough validation of models could contribute to building confidence and mitigate the need for understanding, but ultimately personnel managers want to be able to understand model results for themselves and be able to explain those results to others.

To solve this problem, research should be conducted to remove the shroud of misunderstanding that prevents planners and analysts from utilizing model results. The source of this misunderstanding is the "black box" effect of the models. The people who use the models are often not trained in sophisticated modeling techniques, and occasional training sessions where model processes are explained do not have a lasting effect. Development of techniques that effectively make modeling processes more evident would not only engender more confidence in the model results, but also promote a better understanding of the personnel force processes underlying the model. It would also allow the users to become a much larger part of process improvement through their greater understanding of the entire modeling process. To accomplish this, methods should be developed to **enable users to visualize modeling processes**.

This approach will enable researchers to **explore and develop more effective modeling schemes** that permit a greater depth of analysis of options and the potential effects of various decisions, including modeling of plans and policies across the entire MPT spectrum. These modeling advances should be integrated with the other proposed information advances to facilitate the transformation of knowledge about the personnel environment into understanding of interrelationships of different aspects of force management and likely consequences of management decisions.

Comprehensive Information Environment

The synthesis of these building blocks will lead to the Personnel Battlefield Simulator and the capability to effectively monitor and manage the personnel force. This environment will enable personnel planners, managers, and analysts at all levels up to the CNP to quickly identify emerging strengths and weaknesses within the force and to evaluate alternative actions that will promote efficient allocation of resources, prevent degradation of readiness, and avoid budget shortfalls. It will go significantly beyond existing systems to include intelligent monitoring of the force by automatically analyzing frequently updated, cleansed force statistics and historical data, deriving correlations and trends, discovering complex data relationships, and giving clear warnings when leading indicators dictate. This force monitoring component will be coupled with integrated models to evaluate alternative courses of action to remedy or exploit identified force conditions. The models will include the ability to quantify the personnel and cost effects of compensation and QOL factors so that scarce funds will be targeted to the programs that will have the most desired effects. It will feature advanced human-computer interaction capabilities that will foster understanding of the full constellation of factors surrounding specific personnel management problems and opportunities.

An important element of the research program will focus on linking all MPT processes into an integrated, modular system. This new approach to MPT systems, based on a single source of verified data, would provide continuous monitoring of readiness and other key outcomes with consistent data and definitions available to personnel at all levels. The integrated system would enable personnel managers to evaluate effects of actual and proposed changes in personnel policies and behavior on costs and readiness.

If this research agenda is successful, personnel force managers will be able to more proactively manage, rather than reacting to crises.

Integrated Research Agenda

Basic Science Foundation

Data Quality

We would investigate new techniques to identify and correct errors in data. Relevant technological advances bearing on this work include advanced intelligent software agents. One promising avenue is an agent system modeled after the human immune system, which is able to identify and eliminate unhealthy conditions (Dasgupta). Development of fuzzy logic techniques to determine dynamic acceptable ranges of values for identification of errors would be explored. Intelligent software agents combined with statistical techniques would be developed to determine the relative frequency, size, and distribution of errors in the data, and dynamically make decisions on how to correct or minimize the impact of these errors.

Intelligent Agents

Research would be conducted to develop intelligent agents to monitor personnel conditions and draw attention to deviations from expected behavior. In order to anticipate force management problems by comparing current force behavior with historical behavior, sophisticated techniques will have to be developed to dynamically identify the data elements and conditions which are likely to have a significant impact on the health of the force.

Data Visualization

Research in data visualization will enable users to interpret numerical data more quickly and effectively. Dr. Priti Shah, a University of Memphis researcher who is an expert in this field, is collaborating with NPRDC on a Basic Science project in this area, Cognitive Studies of Complex Data Visualization (Shah).

Econometrics / Alternative Compensation Schemes

Innovative econometric techniques need to be developed to evaluate alternative compensation possibilities. NPRDC has already begun to explore these areas with Dr. Keith Womer, Dr. Walter Mayer, Dr. Robert Dorsey, and Dr. Laura Razzolini of the University of Mississippi.

QOL Assessment

A variety of new techniques, including conjoint analysis and examination of links between observed variables and latent variables, such as attitude, would be investigated as an approach to the modeling of QOL effects.

Exploratory Development

Data Visualization

Interpretation of information provided by computer systems will be facilitated by developing visual information filtering techniques, which is currently the subject of an NPRDC exploratory development project, Visual Information Filtering for Force Management.

Personnel Data Quality Assurance

The first step toward improvement and measurement of data quality is R&D of a data quality facility which would use new techniques to identify and correct errors in the personnel data.

Data Mining

Research would be conducted in the area of data mining to determine which techniques (neural networks, decision trees, genetic algorithms) are most applicable to identifying meaningful trends in databases containing personnel data (Das, Lin, et al).

Model Visualization/Interpretation

We would investigate techniques to enable users to visualize modeling processes, transforming the “black box” into a “transparent box”, using techniques from the study of human-computer interaction. Techniques would be developed to enable managers to gain insight into the modeling process in the normal course of using a model, for example, by displaying an animation that metaphorically represents the process.

Econometric Modeling Improvements

Improvements to the current ACOL-based econometric modeling technique should be researched to allow analysts more flexibility in analyzing the effects of a variety of different compensation schemes on a variety of different stay/leave choices, including extensions and multiple year commitments. Results from the basic research into Econometrics / Alternative Compensation Schemes and QOL Assessment would be extended to evaluate tradeoffs between proposed techniques.

Advanced Development

Comprehensive Officer Force Management Environment

This current project will integrate many of the concepts of this vision for personnel planning and policy analysis on a small scale, excluding the data warehouse, for the officer personnel force only.

Enlisted Personnel Battlefield Simulator

This project would go beyond the Comprehensive Officer Force Management Environment project by integrating the concepts of the Personnel Battlefield Simulator vision on a larger scale. This would include full integration of all relevant enlisted personnel planning and policy analysis data into an information system that facilitates user understanding of the entire enlisted personnel environment.

Integrated Cost Tradeoff Modeling

Selected econometric techniques and costing methods would be integrated into

planning and analysis models so that personnel behavior and proposed personnel policies can be evaluated by cost.

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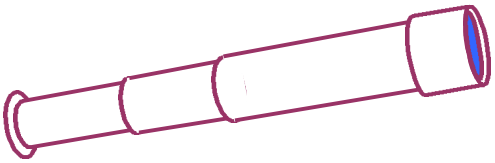
Distribution and Assignment

Vision



In today's enlisted personnel assignment system Sailors interact with their assignment managers or "detailers" largely by telephone. In the future, intelligent software agents will represent Sailors in a Web-based, market-like personnel distribution system. These agents will carry a Sailor's career history and experience, as well as his personal preferences, as it searches for matches with intelligent agents representing Navy commands with job vacancies. A third set of agents in the distribution and assignment marketplace will patrol the market to monitor assignments and to ensure that critical policies are executed.

The future Navy will place greater demands and stress on our Sailors. Radically different crew rotation schemes will be commonplace. Time away from home, both on deployment and in training, will increase. The Navy's ability to retain this smaller, yet highly skilled work force will be severally challenged. Increased compensation will not be enough. A distribution and assignment system based on graduated incentives for more arduous assignment will play a fundamental role in the Navy's retention effort.

The Web-based architecture consisting of cognitive software agents will allow Sailors to apply for an array of available jobs, get real-time descriptions of those jobs and their locations, and exchange e-mail with their detailer to ask for additional information, do career planning, and negotiate their assignments.

The system will provide Sailors and detailers with complete information for making informed assignment decisions. In addition to giving a Sailor a slate of available jobs, he will be able to, among other things, examine the promotion status of other Sailors who successfully completed each of the jobs, and view tradeoffs among the assignments in terms of location preference and career advancement.

Similarly, detailers and distribution managers will be supported by sophisticated decision support tools providing rapid assessment of personnel shortages and surpluses in specific fleet or shore units, by mathematical models that quickly examine the many assignment combinations and suggest best matches, and by analytic tools to examine trends and patterns in the execution of important personnel policies.

A "reduced crew" Navy will require more from fewer Sailors resulting in more "one of a kind" jobs and personnel. The misplacement of a single Sailor will likely have more impact on the unit's ability to perform. The future distribution and assignment system will be the cornerstone to ensuring that the Navy "puts the right person in the right place at the right time."

Introduction to Navy Personnel Distribution and Assignment

Simply stated, personnel distribution and assignment is the process of matching the right person to the right job. Distribution is better known as matching "faces" or Sailors with "spaces" or jobs. For many years the Navy personnel distribution process has relied on what is often referred to as the "Triad of Detailing." This triad consists of three distinct functions: allocation, placement, and assignment or detailing. While each performs a specific function, elements of each directly influence the performance or outcome of the others.

During the allocation process, personnel expected to be available for assignment within a specified future time period are allotted to specific areas such as the Atlantic Fleet, Pacific Fleet, Bureau of Naval Personnel (BUPERS), or Reserve-Manning Control Authorities (MCAs) and to either sea duty or shore duty. The objective of allocation is to equitably spread available personnel among these existing and competing requirements. The Enlisted Distributable Projection System (EDPROJ) is the principal analytical tool used in the allocation process.

Placement monitors the manning of the various activities. In so doing, a placement officer is considered an activity's advocate. Emphasis is on ensuring that the activity is manned with the right individual, on time and with the correct training. For enlisted placement the Active Readiness Information System as well as the Enlisted Assignment Information System (EAIS) are the principal information systems used.

The assignment leg of the triad is most frequently referred to as detailing. Assignment is primarily concerned with matching a particular individual with a particular job based on the needs of the Navy and the needs of the individual. The detailers are generally considered the Sailor's advocate. With different skills, paygrades, and experiences the Sailors must be matched against jobs with various skill, paygrade and experience requirements. The complex assignment process is made even more complicated by the myriad of eligibility rules, regulations, and personnel policies associated with personnel assignments. The assignment officer typically strives to ensure his constituent is assigned to billets of ever-increasing responsibility, whether at sea or ashore. While EAIS is the principal tool for making assignments, the enlisted distribution system has been essentially unchanged for over twenty years.

Operational Problems

Assigning approximately 130,000 Sailors a year requires over 200 detailers in the Bureau of Naval Personnel. The vast majority of personnel assignments are determined by negotiation between detailers and Sailors over the phone. A centralized procedure requiring Sailors to call their detailers within nine months of the planned rotation date, enlisted detailing is often time-consuming, inefficient and ineffective. The detailers spend over 40 percent of their time negotiating with individual Sailors about their next assignments. Studies have shown that much of the discussion between the detailer and Sailor is merely identifying the available and appropriate jobs based on the Navy needs and the Sailor's preferences. Sailors frequently make hasty decisions after contemplating the few choices that their detailer offers. In addition, this first-come-

first-served approach does not optimally execute the multiple and frequently conflicting Navy personnel policies such as meeting more Sailors' preferences, utilizing more Sailors' skills and training, and minimizing Permanent Change of Station (PCS) move costs.

Technological Advances in Support of This Research

Optimization and Mathematical Programming

Advances in optimization theory and mathematical programming have facilitated NPRDC's ability to solve extremely large and complex assignment problems. The Navy assignment problem is very complex and really consists of many large-scale combinatorial problems. Distributing a large number of Sailors to jobs every month in accordance with a large number of rules and policies is a large mathematical modeling technical problem and a very computationally intense operational problem. Detailers develop new assignment slates every two weeks for over 100 enlisted occupations, resulting in over 2,000 separate assignment problems per year. While every person is not eligible for every job, there are still about 36 million assignment alternatives per year. In addition to the size of the problem, detailers must consider many conflicting policies such as minimizing PCS moving costs, maximizing skill utilization and satisfying Sailor's individual location preferences.

NPRDC's approach to making Navy person-job matches has been to develop novel mathematical formulations and advanced computational algorithms to solve a network with side constraints optimization. Conventional linear programming techniques could not be used because of the exponential growth in problem sizes, the requirement for integer solutions (you can't divide a Sailor in half!) and the non-standard constraints. Our research successfully exploited the recent computational advances in mathematical programming and optimization theory and developed mathematical models, integer programming, goal programming, heuristic, and multi-criteria network codes with side constraints, and reoptimization capabilities that solve Navy's large-scale and multi-objective problems. In addition, algorithms were developed that utilized techniques similar to those employed in the Karmakar interior point method, genetic algorithms, greed algorithms and heuristics. In cases where sample problem sizes and types were amenable to being solved using conventional linear programming techniques, the advanced algorithms developed solved the assignments quickly and more efficiently. NPRDC performed model validation and comparative analyses demonstrating that this new optimization model could generate significant improvements over manual methods in personnel assignment measured by average moving expenses, preferences satisfied, grades matched, and skills utilized. Aside from the usefulness in supporting day-to-day decision making in personnel assignment, the same optimization model can be used to link the daily assignment process to assignment policy.

Expert and Knowledge-Based Systems

Advances in expert and knowledge-based systems technology have made it easier to develop expert system or knowledge-based models without the use of artificial intelligence programming

languages. By defining a set of rules and user-supplied data through interaction with an inference engine, an expert system is able to derive or deduce new facts or data from existing facts and conditions. NPRDC developed a proof-of-concept rule-based expert system prototype that quantifies the myriad of complex assignment rules and methods and procedures of detailers as it emulated the screening and qualification process. The prototype was user-tested, validated and verified. The expert-systems prototype will be installed as a module of a larger suite of assignment and distribution systems called MAST (Military Assignment Selection and Transfer).

Intelligent Distribution Agent

The intelligent distribution agent field has spawned some technological techniques that provide for an integrated and distributed approach to improve information delivery and analysis, communication, and decision-making in the manning, allocation and assignment processes. For most of its four decades of existence, artificial intelligence has devoted its attention primarily to studying and emulating individual functions of intelligence. During the last decade, researchers have expanded their efforts to include systems modeling a number of cognitive functions.

By an intelligent or autonomous agent (Franklin and Graesser 1997) we mean a system situated in, and part of, an environment, which senses that environment, and acts on it, over time, in pursuit of its own agenda. It acts in such a way so as to possibly influence what it senses at a later time. That is, the agent is structurally coupled to its environment (Maturana and Varela 1980). Biological examples of autonomous agents include humans and most animals. Non-biological examples include some mobile robots, and various computational agents, including artificial life agents, software agents and computer viruses.

Designing intelligent software agents that are equipped with cognitive features chosen from among multiple senses, perception, short and long term memory, attention, planning, reasoning, problem solving, learning, emotions, moods, attitudes, and multiple drives can simulate the human thinking processes. Such agents today are more flexible, more adaptive, more human-like than any currently existing software because of their ability to learn and deal with novel input and unexpected situations.

Designing and developing cognitive software agents to represent the interests of detailers, Sailors, N-1 and Navy Personnel Command, the MCAs, resource sponsors and others makes it more feasible to improve the communication, information delivery, analysis and decision-making in the distribution and assignment process.

Challenges to Overcome

Before the distribution and assignment methodologies can become a part of the Navy manpower and personnel organization, a variety of issues must be addressed and resolved.

One set of hurdles lies in the capacity and performance of the mathematical programming algorithms and computers. At the strategic policy level, some problems may require an optimization model to examine all possible combinatorial assignments of all people to jobs. Though current optimization models can handle separate communities and ratings and other

large groupings, none of the models can handle a problem that considers assignment of more than 1500 people to 2500 jobs in a single run. The Navy assigns at least 11,000 people per month. The problem is a combination of the RAM constraint of modern computers and the CPU-intensive nature of the optimization algorithms.

A related hurdle is the lack of optimization-oriented simulation development environments. Though simulation tools and packages abound with nearly any feature or functionality desired, none have a comprehensive optimization feature. Many of the approaches that NPRDC has examined to evaluate policy impacts in the distribution area require both simulation and optimization functions. In particular, embedding an optimization algorithm within a simulation architecture is often the best approach to model the assignment or distribution process over time.

Though intelligent distribution agent technologies have advanced tremendously just in the last five years, development of separate autonomous agents for the different stakeholders in the distribution process (detailers, Sailors, community managers, etc.) will require a more sophisticated representation of their cognitive functions (e.g., reasoning, memory, problem-solving). In addition, the underlying communication technology among software agents (e.g., e-mail, operating system commands, messages and natural language) is not all equally developed. The technology for communicating (encoding and decoding) using e-mail and natural language is still immature and somewhat unreliable. Also, constraint satisfaction methodologies in multi-agent architectures have not been widely tested. In addition, the ability of intelligent agent technology to adequately represent the decisions, emotions, consciousness and problem-solving capabilities of humans is still evolving.

Another problem relates to the vast amounts of data or knowledge required to execute the various decision support models for the distribution arena. Capturing, storing, organizing, validating and cleansing the data for the various models and systems will be a challenge. Making the data available in real time, at the appropriate level of aggregation and ensuring the consistency across models is a fundamental requirement.

Integrated Research Agenda

Basic Science Foundation

- Develop overall conceptual intelligent distribution agent architecture for the distribution area.
- Define, design and develop constraint satisfaction methodology. Explore the use of various linear and non-linear functional approaches to determine how a proposed action or decision will meet the requirements or needs of a stakeholder (e.g., Detailer, Sailor, Command).
- Define, design and develop emotions, consciousness, metacognition and learning functions of agents.

Exploratory Development

- Design and implement a prototype Sailor cognitive agent. Use object-oriented class structures to code and test prototype.
- Refine the constraint satisfaction equations. Improve estimates of the

coefficients, and the general functional form.

- Refine the design of the Sailors cognitive features.
- Test cognitive software agents. Gather data of actual responses and decisions and compare against the functional design.
- Validate and verify results.

Advanced Development

- Using results from exploratory development, design a cognitive software agent prototype adding the Detailer cognitive agent.
- Expand scope of cognitive software agent capabilities. Initially, emotions, consciousness, learning and metacognition will be captured in the intelligent agents. Additional cognitive features such as attitude, perception or multiple drives will be added to the intelligent agent.
- Incorporate knowledge-base for enhanced learning. The capability to learn from past decisions of cognitive intelligent agents by capturing and evaluating actual past decision scenarios will be developed. Development of a knowledge-base will serve as a foundation for developing this learning capability.
- Incorporate natural language communication capabilities among cognitive software agents. Communication among the agents will initially be based on structured formats such as tables and screens. An expanded capability to encode and decode the context of e-mail and natural language will be designed and developed.
- Design and develop optimization functionality within the Detailer agent. The Detailer agent will need to make assignment decisions only after optimization of alternative assignments has been made. Coding an optimization module will be required.
- Assess the effectiveness of interactions between the cognitive agents and the overall system. Measuring how the communication, responses, actions and decisions by the cognitive intelligent agents improves the overall distribution processes (readiness, PCS costs, crew stability, etc.) will be analyzed and documented.
- Demonstrate a prototype “assignment market” that incorporates intelligent agents for all market participants.
- Validate and verify results.
- Evaluate effectiveness and benefits of the prototype. Develop a cost/benefit analysis of the intelligent decision agent prototype.

Anticipated Benefits for the Navy M&P Organizations

The research, design, development and implementation of the new distribution and assignment system will provide benefits to Sailors, detailers, type commanders, MCAs, policy analysts, and other major stakeholders in the distribution process.

Development of a Web-based intelligent distribution agent architecture that captures and quantifies the data, information, knowledge, regulations, policies, decision criteria and logic of the various distribution

and assignment processes as well as the large-scale optimization algorithms of the assignment models and the technologies of Job Advertisement and Selection System (JASS) and Computer Enhanced Detailing and Distribution System (CEDAD) will significantly improve the information delivery, decision-making, planning, analysis, policy execution and resource allocation for all stakeholders involved in the distribution process. Use of intelligent software agents will increase the flexibility of the distribution process to keep pace with the dynamic nature of requirements, changing force composition, policy and environmental uncertainties, decreasing budgets, changing operational tempos and changing career interests. Sailors will have more timely, accurate and relevant information for making career-enhancing decisions such as the best jobs or types of training that enhance promotion. Detailers will be able to make better person-job assignments through tradeoff assessments and by analyzing trends and patterns in the completed duty assignments. Type commanders and the MCAs will be provided real-time information related to policies and actions that may impact their ability to achieve high levels of warfighting readiness. Application of this technology will improve the Navy's ability to put "the right person in the right place at the right time."

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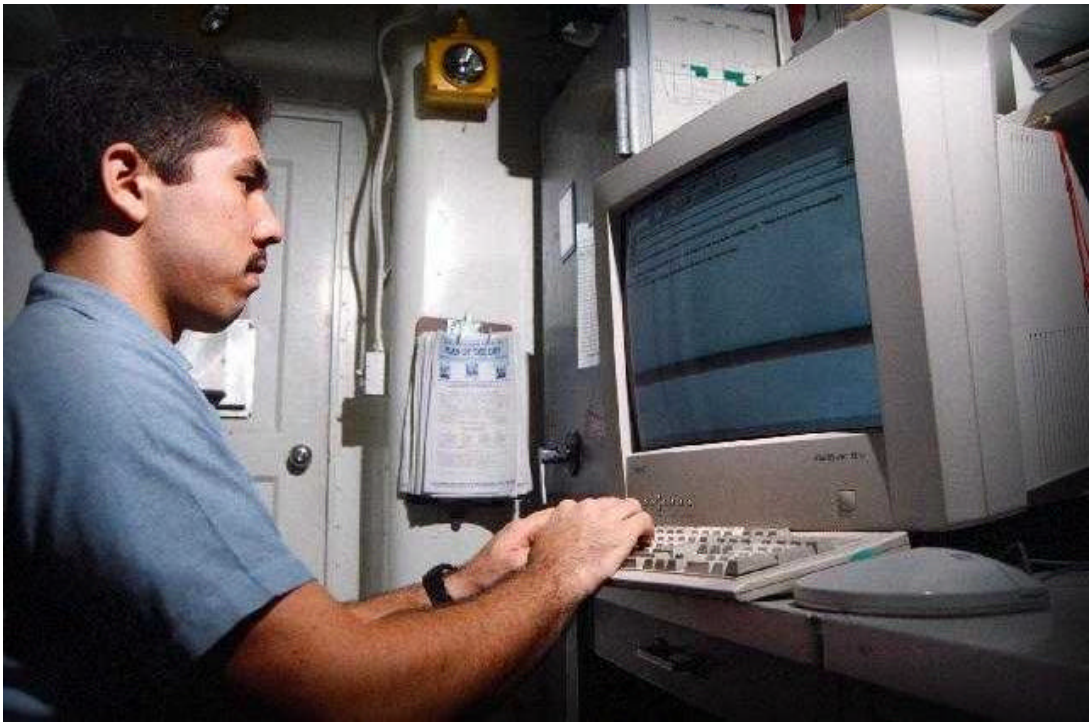
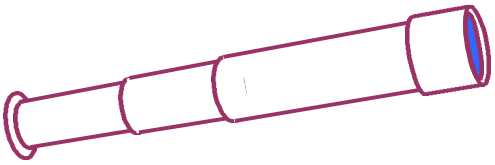


Navy Manpower and Personnel Knowledge Management Systems

Vision



Early in the next century, the Navy manpower and personnel (M&P) enterprise will exploit a knowledge management library (KML) to create more accurate and robust plans and policies and support more informed and responsive decision-making. The library will contain hypermedia, such as video clips, audio clips, databases, and electronic documents which provide deep insight into past decision-making and policy generation. Video and audio clips will contain comments and narratives of how previous decision-makers and analysts addressed various M&P issues. The system will gather these "knowledge clips" through technological advances in the capture and transmission of video/audio over the Internet and corporate intranets. Innovative new software will catalogue the hypermedia into an intelligent taxonomy that allows users to retrieve knowledge clips on a particular subject with a few simple mouse clicks. By providing access to this library of corporate memory, the KML will allow best practices to improve over time and thereby strengthen the efficiency of the enterprise.

As an example, consider the Lieutenant Commander who has just reported onboard as an enlisted community manager (ECM). He has just come from sea duty and has no previous personnel management training or experience. On his first day, the new ECM accesses the knowledge management system (KMS) to learn about his new job (the billet was gapped and he received no turnover). He discovers the recurring tasks required in the job, the available information resources (e.g., historical retention data, and previous strength plans), and a step-by-step process for executing those tasks. The step-by-step process links directly to the data and models that will be needed to execute the tasks. Tutorials are provided on how to run models and use data. Terminology is quickly learned. The ECM sees his predecessor discussing key issues pertaining to the community for the last six months and what actions were taken to deal with those issues. Within two weeks (vice several months in today's environment) the new ECM is performing at nearly the same level of proficiency as his predecessor.

After only three weeks on the job, the ECM is called upon to provide a complex analysis of how a reduction in the Permanent Change of Station (PCS) budget will affect his community. Unfortunately, this analysis, is not one of the recurring tasks that the ECM has learned about earlier. However, this type of analysis has been conducted before. By using the KML, the ECM discovers that a similar exercise occurred four years earlier. Listening to the ECM who responded to that drill four years ago, the new ECM quickly develops an analysis plan for addressing the new situation. However, this ECM also realizes that additional data sources (recently implemented and catalogued in the KML) are now available to help with the analysis. Thus, the ECM, using a similar plan of attack from four years earlier, develops a response that now incorporates the new data. From the KML, the ECM pulls together data pertaining to the community members' locations, projected rotation dates, available billets for the next 12 months (new data), the current sea/shore ratio, the desired sea/shore ratio, and expected retention and attrition rates. The analysis reveals that the community must execute a certain number of rotational moves in order to maintain a healthy sea/shore ratio. The argument is made to fence this community from any cut in the PCS budget. Without this analysis, which was made possible by the corporate memory retained in the KML, this particular community would likely have

suffered additional attrition from unbalanced sea/shore ratios, thus impairing readiness. Once the analysis is complete, the new ECM adds a new entry to the KMS, explaining how he responded to this exercise. Future ECMs will benefit from the added knowledge provided by this individual. However, even as these "best practices" are preserved, they will not constrain future analysts to a pre-determined path, but rather serve as guides to potential courses of action.[1]

Operational Issues Affecting Knowledge Management

Today, Navy M&P organizations are faced with a persistent loss of knowledge accumulated by their staffs. Continuous turnover of uniformed personnel results in a devastating erosion of expertise and corporate knowledge of the business functions that support the Navy's M&P processes. Many of these functions require extensive knowledge and analytical ability gained only from years of experience working in the functional area. Without this core knowledge and the benefit of past trial and error, process managers make uninformed and sometimes costly decisions.

Such uninformed decisions in the M&P arena can have harmful consequences. Unfortunately, the results generally take a long time to mature. Accurate accession plans, strength plans, reenlistment bonus levels, promotion flow points or retention goals can ensure sufficient, qualified personnel to man the Navy, but if inaccurate, can cause shortages or excesses that require years to counteract. For example, an aviator accession plan that fails to anticipate high or low levels of attrition can lead to chronic shortages or surpluses of pilots. In the first case, the Navy's readiness levels are severely impacted while the second case can lead to excessive personnel spending, reduced morale, and promotion bottlenecks which will ripple through the aviation community for years.

As an example, consider the common, recurring issue of "bow-waving," which typically suffers from "memory loss" within the M&P arena. Bow-waving occurs when planned actions (e.g., promotions or PCS moves) for a fiscal year cannot be completed due to some external factors. Whether delaying promotions across fiscal years due to year-group sizing, budget constraints, or the frequent delay of PCS orders due to funding shortfalls or carrier rate increases, bow-waving has plagued Bureau of Naval Personnel (BUPERS) for years. These unexecuted actions are typically carried over into the next fiscal year, causing disruptions in personnel plans and impacting the ability to execute planned actions for the new fiscal year. Each division (e.g., promotions, assignment, budget) approaches this issue differently. Successful tactics are not shared, nor are the impacts from one division's actions always immediately recognized across the organization. Would the decision made three years ago to delay promotions work better today than the current plan? What was the impact of that decision? What was the cost in retention? What actual savings were realized? Just as important, what was the manager thinking when he made the decision?

A similar problem is the loss of lessons learned. These "after action" reports rarely outlive their authors by more than one or two tours. In the past, when and if

[1]Malhotra, Yogesh (1998). "Toward a Knowledge Ecology for Organization White-Waters," Keynote Presentation at the Knowledge Ecology Fair 98: Beyond Knowledge Management, February 26-27, 1998.

documented, they were usually the result of some problem arising. Ten years later, when the same issue resurfaces, the same analysts (if still holding the same positions) will likely remember the problem, but not necessarily the solution and the thought processes involved. Rarely are "lessons learned" recorded when things work as planned. The failure to document success stories deprives the Navy of valuable experience.

The underlying operational environment is primarily responsible for this loss of knowledge. Uniformed personnel tour lengths of two to three years do not afford the needed continuity while few civilian positions have a sufficiently broad perspective to fully grasp the business functions of all M&P processes. Uniformed and civilian replacements require extensive on-the-job experience to replenish the knowledge base. Training alone, where available, does not suffice and is costly. Routinely, the training consists of one to two weeks in parallel with the outgoing manager. This is only as valuable as the incumbent's performance. If the function was managed poorly, chances are the function will continue to be managed poorly. A short turnover likewise does not always provide the opportunity for a relief to participate in critical tasks that do not occur during the contact relief process (e.g., the development of strength plans or Program Objectives Memorandum (POM) issues that occur cyclically). Regardless, it is unlikely the incumbent will be able to impart all the knowledge gained during the tour—particularly the cognitive, decision making process.

No centralized reference library exists for functional managers to turn to when issues arise. Decisions are made based on the best information available, with little insight into the pitfalls of similar decisions made in the past. The uniformed functional manager will quite often be transferred to his/her next assignment before the results of a decision, good or bad, are even known. The "relief's relief" can very well make the same mistake again or, at best, try to rectify the mistakes made by his/her predecessors. Further, when good decisions are made, managers often do not get credit for long-delayed successful program outcomes. This often acts as a disincentive for them to focus on long-term goals, solutions, and outcomes, which is crucial for successful management of the Navy's manpower and personnel programs.

Functional experts frequently must conduct extensive analysis to arrive at a decision or to produce adequate information for executive level decision making. Many issues (e.g., changing the retirement system) are raised, researched and analyzed repeatedly over the years, but the thought processes and the methodologies used to arrive at decisions is often lost or documented poorly. Meanwhile, Navy analysts working on these issues have often rotated to new positions, leaving new analysts the task of deciphering how and why their predecessors arrived at their conclusions. So when the same issues arise, the research and analysis must be repeated, data reproduced, logic redeveloped, and decision options reconstructed. Even if documentation exists, the incumbents do not have the benefit of the thought processes involved in the earlier decisions. The complexity of the decision-making process is lost.

Further, there is little information shared across the numerous functional areas. Research, analysis, and decision making to address problems encountered by one manager are rarely shared with or utilized by

other functional managers for similar issues. Each manager approaches an issue independently, quite likely unaware that a similar (or possibly a supporting) matter has been thoroughly researched and reviewed by another segment of the organization. Again, much effort is expended on analysis that has already been done. Sharing of such information between functional areas would help alleviate "stovepiping" and benefit the entire organization.

These long-standing problems are exacerbated by the Base Realignment and Closure (BRAC)-directed relocation of a significant segment of the BUPERS staff to Millington, TN. BRAC caused many civilian employees, a viable source of expertise and continuity, to seek other employment and also forced many into early retirement. Combined with the continued reduction in the BUPERS staff due to the Department of Defense (DoD) drawdown, the impact has been to eliminate much of the already limited corporate knowledge base. Many BUPERS positions are not amenable to short turnover periods due to the dynamic nature of the function. Problems and issues change from week to week and month to month. Abbreviated tours allow only minimal time to understand the function, much less to gain the knowledge to make informed and intelligent management decisions.

Because the loss of knowledge from rotating or retiring analysts will always be a factor in Navy M&P processes, the ability to capture the thought processes of analysts offers the potential for providing valuable assistance to future Navy analysts. A new technology is preferable to changing uniformed personnel policy, since the Navy's promotion system is based in large part on the rotation of its personnel to increasingly more demanding positions. To appropriately compensate civilian personnel tasked with such "knowledge" responsibilities would require elevating grade levels beyond those that exist today and is not considered to be as cost effective as process knowledge management.

An Introduction to Knowledge and Knowledge Management

Knowledge within an Organization

In order to help alleviate these problems, the development and implementation of a KMS or KML is required. What exactly, though, is "knowledge" or "knowledge management"? Given the recent explosion of this field in the academic and business environments, many definitions have been offered. One shared theme is that knowledge in the minds of organizational members is of greatest value as an organizational resource.[2] This organizational wealth is referred to by various labels such as knowledge capital, knowledge assets, intellectual capital, and so on. "Organizations interact with their environments, absorb information, turn it into knowledge and take action based on it in combination with their experiences, values and internal rules. Without knowledge, an organization could not organize itself. It would be unable to maintain itself as a functioning enterprise."[3] In the Navy M&P environment, knowledge can take many forms, including:

[2]Malhotra, Yogesh (1997). Current Business Concerns and Knowledge Management [WWW document].URL http://www.brint.com/interview/times.htm

[3]Davenport, Thomas H. and Prusak, Laurence (1998). Working Knowledge: How Organizations Manage What They Know, Harvard Business School Press, 1998.

- Processes for development of manpower plans and policies
- Impact of plans and policies on force behavior
- Impact of plans and policies on other organizations' missions
- Value and interpretation of historical M&P data
- Specialized subject area expertise (e.g., specific enlisted community behavior, reenlistment bonuses, retirement system analysis, etc.)
- Organizational constraints
- Political landscapes
- Uses of specialized software (often the result of previous research products)
- Pitfalls of using specialized software
- Lessons learned from past policy mistakes

The Science of Knowledge Management

Given that an organization creates and survives by its knowledge, the concept of knowledge management takes on added importance. A variety of definitions of knowledge management have emerged:

- "The acquisition, sharing and use of knowledge within organizations, including learning processes and management information systems"[4]
- "…Embodies organizational processes that seek synergistic combination of data and information processing capacity of information technologies, and the creative and innovative capacity of human beings"[5]
- "Creation, acquisition and transfer of knowledge and modification of organizational behavior to reflect new knowledge and insights"[6]
- "Finding out how and why information users think, what they know about the things they know, the knowledge and attitudes they possess, and the decisions they make when interacting with others"[7]
- "Getting the right knowledge to the right people at the right time so they can make the best decision"[8]

The latter definition neatly summarizes the anticipated outcome from building a KMS for Navy M&P organizations. To get there, research and development are necessary to evaluate the applicability of cognitive process interpretation and capture—as well as evolving knowledge management technology—to this problem. Cognitive process capture involves recording actual thought processes involved in decision making. Knowledge management differs significantly from simple data management, which is generally

[4]Business Process Resource Center (1998) " Knowledge Management" [WWW document]. URL http://bprc.warwick.ac.uk/Kmweb.html

[5]Malhotra, Yogesh (1998). "Knowledge Management for the New World of Business," in Executive Intelligence, Hewlett-Packard Executive Programs, August, 1998.

[6]Garvin, D.A. (1994) "Building a Learning Organization," Business Credit, 96(1), January 1994, pp.19-28.

[7]Hannabuss, S. (1987), "Knowledge Management," Library Management, 8(5), 1987, pp. 1-50.

[8]Petrash, Gordon (1997), as quoted in InformationWeek (Issue 653), October 20, 1997.

little more than storage and retrieval. In this case, knowledge management involves capturing, parsing, classifying, organizing, storing, and retrieving explicit and tacit knowledge. Explicit knowledge is stored and made publicly available (e.g., definition of a retention rate) while tacit knowledge resides in people (e.g., the judgment that makes an analyst choose one policy option over another).[9] The thought processes and information analyses that go into historical decisions will help future M&P managers effectively and efficiently manage their functional processes.

Technological Advances in Support of this Research

Previous NPRDC Work

Previous relevant work conducted by NPRDC has focused extensively on the development of information delivery systems (IDS). These systems (e.g., TARGET, RIDS, AIMS, DIPM, etc.) sought to capture historical data (e.g., individual master file records or aggregate force behavior data) and enable users to intelligently query the data as needed. These systems focused primarily on retrieving desired explicit knowledge. More recent work has centered on applying data mining techniques to these databases in order to discover additional explicit knowledge. Data mining typically involves the use of one or more algorithms (e.g., neural networks, induction, association, fuzzy logic, statistical, visualization) to identify knowledge buried in the data.[10] However, even these processes are limited to excavating explicit knowledge. An effective KMS will capture and link together both explicit and tacit knowledge.

Hardware and software for video/audio transmission and capture

Toward this end, major technological advances have been made which enhance the opportunity for the implementation of a KMS. On the hardware side, faster CPUs and larger storage devices offer the ability to maintain vast amounts of data, including video and/or audio clips. Higher communication bandwidths permit advances in video technology, such as video teleconferencing and video interaction via the Internet. RealNetworks, Inc. provides easy to use software for transmitting streaming video and audio over the Internet. Depending on the bandwidth, these transmissions are capable of broadcast quality (i.e., 30 frames per second). Consequently, the capture and transmission of video or audio images is becoming increasingly easy, even down to the level of the personal workstation.

In software, advances have been made that allow desktop editing and cataloguing of video or audio clips (hereafter referred to as “knowledge clips”). For example, such products as Adobe Premier© and Macromedia Director© allow knowledge clips to be digitized and translated into AVI files or Quicktime® movies. These files can then be incorporated into a menu-driven system that would allow users to intelligently retrieve and view the clips at will. Such systems could reside on an organization’s intranet or be made available over the Internet, with access restricted by security software. Other current advances,

[9]Nonaka, Ikujiro and Takeuchi, Hirotaka (1995). The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation, Oxford University Press, 1998.

[10]Gerber, Cheryl (1996), “Excavate Your Data,” Datamation, May 1, 1996.

such as video on demand, utilize fast, powerful servers to play selected videos over the Internet. Thus, the ability to organize and retrieve knowledge files is expanding rapidly while costs continue to decline.

These systems are becoming sophisticated enough to allow hyperlinks to databases and other historical information which might be referenced in the knowledge clips. For example, if an analyst indicated that his analysis relied on a time series from a particular database, the user could link to, retrieve, and view that data while viewing the clip. Similarly, if the original analyst produced a report which documented his analysis, the new analyst could be viewing, on screen, relevant sections of the report as his predecessor referred to them in the commentary. This capability would enable the user to more clearly grasp how the analyst's thought processes were shaped or swayed by the materials and data that were utilized as well as the external events and circumstances that impacted the process. Thus, knowledge clips can contain not only a warehouse of historical analyses but also can serve as learning tools for the new analysts. Functional managers new in the job can readily learn how their predecessors performed the job and what sources of data and information were used to come to decisions or conclusions. Further, some or all of these data sources could be updated with recent data so that the new analyst would have a running start in performing similar analyses.

COTS Knowledge Management Software

Commercial off-the-shelf software (COTS) for generating, codifying, and/or transferring knowledge is becoming available. Such products include:[11]

- grapeVINE (grapeVINE Technologies) uses a knowledge chart, user interest profiles, and several other components to add value to information on an individual basis, promoting knowledge creation and knowledge transfer.
- IdeaFisher (IdeaFisher Systems, Inc.) works through associative lists of words and phrases to help people put together disparate pieces to generate new ideas.
- Inspiration (Inspiration Software, Inc.) allows users to develop flexible, graphical concept maps which allow people to represent, and then re-present, concept linkages for synthesizing diverse ideas into new ideas.
- Idea Generator (Experience in software) uses methods like thought exercises and point-counterpoint drills to assist people in moving to a creative mindset which would have been difficult to achieve from within their own paradigms.
- KnowledgeX (KnowledgeX) allows an organization to create a map of its interrelated set of contacts, documents, events, and other interactions with information, allowing users to continuously comment, update, and explore the nodes or destinations on the map and create and change the relationships.
- Knowledge Management Suite (Dataware Technologies, Inc.) maintains a taxonomy which organizes documents

[11]Ruggles, Rudy (1998), "Knowledge Tools: Using Technology to Manage Knowledge Better" [WWW document]. URL http://www.businessinnovation.ey.com/mko/html/toolsrr.html

stored in different repositories and allows users to add metadata to documents they submit to the repositories, putting their contents into perspective.

- Notes (IBM) enables people to communicate with each other in a virtual space, over time, capturing the interactions, and permitting context and understanding to build up.
- NetMeeting (Microsoft) combines video, voice, and document sharing capabilities at the individual desktop.

Research Advances in Knowledge Management

Research advances have been made in applying cognitive task analysis to specific job tasks. The idea of capturing human performance on video, and allowing the analyst to provide narration fuses behavioral-rational [12,13] and cognitive analytic techniques.[14] The behavioral steps necessary for the performance of the task are archived dynamically on video, and the cognitive underpinnings which direct this behavior are archived on the accompanying audio. The challenge of capturing and representing these underpinnings is the primary focus of cognitive task analysis (CTA) research.

The Air Force has demonstrated repeated success toward this end using the PARI methodology as part of its Basic Job Skills Research Program. [13,15] Additional research is currently being performed using an automated knowledge elicitation device known as DNA.[16] These Air Force programs have been successful in identifying and representing the cognitive underpinnings for electronics trouble shooting,[13] technical troubleshooting and meterology,[15] and statistics.[16]

Other institutions are establishing knowledge management research centers. One example is the Department of Computer Science at HKUST (Hong Kong), which focuses on cooperative and intelligent database/information systems, distributed data systems, and data and knowledge base systems integration. Another is the Kentucky Initiative for Knowledge Management (KIKM), whose purposes include (1) fostering cutting-edge research that stimulates, discovers, and explores new computer-based possibilities for knowledge management, and (2) facilitating effective, up-to-date instruction about the rapidly growing and changing field of knowledge management, including computer-based possibilities for supporting the decision making, communication, and coordination of individuals, groups, and organizations.[17]

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[12]Gagne, R.M. (1974), "Task analysis: Its relation to content analysis", Educational Psychologist, 11, pp. 11-18.

[13]Hall, E.P., Gott, S.P., & Pokorny, R.A. (1995), "A procedural guide to cognitive task analysis: The PARI methodology", Technical Report (AL/HR-TR-1995-0108), Brooks Air Force Base, TX: Air Force Human Resources Laboratory.

[14]Greeno, J.G. (1976), "Cognitive objectives of instruction: Theory of knowledge for solving problems and answering questions. In Klahr (Ed.), Cognition and Instruction (pp. 123-159), Lawrence Erlbaum Associates, 1976.

[15]Pokorny, R.A. (1998), "Efficient cognitive task analysis using expert critiques to acquire expertise", In Proceedings of the 42nd Annual Meeting of the Human Factors Society, Human Factors Society, 1998.

[16]Shute, V.J., Torreano, L., & Willis, R. (in press), DNA: Towards an automated knowledge elicitation and organization tool. In S.P. Lajoie (Ed.) Computers as Cognitive Tools, Volume 2, Lawrence Erlbaum Associates.

[17]University of Kentucky (1998), "DSIS General Information – Kentucky Initiative for Knowledge Management (KIKM)" [WWW document]. URL http://www.uky.edu/BusinessEconomics/dssakba/GEN_INFO/kikm.htm

In short, advances in the management and use of information, communications, hardware/software, and cognitive task analysis will enable organizations to build vast libraries of corporate knowledge. These libraries could be shared with other organizations or remain solely a Navy resource to be used by Navy analysts only. However, many obstacles stand in the way of realizing these opportunities.

Challenges to Overcome

Before KMSs can become a routine part of the Navy M&P organization, a variety of research and non-research issues must be addressed and resolved. A research program, outlined later in this paper, will strive to answer most or all of the research issues.

Non-Research Issues

Some non-research issues include:

- What parts of the Navy M&P organization will contribute to the knowledge library?
- Who will "own" the knowledge within it?
- Who will create, control, and manage the technology behind the library? While a prototype library might encompass a small piece of one organization (e.g., Enlisted Community Plans and Policies), these issues should be addressed early on to avoid intra- and inter-organizational controversies.
- Which jobs/analysts should contribute to the library?
- Which topics/issues should be included?
- Should multiple, often conflicting, views be collected?
- Is knowledge contribution voluntary or mandatory?
- What privacy and legal issues must be addressed to ensure that the system is used fairly and without prejudice?
- Who has access to the knowledge library?
- What security measures need to be taken to restrict access?

Ideally, these issues will be addressed during the early stages of development of a KML. The identity of those responsible for making these decisions should be established at project inception.

Research Issues

Knowledge capture and codification. A variety of major research issues stand in the way of our KMS vision. One of the most important tasks will be to determine how best to capture and organize the thought processes of the decision-makers and analysts involved. Should knowledge be obtained for all tasks that comprise a particular job or should knowledge be obtained separately by major tasks? The organization of knowledge within the system will be crucial to its subsequent use and utility. Putting someone in front of a microphone or camera to talk extemporaneously about an issue or task may produce disorganized or rambling thoughts. Instead, some sort of logical structure should be imposed on "depositions" given by analysts. Application of cognitive task analysis should be able to create a methodology template for capturing relevant thought processes inherent in the execution of an analysis or task. This template would serve as a guide to those providing knowledge clips on what types of information, thoughts, and procedures

should be discussed. Through cognitive task analysis, a flow chart could be generated which would detail the if-then decisions made during an analysis. Thus, the template for capturing the knowledge might be very structured, suggesting a rigid set of contents or a certain order to providing information. Or it might be looser, allowing the contributors to express themselves openly and freely. The template might want to record "key words" pertaining to the issue at hand, which will allow subsequent cataloguing of the knowledge clips. Once a template for capturing knowledge is developed, tested and proven useful, the analysts should feel comfortable using it to provide information. It should also provide for consistent information recording; that is, when used more than once by the same analyst, the recorded information (for the same issue or analysis) should be relatively constant from recording to recording.

Research is also required to determine whether group or individual knowledge clips best serve the organization. If a group of analysts worked on an issue, should the knowledge clip contain a group recording or multiple recordings from individual group members? With a group recording, one would be able to see and hear how the analysts arrived together at a particular solution to a problem, thus preserving the interactions of the group. However, in such settings, the dissenting voices or second-guessers would not likely be heard, as they might be heard in individual clips. Which process yields the most or best knowledge?

Also, a decision as to the best type of knowledge clip to create (paper vice video vice aural) will need to be made early on in the design process. What information would be lost using just a paper report? What added value accrues from hearing or seeing knowledge contributors? Again, cognitive task analysis can help answer these questions by helping to assess the value of the thought processes contained in paper reports, audio clips, and video clips to viewers. Similarly, research should help discover how organizations can avoid having their "best practices" become so ingrained as to prevent employees from learning new techniques, particularly when discontinuous and radical change in the M&P environment call for new approaches.

After developing a process for capturing knowledge clips, additional work must be done to determine how to catalogue or codify those clips into a meaningful, useful library. What type of taxonomy will best serve the organization? How should the cataloguing process be done to enhance the value of the clip to potential viewers while minimizing the time required to perform the process? Will an association of key words attached to the knowledge clip suffice for cataloguing it and allowing interested parties to retrieve it at a later time? Or will a transcript of the clip be required in order to permit the viewers to execute a word search on all that was recorded? Which documents, files, and databases (if any) should be hyperlinked to the knowledge clip? In short, how will the organization develop a map of its knowledge resources? This map ought to indicate not only the types of knowledge available, but also the organizational repositories (i.e., people and places) of the knowledge.

As the volume of knowledge clips grows over time, the library should be sufficiently flexible to allow the inclusion of additional new topics or analyses while maintaining a logical structure that enables viewers to easily locate desired information. This stage of research, more technological than the others, will require a good deal of vision to look ahead five to ten years and plan in advance for growth and expansion of the KMS.

Knowledge dissemination. After capturing and codifying the knowledge, the other major research hurdle pertains to the dissemination of the knowledge to others. Simply building a library will not ensure its use (witness public libraries today). What methods or procedures will ingrain the library into the everyday regimen of employees? How will knowledge be retrieved? How would associated files and databases be made available to the user? The entire process of searching for, retrieving, and displaying knowledge clips will have to be researched in order to exploit the value contained in those clips.

Many of the above obstacles will have to be overcome in order to develop and implement a system that can create value for an organization. In order to address these issues in an orderly and timely way, a multi-year research and development program is required.

Integrated Research Agenda

A multi-year, multi-stage research effort is required to develop, test, and implement a prototype KMS. The research can be divided along the following lines:

Basic Science Foundation

- Apply cognitive task analysis to a Navy M&P task or billet to develop a template for eliciting knowledge from an analyst. Build on previous work as possible (e.g., conducted at Brooks Air Force Base).
- Develop appropriate measure(s) and procedures for codifying the knowledge (e.g., flow chart, key words, written transcript, etc.).
- Determine appropriate technologies for administering the template and collecting knowledge.

Exploratory Development

- Using the appropriate technologies, test and evaluate the knowledge collection procedures developed under basic science foundation research as applied to a set of tasks or billets in Navy M&P.
- Assess the utility of the obtained knowledge to analysts who are unfamiliar with the tasks or job requirements of the billets.
- Based on feedback from knowledge-givers and knowledge-receivers (i.e., analysts who would relieve the knowledge-givers), modify the knowledge collection template and knowledge collection technologies accordingly.
- Using the results from the basic science foundation research, develop a schematic for building and maintaining a library taxonomy that will codify the captured knowledge.
- Determine how best to hyperlink supporting documents and databases to the knowledge clips.
- Demonstrate hyperlink capability by linking one knowledge clip with corresponding files.

Advanced Development

- Using the results from exploratory research, design a prototype knowledge collection system and library for one organization in Navy M&P. Explore off-the-shelf software for possible inclusion

into the system. The design should address issues pertaining to knowledge codification and distribution and system security, access, privacy, management, and control. The system should be able to link with supporting documents and databases, as appropriate.

- Identify the billets and/or tasks that should provide the initial entries for the knowledge library. Develop an implementation plan.
- Develop the knowledge collection system by integrating it, as appropriate, into existing organization computer networks. Ensure the technology is compatible throughout the organization.
- Begin implementation of the KMS by collecting knowledge from the list of billets and tasks and as additional events or tasks warrant (e.g., one-time studies, fire drills).
- Assess effectiveness of knowledge library by evaluating its usefulness to new replacements in the designated billets. If possible, measure improvements in task learning time and quality of work.
- Identify and make improvements to system to enhance its effectiveness.
- Turn over knowledge library to organizational staff. Follow up periodically to assess use, usefulness, and recommendations for improvement.
- Develop plan to expand knowledge library across organizations, as appropriate. Address issues pertaining to ownership, security, accessibility, compatible technologies, etc. Transition to engineering development.

Anticipated Benefits for Navy M&P Organizations

Implementation of a KMS throughout various organizations in Navy M&P offer the prospect of substantial payoffs—particularly in jobs outside the Sailor's primary warfighting specialty, such as analyst positions that may be held only once in a career (e.g., detailer or community manager). These payoffs are likely to be seen at the individual level, the group level, and the organizational level.

Benefits for the Individual

For the individual analyst who is just entering a new position, the store of knowledge concerning the job tasks or the analyses performed by previous analysts permit him/her to immediately gain insights into the job and “hit the ground running.” With a reduced learning curve, the analyst can become productive in a shorter amount of time. This productivity may be evidenced by tasks performed with greater consistency, accuracy and/or timeliness, which in turn contribute to the overall wellbeing of the organization and its plans and policies. The knowledge warehouse, if used properly, allows the analyst to avoid making the same mistakes that previous analysts made. The linkage to supporting documents and databases will allow the analyst to quickly become familiar with the tools of the trade.

For the analyst who has been in the position for some time, the knowledge library offers the opportunity to leave a legacy of his/her accomplishments that can benefit other analysts in the future. New ways of doing business can be passed on for years to come and, if proven successful, can become an ingrained part of the organization. The library can thus become

an incentive to analysts to perform as well as, or even outperform, their predecessors. Rather than having an analyst or functional manager feel that his/her contributions will be lost or never recognized, contributing to the library of knowledge offers the analyst an opportunity to change the organization in small or perhaps large ways, depending on the task or analysis at hand. In time, doing an analysis the way "Pat did it" may become a routine practice within an organization. Further, experienced analysts can also contribute to the library by revisiting previous analyses (theirs or those of others) and updating the knowledge on a particular issue by providing outcomes (that may have taken months or years to realize) from policies or plans based on those analyses. These after-action contributions are vital to building a valuable knowledge warehouse.

Benefits for Groups

For groups of analysts (from one or many organizations) who are charged with addressing a set of issues (e.g., the Quadrennial Military Review of Compensation Commission), a knowledge library of previous similar gatherings can play a valuable role in helping the group avoid rehashing well-trod ground and instead address the issues in new and innovative ways. The group can benefit from hearing previous groups discuss their approaches to recurring issues. In fact, such knowledge could be imparted individually to group members via the Internet (or private network) prior to any group meetings. Similarly, once a group finishes its work, its findings, discussions, decisions, or recommendations could be made available through a KMS to interested parties with access privileges. The value provided by this approach, above that of a written report disseminated via the Internet, is an insight into the thought processes of the group, of roads considered but not taken, of rationales that lead to the final outcomes. Even dissenting opinions, often not found in written reports, could become part of the knowledge record for a group's proceedings.

Benefits for the Organization

For an organization such as the Navy's M&P enterprise, a knowledge library has the potential to become the permanent corporate memory database. While paper or electronic files are often never cross-referenced with other sources to provide even the barest thread of consolidated knowledge, knowledge clips offer the potential to become a longer-lasting record of how an organization functions, how decisions are made, and how plans and policies are crafted**.** Knowledge clips are likely to last longer within the organization due to their uniqueness as audio or visual files and the links they would provide to valuable resources used in the tasks or analyses. The knowledge clips would benefit all levels of the organization. Management personnel may want further insights into the reasoning behind reports produced by their employees. Lower level employees will benefit by understanding the thought processes of their superiors (or colleagues). The sharing of thought processes throughout the organization will serve to make the organization a more cohesive and productive unit.

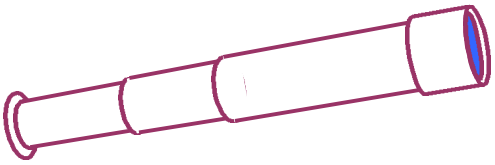
Organizations can also improve by gaining access to knowledge clips produced by other organizations with which they interact. For example, for a particular issue that affects multiple organizations (e.g., bow-waving), each organization can ascertain how others are dealing with the issue and perhaps gain a better

understanding of how its decisions affect other parts of the Navy. This cross-pollination of knowledge among organizations should serve to improve their ability to fashion well-reasoned plans and policies.

Thus, the Navy's entire M&P organization stands to benefit from the improvement of each of its parts. Better plans and policies can lead to improved morale, reduced costs, and/or increased readiness. The legacy of implemented KMSs offers the potential for these improvements to *persist* over time and to increase as the knowledge base is expanded. A successful knowledge library provides the capability for tomorrow's analysts to stand on the shoulders of those who have proceeded them.

Personnel Surveys and Program Evaluation

Vision



Early in the 21st Century, a Sailor, deployed on a ship located in a remote part of the world, receives an e-mail message at his shipboard terminal. The message indicates that a congressional committee has asked the Navy to provide information about its berthing on ships and other quality of life (QOL) issues. A Navy computer program has randomly selected a representative sample that included this Sailor as one of the participants in an attitudinal survey addressing these issues. The Sailor clicks on the secure Web site address specified in the message, is assured that his responses will be confidential, and accesses the Quality of Shipboard Life Survey. As soon as the Sailor completes the survey, the responses are electronically transmitted to a survey database where the data are analyzed and results updated on a real-time basis. The database is linked with a larger QOL decision support system (DSS) that contains the results of ongoing QOL program evaluations, past surveys, and other "hard data" (e.g., resource levels, usage statistics, ship class data) related to QOL programs. In Millington, TN, Navy research psychologists access the QOL DSS, get the latest survey results, and make queries to the DSS to provide contextual information to help interpret the survey data. In Washington, DC, a Navy QOL project officer has been tasked to draft a point paper response to the congressional query. With data supplied from the Fleet Sailor and others in the sample, with analysis from Millington, TN, and with her own access to the DSS databases, the staff officer prepares the Navy's response and forwards it up the chain of command. From the Fleet Sailor's survey data to the Navy's congressional response, a virtual electronic bridge has been established rapidly linking long distances and many time zones.

The next five to ten years will present numerous requirements and opportunities for conducting effective surveys and program evaluations, but also major environmental and operational challenges. These challenges will require dramatic changes in the way surveys and evaluations are designed, distributed, analyzed, and utilized. Among the issues that will need to be addressed are the increased technological complexity of the military workplace, the increasing pressures to do more with less, the continued reorganization and downsizing of military and federal organizations, and the increased diversity of the workplace. To meet these challenges and to better evaluate new policies, effectively inform decision-makers, and more accurately justify new expenditures, the Navy's survey and evaluation capabilities will need to undergo a basic transformation. While new and emerging computer technologies will be essential components of the changes, advances in methodology, statistics, and theory will also play a part. It is envisioned that in the next five to ten years, changes in Navy's survey and evaluation capabilities will be such that:

- Navy analysts will be able to conduct surveys and evaluations faster, better, and more effectively.
- Improved computer-based feedback mechanisms will allow survey and evaluation results to be distributed to interested users and stakeholders in real time.

- Navy policy makers will be able to rapidly and accurately assess the attitudes of Fleet Sailors.
- Policy makers will be able to quickly obtain and easily utilize survey and evaluation results.
- Program managers will be able to access on-line decision support systems containing survey, evaluation, and related database results.
- Local commands will be able to use sophisticated data-gathering tools to conduct, analyze, and interpret their own surveys and evaluations.
- Better utilization of results will improve management decisions and program effectiveness.

Introduction to Personnel Surveys and Program Evaluation

Policy makers throughout the Department of Defense (DoD) and the federal government have an ongoing need to obtain information from their personnel and to evaluate programs that they oversee. To develop policies, evaluate programs, understand concerns, and provide better support, government organizations such as the Navy need to regularly take the pulse of their members and programs.

During its more than 25 years of existence, surveys and evaluations have played major roles in the history of the Navy Personnel Research and Development Center (NPRDC). From its involvement in one of the largest military survey programs of the 1970 and 1980s—the Human Resource Management program—to more contemporary efforts to study areas such as satisfaction with Navy Morale, Welfare, and Recreation programs or an evaluation of QOL programs in the Navy and Marine Corps, surveys and program evaluations have been defining areas for NPRDC. In addition to these efforts, notable survey and evaluation work has occurred in the areas of total quality leadership, career development, equal opportunity, sexual harassment, military personnel issues and policies, recruiting, civilian personnel and performance appraisal systems, intern programs, housing, pregnancy, and correctional custody. The results of these studies have been published in numerous technical reports and journals and presented at professional and military conferences. The findings from these studies have also been briefed to the highest levels within the Navy, Marine Corps, and the DoD, including the Undersecretary of the Navy, the Chief of Naval Operations, the Commandant of the Marine Corps, and the Chief of Naval Personnel.

Although many successes occurred, past surveys and evaluations were all too often individual projects funded to address specific sponsor concerns, rather than reflecting a coordinated and programmatic research and development (R&D) approach. As the military continues to downsize and resources become more scarce, the personnel survey and program evaluation areas will need new paradigms, more reasoned execution, and better utilization of findings.

In the Navy and Marine Corps, many personnel surveys and program evaluations have traditionally relied on mail-out paper-and-pencil instruments that respondents complete and return. Although this

methodology continues to be successfully used, the process has drawbacks. It is time consuming, expensive, and increasingly subject to potential bias due to declining response rates. Furthermore, once the results are analyzed, the process of providing briefings to decision-makers and disseminating the results to relevant customers is labor intensive and expensive. Therefore the Navy needs to make its survey and program evaluation capabilities more effective and efficient by capitalizing on advances in instrumentation and technology, and developments from the cutting edge of social science theory, statistical analyses, and computer systems. To succeed in the future, information must be available quickly and presented in a user-friendly manner to those who need it.

This chapter addresses some of the significant developments in the field of survey and evaluation research. It suggests directions that can be taken to provide more effective service to customers in the Navy, Marine Corps, DoD, and the federal government, and achieve the end-state vision for surveys and program evaluations.

Key Operational Issues and Environment Over the Next Five Years

Over the next five years it is anticipated that the operating environment within the Navy will present a number of opportunities for the application of survey and program evaluation techniques. Outlined below are factors that describe the anticipated future state of affairs.

Operational/Environmental Factors

- ***World is getting more complex and technologically sophisticated***. Surveys and program evaluations will both utilize the new technologies (e.g., Navy's IT-21 system) and study their impact on military personnel and programs.
- ***Diminishing resources will lead to the need to do more with less***. In a resource-scarce environment there will be a greater imperative to identify measures of effectiveness, evaluate programs, and keep those that are cost-effective.
- ***Military and federal government will continue to be marked by reorganization and downsizing***. Personnel surveys will be needed to assess the impact of organizational changes on bottom-line indicators such as performance, productivity, and job satisfaction.
- ***Demographics of military and civilian society will continue to grow more diverse.*** The percentage of minorities and women in the military will continue to increase, posing challenges and potential conflicts. Surveys and program evaluations can anticipate areas of conflict, assess changing needs, and evaluate effectiveness of interventions in demographically diverse environments.
- ***Increased demand for surveys and evaluations.*** Recent developments associated with reinventing government will increase demand for surveys and evaluations in federal agencies. As a result of the *National Performance Review*, customer satisfaction surveys became a major undertaking in the federal government. On 11 September

1993, President Clinton issued Executive Order 12862, "Setting Customer Service Standards." This Executive Order established three survey tasks that government agencies are required to conduct periodically:

- Surveys of customers to determine the kind and quality of services wanted
- Surveys of customers to assess satisfaction with current services
- Surveys of front-line employees to identify barriers that are preventing the government from matching the quality levels achieved by business

Similarly, the Government Performance and Results Act of 1993 calls for the use of performance measurement in federal agencies by the year 2000. This will surely increase the need for survey and evaluation services within federal agencies.

Technological Advances That Will Have Positive Effects

Change is occurring so rapidly in the personnel survey and program evaluation areas that it is difficult to remain current, let alone predict future impacts. Nonetheless, it seems clear that advances in computer technology and interconnectivity as well as statistical and theoretical advances in program evaluation and personnel surveys will positively impact future efforts.

Advances in computer technology

- ***Surveys are becoming more computer-based***. Computer-based technologies are being increasingly used as a method of survey administration and personnel assessment. While disk-based survey software has been used by the Navy and others for over a decade, other computer-based technology is growing in popularity. These include:
  - E-mail
  - Web/Internet
  - Multimedia

While other services such as the Air Force and Army are increasingly using these new assessment technologies, the Navy's unique environment (e.g., large numbers of personnel deployed on ships) does not allow simply incorporating these procedures without additional R&D to determine their best use. With the Navy moving to a network-centric environment under IT-21, the challenge will be to optimally utilize these computer-based survey tools in the soon-to-be fully wired Navy.

Advances in methods, statistics, and theory

- ***Methodological, statistical, and theoretical advances are occurring in surveys and program evaluation***. In addition to computer-based changes, the survey and program evaluation fields are experiencing methodological, statistical, and theoretical advances that will have positive effects on future projects. Among these are:
  - Using templates to guide program evaluations
  - Providing better feedback and reporting of survey and evaluation results
  - Conducting integrated rather than piecemeal surveys and evaluations

- Utilizing advances in attitude-behavior theory and models. For example, expectancy models have had much success predicting behavioral intentions on the basis of prior attitudes.
- Advances in statistical analyses. There are now a wide array of powerful statistical analyses that will improve both survey and evaluation activities. Techniques such as structural equation modeling, statistical inference from multistage sampling procedures, and prospective evaluation to project trends in the military, may prove useful.

Technical Challenges to Overcome to Solve Operational Challenges

Despite the advances in methods, theory, and practice, surveys and evaluations face barriers to their utilization within military and government organizations. The following are a number of major challenges that need to be overcome if our vision is to be successfully realized.

Attitudinal and Political Challenges

- ***Many organizations fear evaluation***. Many organizations that commission surveys and evaluations never fully utilize or disseminate the results since they are apprehensive about the potential negative consequences of being diagnosed and evaluated. This concern may lead to the results of surveys and evaluations being ignored, not publicized, or not acted upon. At an R&D level, we will need to address how policy makers react to feedback and utilize the results. On a political level, we will need to strive for sufficient clout so there is a greater push for the release of findings and their use.
- ***Resistance to change is common in military and government organizations.*** Despite the pressures for change, military and government agencies are often resistant. Many military behaviors reflect customs and traditions that are hundreds of years old. Others exhibit a bureaucratic response to change, and perpetuation of the old ways to protect status and turf. While the change imperative is an opportunity for expansion of surveys and evaluations, resistance to change can be a barrier. This suggests that an R&D task is to go beyond the generation of results and recommendations to study the best ways the data can be presented, fed back, and disseminated such that the prospects for utilization are increased and the likelihood of change maximized.
- ***Policy makers want surveys and evaluations to provide quick and easy answers to complex questions***. Policy makers and project sponsors often want surveys and evaluations to provide quick answers to questions they face. These may stem from congressional or DoD taskers regarding funding, the allocation of resources, and the impact of proposed policy changes on military outcomes. Given the current state of survey and evaluation technology, it has been difficult to answer these questions in the rapid timespan required. Furthermore, data that is gathered this quickly will rarely be able to gauge with scientific generalizability the true impacts of proposed programs and policies. An

R&D challenge to reaching the end-state vision will be to see if new and emerging survey and evaluation technologies can be effectively exploited to develop a scientifically valid, quick-response capability.

Funding Challenges

- ***Surveys and evaluations are expensive***. When done correctly, large-scale personnel surveys and program evaluations are expensive. For example, Navy mail-out surveys typically cost between $100K-$300K to conduct. Program evaluations can easily require multiple years of funding costing hundreds of thousands of dollars. As we explore alternative means of survey and evaluation administration, one goal should be cost savings. For example, if it were possible to conduct a large scale personnel survey over the Web, tens of thousands of dollars of postage charges incurred on mail-out surveys would be eliminated.
- ***R&D funding for surveys and evaluations has been sporadic***. Previous funding for surveys and evaluations has often been limited to single-shot, single-issue efforts. Basic research support for surveys and program evaluation has been difficult to obtain. During the 1970s, the Office of Naval Research consistently funded basic research within the field of social psychology. If the end-state is to be realized, increased R&D support for survey and evaluation efforts needs to be achieved.

An Integrated Research and Development Agenda

It is intuitively appealing to simply upgrade the technology and instrumentation of personnel surveys and evaluation procedures and assume that these changes will add value to the current assessment process. However, the new technologies need to be assessed and tested within the context of an R&D effort to determine their effectiveness and how they can be optimally implemented in military and other government settings. Many of the survey and evaluation efforts of the past decade were not funded within traditional R&D (i.e., 6.1-6.3) funding programs. Most often they received operational funds to address specific issues of interest to military and government sponsors.

R&D efforts are needed because the impact of new survey and evaluation procedures is not always known in advance. For example, during the mid-1980s, the Navy's Office of Civilian Personnel Management sponsored an NPRDC prototype demonstration effort called CENSUS (Computerized Executive Networking Survey System) that was designed to determine whether computer administration improved the quality of responses to Navy personnel surveys. There was an underlying assumption, based on previous research, that computer surveys would be superior to paper ones. However, the CENSUS project repeatedly found that computer and paper surveys produced identical results (see Rosenfeld, Booth-Kewley, & Edwards, 1993, for a review). This was supported in other basic research studies as well (Booth-Kewley, Edwards, & Rosenfeld, 1992). Thus, before new survey technologies are implemented in operational

settings, they should be rigorously tested in an R&D environment.

While not every issue related to surveys and program evaluation can be addressed through basic, exploratory, or prototype demonstration research, certain areas are in clear need of R&D efforts.

Alternative measures of attitudes

Direct measures of attitudes through responses to items on surveys and questionnaires have been the core of many NPRDC-sponsored surveys. However, it is well known that responses to these survey items may be prone to faking and social desirability biases. Particularly when the questions ask for sensitive information, respondents may not be totally candid. One alternative approach uses response latency (i.e., how long it takes to respond) to measure attitudes. Several previous studies suggested that response latency may have potential as a measure of faking on questionnaires (e.g., George & Skinner, 1990). In a Navy-funded R&D project, Reynolds and Sheposh (1998) used response latency in an effort to obtain measures related to Navy Core Values Training that were less prone to social desirability biases than traditional attitudinal measures. They found that latencies to training versus control materials were faster, suggesting that the trained values had become more ingrained. On a methodological level, Bassili and Scott (1996) contended that response latency might be a useful means of screening out potentially bad or misleading survey questions. It was suggested that questions taking excessive processing times were likely confusing or ambiguous. Others (see Schwarz & Sudman, 1996) have indirectly measured attitudinal responses by assessing the speed and nature of cognitive processing about survey topic areas.

These efforts suggest that innovative alternatives to traditional attitude assessment such as response latency be investigated through future basic and exploratory research studies.

Comparison of survey administration and feedback formats

During the last decade, automated alternatives to the mail-out paper-and-pencil survey have become popular. Increased use of telephone, computer, e-mail, and Internet/Web surveys and analysis can be found (see Kuhnert & McCauley, 1996; Rosenfeld et al., 1993, for reviews).

Although the technology for alternative survey administration exists, the feasibility of using this technology in settings such as the Fleet needs to be explored. Issues such as determining the percentage of personnel having access to the Internet, the best method of delivery, security issues, success of reaching a representative population, availability of e-mail addresses for all personnel, impact on return rates, and optimal length of electronic surveys, need to be resolved through R&D. It has been widely reported that Internet users are better educated and more technologically sophisticated than the rest of the population. In military settings, controlled tests need to be done to ensure that respondents to Web-based surveys are not skewed due to these or other potential biases. This should be done in a series of prototype test demonstrations of various survey delivery methods: e-mail, Web, survey-on-a-disk, etc., conducted in different operational settings.

From a research perspective, the various administration modes may have implications for the accuracy of responses to survey questions, particularly those that ask about sensitive topics. Many Navy and Marine Corps personnel surveys contain sensitive questions relating to issues such as sexual harassment, racial discrimination, and pregnancy issues. Since there is concern that survey responses to these items may be less than truthful, it is of interest whether alternative administration methods may lead to more candid responses (see Tourangeau & Smith, 1996). While previous R&D studies have compared paper surveys with surveys administered on a PC (Booth-Kewley et al., 1992), additional research testing surveys administered on e-mail and the Web needs to be conducted with special focus on the candidness of responses.

In addition to exploring optimal methods of survey administration, R&D is also needed to study various methods of survey feedback, including better ways of presenting analyses and interpretations of results to users in the field. One current problem is that survey results are often not optimally used or fed back to relevant audiences. Through R&D it can be determined whether new and emerging computer technologies enhance the impact of survey feedback and how the survey data are used. Also, it should be determined whether leaders and policy makers have information processing "styles" such that feedback presentations could be custom-tailored in ways to make them maximally effective.

Factors affecting survey response rates

Not everyone who receives a survey completes it. As this nonresponse rate increases, the validity of survey results is threatened. Nonresponse bias may occur if the people who do not respond are systematically different than those who do. The response rates to Navy surveys have been gradually diminishing. For example, in 1989, the Navy Equal Opportunity/Sexual Harassment survey had a response rate of 60%. The 1997 administration of the same survey had a response rate of 45%.

Survey research has identified a number of factors that can increase response rates. These include incentives, follow-ups, shorter surveys, and personalization of the cover letter and survey materials (see Edwards, Thomas, Rosenfeld, & Booth-Kewley, 1997). Some of these techniques such as personalization and increased follow-ups have been successfully used in Navy and Marine Corps personnel surveys (Culbertson, Rosenfeld, & Perry, 1997). However, these and other factors that affect nonresponse have not been studied in an R&D environment to determine what are the key variables, either individually or in combination, that might increase response rates in military populations. Furthermore, response rate research has traditionally been studied using mail-out paper surveys as the model. As indicated, future surveys will increasingly use computer and Web-based methods of administration. An investigation of nonresponse in military environments, therefore, should determine how these new and innovative administration modes might impact response rates as well.

Theory-based evaluation and surveys

Since a great deal of previous survey and evaluation work was sponsor-specific, it rarely involved theory-based research. However, using theory to guide research is

becoming increasingly important. In program evaluation, the development of a theory of evaluation is playing an increasingly important role in charting the future of the field. Accordingly, we recommend that evaluations and surveys focus on the development and use of theory. Theory-based evaluation provides a better chance of explaining how and why the factors under study are responsible for the outcomes. In addition, theory-based evaluation permits assessment of the impact of programs in cases where the design and methodology are faulty.

One potential research area would look at a distinction made between two types of evaluation theory: implementation theory and programmatic theory (Weiss, 1997). Implementation theory looks at how a program is carried out (i.e., the extent to which the program is conducted according to plan). Programmatic theory looks at the mechanisms (i.e., the change in responses resulting from the program activities) that moderate or mediate the relationship between program activities and outcomes.

A sociotechnical analysis may be a promising approach for the collection of information related to program theory. A sociotechnical approach examines the technical, psychological, and social aspects of the program or system being evaluated. When evaluating a program using a sociotechnical analysis, the program's mission, operation, and boundaries, as well as the technical and social systems involved, would be assessed. Because its approach is all-inclusive, the sociotechnical approach can identify and assess the relevant mechanisms that are operating more readily than can traditional evaluation approaches. The sociotechnical approach would be particularly useful for organizations in transition (Farley, 1991). An R&D assessment of the efficacy of approaches such as sociotechnical analysis is recommended as a step in reaching the end-state vision of more innovative and useful program evaluations.

Program templates

One relatively new evaluation tool that could be used in the assessment of program implementation is the program template (Scheirer, 1996). A program template is a standardized format that specifies the components comprising the program interventions, details the intended components at a specific site and provides summarization of program delivery (Loucks-Horsley, 1996). It is a tool for program managers who wish to design, monitor, evaluate, and improve their programs in ways that reflect best practice. Template matching uses qualitative and quantitative organizational diagnostics to match policy to organizations and to people. By profiling programs by means of templates, evaluation and program planning are more closely connected and the inter-relationships of multiple components are better articulated, which ultimately results in improved documentation of the program implementation.

Profiling organizations

The role of organizational climate and/or culture may play a role in evaluations, especially in military settings where climate and culture may be especially salient. Organizational culture, while having been extensively studied through personnel surveys, should also be considered in the area of evaluation. Evaluation studies should routinely document the organization's basic assumptions about itself, its structure, and its underlying management practices. Research

could utilize personnel survey approaches to systematically collect organizational climate or culture data to yield a profile of organizations. This profile could then be used to predict other bottom-line indicators (e.g., readiness, willingness to change, etc.). The availability of such information would place the results of evaluations in a broader context of what works and what does not.

Evaluation utilization

With the Government Performance and Results Act expected to take full effect in 2000, the need for evaluation activities will increase. The expertise of evaluators will be required so that valid and reliable performance measurement systems, analyses, and reporting systems are designed and implemented. Unfortunately, examination of program evaluation and assessment over the last two decades indicates a deficit in the dissemination and utilization of evaluation information (Wholey & Newcomer, 1997). It is evident that research on factors that would produce an effective dissemination and utilization model is needed. One line of research that holds promise is the study of the type of utilization required: (a) instrumental utilization, which refers to direct decision-making based on evaluation results, and (b) conceptual utilization, which refers to the enlightenment (changes in attitudes and cognitions regarding a program) that occurs as a function of the reported findings. We recommend conducting R&D focusing on the nature of the effect that the dissemination of results has on policy-makers and program managers. Such work should help achieve the end-state vision of better utilization of results that improve management decisions and program effectiveness.

Survey/evaluation Decision Support Systems (DSSs)

Research in designing effective DSSs for managers and policy makers that encompass survey and program evaluation data is another line of prototype demonstration research to be pursued. Although it is clear that managers request survey and program evaluation information, experience shows they often do not use the information in their decision making processes. Research would explore the decision making strategies used by managers and policy makers, especially those that apply to survey and program evaluation areas. It would determine how characteristics of surveys and evaluation information, and the display and manipulation of such information, impact on the use of information in the decision making process. The results of this research would explore what aspects of a survey/program evaluation DSS optimize decision making processes (Bennett, 1983).

A second component of this research would explore design features of computer-based DSSs relating to survey and evaluation results (Shneiderman, 1998). While large amounts of survey and evaluation results have been gathered, the data bases where they are stored have not been optimally warehoused or fully exploited. In designing better DSSs the answers to the following questions will need to be determined: What information capabilities of survey/evaluation data desired by managers can be incorporated into a DSS? How does this survey/evaluation data have to be integrated with other information (e.g., “hard measures”) to be used? How do managers want to query and display the information so it is most useful to them? Based on these findings, prototype survey and evaluation

DSSs would be developed for testing by program managers and other decision makers.

Survey and Program Evaluation Institute

To achieve the end-state vision, Navy survey and evaluation efforts will need additional support and an innovative context that provides an historical framework as well as structure. It is proposed that the efforts be combined and managed under the rubric of a Survey and Evaluation (SURE) Institute. The Institute will fill the need for a centralized repository for surveys and program evaluations containing tools, techniques, and findings. A formalized Institute is envisioned whose staff would have the comprehensive range of abilities to conduct surveys and state-of-the-art program evaluations.

It is proposed that the Institute needs to be modeled after successful social research organizations (e.g., Rand Corp, Michigan Institute of Social Research, National Opinion Research Center, Research Triangle Institute) with one goal being increased name recognition, which is vital to attract new business. Such an Institute would: a) carry more status and weight, b) attract higher level sponsors, and c) produce results that are more influential.

The Institute would be an “instigator” of work and not just a “reactor.” It would generate its own studies (both basic and applied) in addition to accepting work from traditional sponsors. SURE would have a vigorous marketing campaign through: internal publications, quarterly and annual reports, conference presentations, journal articles, and a Web site that would both serve to publicize results and provide the Institute with instant credibility. It is through the workings of a fully-functional Institute that the end-state vision can best be realized.

The increased status of SURE would allow for consortium relationships with other social research organizations through which methods, techniques, and findings could be shared. It would also allow the Institute to develop a training wing to offer short courses to teach program managers and others throughout the federal government how to: a) do surveys and evaluations, b) interpret survey and program evaluation data, and c) design effective interventions to act on results. These short courses could be an additional source of revenue for the Institute as well as being a vehicle for expanding the customer base beyond the Navy and Marine Corps. This expansion of customer base is vital. It is our view that the traditional Navy and Marine Corps sponsors cannot by themselves supply sufficient work and financial resources to fully fund the Institute's operations.

Outcomes, payoffs, benefits to the Navy

The proposed end-state vision can provide a degree of structure, stability, and coherence that would allow survey and evaluation projects to be more responsive and methodologically sophisticated, be done quicker with more authority, and be able to answer a wider range of questions. Furthermore, the extensive use of new and emerging technologies will provide better information for making policy decisions. This should lead to improved policy decision making and better programs.

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SAILOR 21: An Epilogue

We hope you have enjoyed reading SAILOR 21: A Research Vision to Attract, Retain, and Utilize the 21st Century Sailor! Many of you may have been surprised by the significance of the changes reflected in our visions. The convergence of a significantly reduced force, dramatic improvements in technology, and scientific understanding of "people issues" have created what we see as an opportunity for a decidedly different and improved Navy personnel enterprise…But, as with other "revolutions in military and business affairs", changes of the magnitude we propose can be unsettling to contemplate, let alone undertake. We would not be surprised if some of you said, "#%&**##, are those R&D guys crazy?" If we got that kind of reaction from you, then we succeeded in at least one of our goals for SAILOR 21—we pushed you outside of your comfort zone and caused you to think about long-term change. We believe that our primary objective as researchers is to initiate profound and beneficial change. Most of the time that means developing and implementing new technologies into manpower and personnel processes. But, it often means organizational change as well. SAILOR 21's visions represent both kinds of change and require a shift from your everyday thinking to fully contemplate.

The time is also right, right now, to think "outside the box" with regard to resourcing people issues. Personnel costs represent nearly one-third of the Navy's annual total budget authority, yet only one-half of one percent of the Navy's R&D budget is spent on manpower and personnel. We cannot meet our world-class expectations for the men and women of our Navy without world-class investment in people-related knowledge and technology.

Although many of you may have doubts about the feasibility of the SAILOR 21 vision (at least initially), remember that SAILOR 21 is intended to shape and guide the discussion of future manpower and personnel R&D and the Navy that can result from it. So, please do not dismiss our ideas because they don't align cleanly with your current views or your own vision. Instead, react to SAILOR 21 by talking with us, even debating with us, but ultimately let's work together to develop a highly productive, and tightly focused, manpower and personnel R&D program. It takes all of us to realize what can be!