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PRIORITIZATION OF ROADMAP RESEARCH

Final Report

N00014-83-C-0668

Sponsored By  
Department Of The Navy  
Office Of Naval Research  
Arlington, Virginia

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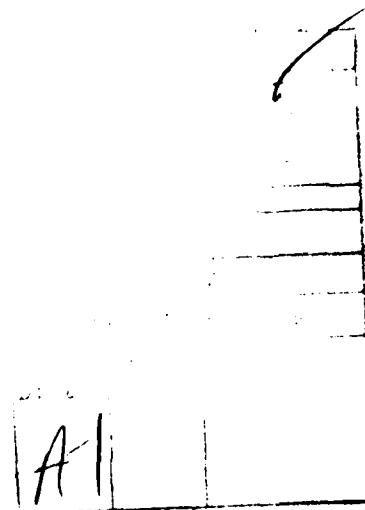
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**ROADMAP  
RESEARCH PRIORITIZATION**

**September, 1984**

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## I. THE PRIORITIZATION PROCESS

### BACKGROUND

In May of 1984, SRA Technologies, Inc. completed the first phase of a project monitored by the Office of Naval Research; the report on that project was entitled "Roadmap for Navy Civilian Personnel Research." The project was designed and implemented in order to respond to the needs of the Navy for a research plan to gather systematic information on the large civilian personnel workforce which supports the Navy mission. The report consisted of a series of research areas, arrayed into logical linear sequences designed to support specific mission objectives. In addition, each research area included a discussion of the context of the research and a descriptive summary statement of the existing literature in the area. In addition, the report included a detailed procedure for prioritizing the accumulated research suggestions.

Following the completion of the Roadmap document, SRA staff began the process of prioritizing those research areas and projects developed during the first phase.

### PRIORITIZATION OVERVIEW

The Roadmap document provided a comprehensive overview of potential civilian personnel research areas. It did not, however, define specific research projects which could be conducted in each area, nor did it indicate which areas were of greatest concern to the civilian personnel community.

In order to transform the Roadmap from what was essentially a reference document into a concrete plan to guide the allocation of scarce resources,

e.g. research and development and studies monies, a number of tasks were carried out:

1. Working from the Roadmap, generic categories of research areas and research projects were identified. These research areas and projects incorporated the original research concepts but cross-cut the original research arrays which had been organized by mission objectives, e.g. recruitment, retention, productivity. The 19 research areas established for the prioritization process contained elements of multiple objectives, as did the specific research projects suggested for each area.
2. It was decided that an initial prioritizing of research areas and projects should be done by the forty participants who had originally been interviewed for the Roadmap, as well as some additional individuals knowledgeable about civilian personnel issues. The second and final prioritizing was to be done by the Project Guidance Team (PGT), made up of representatives from OP-14, OP-01, the Naval Material Command, the Navy Personnel and Research and Development Center, and the Office of Naval Research.
3. A mail questionnaire was developed (see Appendix A) and sent to 51 potential respondents. They were asked to evaluate each of the 19 research areas on the basis of three criteria:
  - The relative importance to the Navy of improving effectiveness in a particular area;
  - The relative need for new information in order to improve capabilities within that area; and
  - The likelihood of being able to use research findings effectively.

Each research area was then rated against each of these three criteria on a Likert scale of one to five; "one" indicated a low degree of importance, need, or likelihood of use, while a "five" indicated a high degree of each of those three attributes.

Each respondent was then asked to make a decision as to the importance of individual research projects listed under each research area; a check mark indicated that it was considered an important project to undertake.

Finally, each respondent was asked to open-ended comments about each research area or project and for suggestions of potential funding sources. (See Appendix B for questionnaire respondents.) The subsequent analysis of the returned questionnaires is found in Appendix C.

4. The last step of the prioritization process involved the presentation of the questionnaire results of the Project Guidance Team and the facilitation of a day-long meeting. During this time the PGT decided upon the top priority research areas and projects and developed plans for their future involvement in implementing the research plan.

## II. FINDINGS AND RESULTS OF THE PRIORITIZATION PROCESS

The results of the questionnaire (see Table 1, 2 and 3 on the following pages) indicated that of the 19 research areas, four had been highly ranked by all the respondent groups, ten research areas fell into the mid-range rankings, and five were clearly considered to be of less immediate importance in terms of seeking out immediate funding.

### Priority Research Areas

The four top priority research areas were:

Area No. 5: Provide Adequate Compensation to Enhance Recruiting, Retention, and Motivation

Area No. 12: Develop Effective Managers and Supervisors

Area No. 9: Develop Effective Systems for Classification and Appraisal

Area No. 13: Integrate New Technology Within Civilian Workforce

For each of the top priority areas, a feasibility analysis was conducted. This analysis suggested a logical sequencing of specific research projects to be carried out within each research area, estimates of the time and cost parameters, and possible funding sources. The information concerning funding sources was derived from the suggestions of the questionnaire respondents.

TABLE 1

## SUMMARY: PRIORITIZATION FINDINGS, ALL RESPONDENTS

<u>Research Area</u>	<u>Combined Score</u>	<u>"Importance"</u>	<u>"Need"</u>	<u>"Use"</u>
1. No. 5 (Compensation)	3.57	4.17	3.64	2.92
2. No. 12 (Effective Managers)	3.52	4.28	3.19	3.08
3. No. 9 (Classification)	3.49	3.78	3.42	3.28
4. No. 13 (New Technology)	3.43	3.75	3.64	2.89
5. No. 4 (Selection & Screening)	3.24	3.69	2.86	3.17
6. Nos. 3 and 7 (Models; Marketing)	3.20	3.64 3.39	2.92 3.28	3.06 2.94
7. No. 1 (Optimum Mixes)	3.16	3.58	3.44	2.44
8. No. 15 (Personnel Practices)	3.12	3.50	3.08	2.86
9. No. 18 (Retain Minorities)	3.10	3.39	3.14	2.42
10. No. 17 (Recruit Minorities)	3.07	3.31	2.89	3.03
11. No. 19 (Insure Non-Discrimination)	3.04	3.50	2.69	2.92
12. No. 10 (Incentives)	2.98	3.39	3.14	2.42
13. No. 16 (Productivity)	2.93	3.31	3.00	2.47
14. No. 11 (Reduce Barriers)	2.75	3.00	2.75	2.50

TABLE 1

SUMMARY: PRIORITIZATION FINDINGS, ALL RESPONDENTS  
(Continued)

<u>Research Area</u>	<u>Combined Score</u>	<u>"Importance"</u>	<u>"Need"</u>	<u>"Use"</u>
15. No. 6 (Job Environment)	2.74	3.14	2.69	2.36
16. No. 14 (Increase KSA's)	2.68	3.00	2.72	2.32
17. No. 8 (Career Development)	2.64	3.00	2.58	2.33
18. No. 2 (Optimum Ratios)	2.35	2.17	2.39	2.22

TABLE 2  
RANKING OF RESEARCH AREA BY EACH GROUP

Priority Rank	Group 1 (Policy Personnel)	Group 2 (Personnel Specialists)	Group 3 (Program Managers)	Group 4 (Other)
1	No. 5 (Compensation)	No. 9 (Classification)	No. 13 (New Technology)	No. 12 (Managers)
2	No. 4, No. 9 (Selection; Classification)	No. 5 (Compensation)	No. 1 (Optimum Mixes)	No. 15 (Personnel Practices)
3	Nos. 17, 18 (Recruit and Retain Minorities)	No. 15 (Personnel Practices)	No. 12 (Managers)	No. 4 (Selection)
4	Nos. 3, 12 (Models; Managers)	No. 12 (Managers)	No. 5 (Compensation)	No. 3 (Models)
5	No. 7 (Marketing)	No. 13 (New Technology)	No. 19 (Non-Discrimination)	No. 13 (New Technology)
6	No. 1 (Optimum Mixes)	No. 19 (Non-Discrimination)	No. 7 (Marketing)	No. 9; No. 10 (Classification; Incentives)
7	No. 13 (New Technology)	No. 4 (Selection)	No. 9 (Classification)	No. 14 (Increase KSA's)
8	No. 15 (Personnel Practices)	No. 18 (Retain Minorities)	No. 10 (Incentives)	No. 5 (Compensation)
9	No. 16 (Productivity)	No. 7 (Marketing)	No. 16; No. 3 Productivity, Models)	No. 7 (Marketing)
10	No. 19 (Non-Discrimination)	No. 17, No. 6 (Recruit; Environment)	No. 6 (Job Environment)	No. 16, No. 17 (Productivity Recruit)
11	No. 10 (Incentives)	No. 11 (Reduce Barriers)	No. 18 (Retain Minorities)	No. 1 (Optimum Mixes)

TABLE 2  
 RANKING OF RESEARCH AREA BY EACH GROUP  
 (Continued)

<u>Priority Rank</u>	<u>Group 1 (Policy Personnel)</u>	<u>Group 2 (Personnel Specialists)</u>	<u>Group 3 (Program Managers)</u>	<u>Group 4 (Other)</u>
12	No. 8 (Career Development)	No. 3 (Models)	No. 11 (Reduce Barriers)	No. 18 (Retain Minorities)
13	No. 11 (Reduce Barriers)	No. 10, No. 8 (Incentives; Career)	No. 17 (Recruit Minorities)	No. 8 (Career Development)
14	No. 14 (Increase KSA's)	No. 16 (Productivity)	No. 4 (Selection and Screening)	No. 11 (Reduce Barriers)
15	No. 2, No. 6 (Optimum Ratios; Job Environments)	No. 14 (Increase KSA's)	No. 14 (Increase KSA's)	No. 19 (Non-Discrimination)
16		No. 1 (Optimum Mixes)	No. 15 (Personnel Practices)	No. 2 (Optimum Ratios)
17		No. 2 (Optimum Ratios)	No. 8 (Career Development)	No. 6 (Job Environment)
18			No. 2 (Optimum Ratios)	

TABLE 3  
MEAN LIKERT SCORES

Priority Rank	Group 1 (Policy Personnel)	Group 2 (Personnel Specialists)	Group 3 (Program Managers)	Group 4 (Other)
1	3.94 (Compensation)	4.05 (Classification)	3.49 (New Technology)	4.08 (Managers)
2	3.64; 3.64 (Selection; Classification)	3.81 (Compensation)	3.46 (Optimum Mixes)	4.00 (Personnel Practices)
3	3.47; 3.47 (Recruit, Retain Minorities)	3.67 (Personnel Practices)	3.36 (Managers)	3.92 (Selection)
4	3.44; 3.44 (Models; Managers)	3.62 (Managers)	3.21 (Compensation)	3.83 (Models)
5	3.38 (Marketing)	3.52 (New Technology)	3.13 (Non-Discrimination)	3.58 (New Technology)
6	3.33 (Optimum Mixes)	3.43 (Non-Discrimination)	3.08 (Marketing)	3.50; 3.50 (Classification; Incentives)
7	3.25 (New Technology)	3.38 (Selection)	3.05 (Classification)	3.33 (Increase KSA's)
8	3.17 (Personnel Practices)	3.24 (Retain Minorities)	3.03 (Incentives)	3.25 (Compensation)
9	3.08 (Productivity)	3.19 (Marketing)	2.97; 2.97 (Productivity; Models)	3.08 (Marketing)
10	3.00 (Non-Discrimination)	3.09; 3.09 (Recruit; Environment)	2.85 (Job Environments)	3.0; 3.0 (Productivity, Recruit)
11	2.97 (Incentives)	2.95 (Reduce Barriers)	2.82 (Retain Minorities)	2.92 (Optimum Mixes)
12	2.91 (Career Development)	2.86 (Models)	2.79 (Reduce Barriers)	2.67 (Retain Minorities)
13	2.75 (Reduce Barriers)	2.62; 2.62 (Incentives; Career)	2.71 (Recruit Minorities)	2.33 (Career Development)

TABLE 3  
MEAN LIKERT SCORES  
(Continued)

Priority Rank	Group 1 (Policy Personnel)	Group 2 (Personnel Specialists)	Group 3 (Program Managers)	Group 4 (Other)
14	2.72 (Increase KSA's)	2.52 (Productivity)	2.59 (Selection and Screening)	2.25 (Reduce Barriers)
15	2.66; 2.66 (Optimum ratios; Job environments)	2.48 (Increase KSA's)	2.54 (Increase KSA's)	2.12 (Non-Discrimination)
16		2.43 (Optimum Mixes)	2.51 (Personnel Practices)	2.08 (Optimum Ratios)
17		2.14 (Optimum Ratios)	2.49 (Career Development)	2.00 (Job environment)
18			2.26 (Optimum Ratios)	

AREA NO. 5: PROVIDE ADEQUATE COMPENSATION TO ENHANCE RECRUITING, RETENTION, AND MOTIVATION

Promising Projects

1. Identify Compensation-related Factors Affecting Recruitment, Retention, and Motivation
  - a. Review literature on predictors of DoD civilian recruitment and retention, as well as literature on measures of motivation and extract key findings on compensation.
  - b. Design and conduct surveys of targeted samples of personnel in key occupations of varying ages and grades (also could include race and sex) to determine perceived importance of factors leading to decisions to enter, stay in, and leave Navy civilian service. Concentrate on salary issues and benefits (current and hypotheticals), but other job environment factors could be included.
  - c. Analyze data, and identify key compensation-related factors affecting recruitment of new employees and those affecting retention and motivation of current employees.
2. Determine Impacts of Employee Turnover
  - a. Analyze current Navy retention rates in key occupational series by grade and length of service.
  - b. Determine turnover costs, based on replacement/retraining costs and lost productivity.

3. Compare Federal vs. Private Sector Salaries and Benefits
  - a. Review previous methodologies, identify shortcomings, and recommend improved approach.
  - b. Conduct new study for selected occupations.
4. Develop Models to Predict Recruitment and Retention Behavior Based on Compensation Factors
  - a. Review OSD models under development and COPES Project and adjust retention models as necessary based on findings from Projects 1 and 3.
  - b. Develop recruitment model based on data from Projects 1 and 3 and from historical personnel records.
5. Identify Feasible, High-Payoff Changes in Compensation Structure
  - a. Review outcomes of Projects 1 and 4 to identify changes most likely to positively impact recruitment, retention, and motivation.
  - b. Analyze the cost-benefit of these changes using Project 2 results and Project 4 models.
  - c. Assess feasibility of changes and identify opportunities for making changes or designing experiments to test the true impact of selected changes.

Approximate Time and Cost Parameters

Project 1: 18 - 24 months  
\$300 - 450,000

Note: Costs vary according to number and size of survey samples. Substitution of focus groups could reduce costs.

Project 2: 6 - 12 months  
\$75 - 200,000

Project 3: 8 - 24 months  
\$75 - 350,000

Note: Lower ranges assume use of existing data sets only.

Project 4: 12 - 18 months  
\$150-300,000

Note: Wait for completion of above projects and OSD study

Project 5: 6 - 9 months  
\$40 - 100,000

Note: Conducted after Projects 1, 2 and 4

Funding Sources: OPM  
OP-01

#### AREA NO. 12: DEVELOP EFFECTIVE MANAGERS AND SUPERVISORS

##### Promising Projects

1. Determine Critical Knowledge, Skills, and Abilities (KSA's)
  - a. Classify managerial positions according to:
    - Level (i.e., executives, middle managers, front line supervisors); and

- Work Group Type (e.g., Lab, Shipyard, NARF, HQ Policy)

and select categories of greatest priority.

- b. For selected categories, review literature to determine best relevant measures of managerial/supervisory effectiveness and potential key KSA's.
- c. Validate KSA's for Navy civilian population through records review and interviewing.

2. Develop Optimum Selection Criteria and Procedures

- a. Identify current selection criteria and procedures and assess relative to findings from Project 1.
- b. Design and test model selection criteria and procedures.

3. Develop Optimum Training/Development Strategies

- a. Identify current training and development programs and assess relative to findings from Project 1 and findings from literature on management training effectiveness.
- b. Identify design parameters for more effective Navy training/development programs.
- c. Develop, test and evaluate curricula for selected categories of personnel.

Approximate Time and Cost Parameters

Project 1: 12 - 18 months  
\$175 - 400,000

Project 2: 24 - 30 months  
\$200 - 500,000

Project 3: 24 - 30 months  
\$200 - 600,000

Note: Costs for all three projects can vary significantly according to the number of categories of managers/supervisors selected for research and development tasks. Initial phase of Projects 2 and 3 could be conducted simultaneously with the latter phases of Project 1.

Funding Sources: 6.3  
O and MN  
OP-01  
MAT 01M  
Syscoms

#### AREA NO. 9: DEVELOP EFFECTIVE SYSTEMS FOR CLASSIFICATION AND APPRAISAL

##### Promising Projects:

1. Assess Current Systems
  - a. Review recent literature linking classification and appraisal systems characteristics to employee retention, motivation and productivity.
  - b. Establish valid measures of time and costs required to administer systems.
  - c. Assess perceptions of current systems (including BPAP, Merit Pay and to a less critical extent SES) by supervisors and employees in selected occupations, including perceived impacts of

systems on motivation, productivity and retention. Identify any opportunities to evaluate behavioral impact based on variations in implementation.

- d. Identify strengths and weaknesses of current systems and key characteristics desired in optimum system.

## 2. Evaluate Replicability of Navy Demonstration Project

- a. Review of evaluation of Demonstration to identify unique and potentially replicable site characteristics that contribute to success.
- b. Identify potential new sites, assess transferability issues, and develop replication strategy.
- c. Design and conduct experimental replications and evaluate impact compared to original and control sites, and develop recommendations for future.

## 3. Assess Alternative Private Sector Systems

- a. Review private sector systems and identify those that best capture the key characteristics identified in Project 1.
- b. Compare performance measures of private sector systems to established measures of current Federal systems and the Demonstration Project (through literature review and selected testing as necessary).
- c. Identify systems with greatest performance potential, and assess opportunities to introduce these systems or to test them in Navy environment.

### Approximate Time and Cost Parameters

Project 1: 12 - 18 months  
\$150 - 250,000

Project 2: 36 - 48 months  
\$300 - 500,000

Note: Cost sensitive to number of replication sites

Project 3: 8 - 12 months  
\$100 - 200,000

Note: Follows completion of Project 1

Funding Sources: 6.2  
6.3  
O and MN MPT  
OPNAV:OP-01  
OPM  
NAVMAT

AREA NO. 13: INTEGRATE NEW TECHNOLOGY WITHIN CIVILIAN WORKFORCE

#### Promising Projects

##### 1. Project Impacts of Future Technologies

- a. Identify major technological changes that are likely to affect the Navy over the next 10 years, particularly including small computer systems development and applications and robotics.
- b. Assess likely impacts of these technologies on current procedures for accomplishing tasks in the specific work areas most affected.

- c. Identify the principal new knowledge, skills and abilities that will be required and determine the major implications for recruitment, training, and re-training.
- d. Review literature and assess attitudes on organizational acceptance/adaptation to new technology; identify key principles to guide future implementation within the Navy in areas identified.

2. Model Program Testing

- a. Design a model program, involving employee education, training, and organizational adjustment, for the introduction of a specific technology in a specific work area.
- b. Test and evaluate the model and assess replicability.

3. Assess Opportunities for Computer-Aided Training (lower priority)

Approximate Time and Cost Parameters

Project 1: 12 - 18 months  
\$150 - 500,000

Note: This project could be done broadly across the Navy as written, or for selected work areas.

Project 2: 15 - 24 months  
\$150 - 300,000

Potential Funding Sources: 6.3  
O and MN  
SYSCOMS

## MID-RANGE RESEARCH AREAS

The mid-range ranked research areas, with those specific research projects chosen by at least 1/3 of the respondents, were then compiled, along with funding source suggestions, as shown below:

Area No. 4: Develop Effective Selection and Screening Mechanisms

Develop measures of quality/performance potential

Identify attributes associated with high performance

Identify, develop, and test effective tools

Funding: 6.2

6.3

OP.01

Area No. 3: Develop Credible Models for Predicting Civilian Personnel Needed for actual and contingency Navy settings

Review and critique existing forecasting models

Develop most credible model

Develop strategies to integrate forecasting into budget

Funding: 6.2

6.3

MPT/Logistics

OP-1

Area No. 7: Use Effective Marketing Strategies for Recruitment

Assess changes in labor pools in future

Identify promising sources of future recruits for selected occupations

Develop and Test effective outreach strategies

Funding: OP-01  
OPM

Area No. 1: Develop Optimum Mixes of Military, Civilian, and Contracted Personnel

Determine current nature and extent of contracting out

Determine cost effectiveness of contracting out

Determine optimum mixes of military and civilian personnel

Funding: 6.3  
MPT/Logistics  
OP-01  
NAVCOMP

Area No. 15: Increase Efficiency of Selected Personnel Practices  
Measure Time and Costs Associated with ULP grievances

Measure Time and Costs Associated with Other Personnel Functions

Funding: OP-01  
O and MN

Area No. 18: Retain Adequate Numbers of Quality Minority Personnel

Identify reasons why minorities stay or leave

Funding: O and MN  
OP-01

Area No. 17: Recruit Adequate Numbers of Quality Minority Personnel

Identify potential institutional barriers, e.g., community, veterans preference, exams, physical barriers, contracting out  
Identify current successful recruiting strategies and assess transferability  
Evaluate cost-effectiveness of EEO structure in meeting EEO objectives

Funding: O and MN  
OP-01

Area No. 19: Insure Non-Discriminatory Treatment of Minorities

Identify current levels, trends, and patterns of discrimination complaints  
Identify and test promising procedures or training programs to reduce discrimination complaints  
Evaluate the cost-effectiveness of the EEO structure in meeting this objective

Funding: None listed

Area No. 10: Develop Individual Incentives to Increase Motivation

Develop valid measures of motivation/morale and productivity and determine relationship.  
Identify and evaluate current Navy techniques  
Identify successful private sector techniques  
Identify potential new techniques and assess feasibility

Area No. 16: Develop Organizational Structures That Enhance Productivity

Identify differences between military and civilian leadership styles and impact on productivity

Funding: OP-01  
OP-04  
MAT 01M

#### LOWEST RANKED RESEARCH AREAS

Finally, those research areas ranked as least important by the respondents were:

- Area No. 11: Reduce Barriers to Individual Motivation  
Funding: NAVMAT R&D
- Area No. 6: Provide Satisfying Job Environments to Improve Job Acceptance Rates, Turnover, Motivation/Productivity  
Funding: 0 and MN
- Area No. 14: Increase Knowledge, Skills, and Abilities of Civilian Personnel  
Funding: 0 and MN; OP-01; NAVMAT
- Area No. 8: Provide Satisfying Opportunities for Career Development  
Funding: 6.2 and 6.3, 0 and MN
- Area No. 2: Develop Optimum Ratios of Supervisors to Employees  
Funding: OP-01; MAT 01M

#### Project Guidance Team Decisions

The final stage of the prioritization project began with a presentation of the results of the mail questionnaire to the Project Guidance Team. In a day-long discussion session, facilitated by the contractor, the group reviewed the results of the questionnaire, and then reached consensus in

terms of research areas and projects for which resources would initially be sought. The top priority areas chosen by the PGT were:

- Develop Effective Managers and Supervisors
- Provide Adequate Compensation to Enhance Recruiting, Retention, and Motivation
- Develop Optimum Mixes of Military, Civilian and Contracted Personnel
- Develop Effective Selection and Screening Mechanisms
- Develop Effective Systems for Appraisal
- Develop Individual Incentives to Increase Motivation
- Integrate New Technology into Civilian Workforce
- Recruitment and Retain Adequate Numbers of Quality Minority Personnel.

The PGT also decided to form workgroups for each research area. The task of these workgroups would be to develop more closely defined and targeted research projects.

**APPENDIX A**  
**QUESTIONNAIRE**

## PRIORITIZATION INSTRUCTIONS

The questionnaire on the following pages is made up of 19 research areas contained in the Roadmap. Under each general area are specific research topics suggested by the study participants. The numbers in parentheses following each research topic indicate the pages in the Roadmap where each research topic is discussed in more detail.

Please read each research area first and rank it on the basis of three criteria.

The first criterion is the relative importance to the Navy of improving effectiveness in a particular area on a 1 to 5 scale. A low score indicates that improving current effectiveness will make little contribution to the Navy's mission, while a high score indicates that increased effectiveness would contribute greatly to the Navy's mission.

### DEVELOP TIMELY PERSONNEL PROCEDURES.

1	2	3	4	5
Slightly Important	Moderately Important	Important	Very Important	Extremely Important

The second criterion is the relative need for new information in order to improve capabilities in a particular area. A low score indicates that the information needed to improve effectiveness is already available; a high score indicates that new information or understanding is necessary before effective action can be taken.

### DEVELOP TIMELY PERSONNEL PROCEDURES.

1	2	3	4	5
Little Need	Some Need	Needed	Important Need	Critical Need

The last criterion is your perception of the likelihood that research findings will be utilized effectively once they are obtained. A low score indicates the respondent's belief that the political, financial, or organizational climate is such that there is little chance that change will be made. A high score indicates that the area is "hot", and there is excellent potential for action based on research or study findings.

**DEVELOP TIMELY PERSONNEL PROCEDURES.**

1                      2                      3                      4                      5

Not likely    Somewhat Likely    Likely    Very Likely    Extremely Likely

To the right of each research area are 3 boxes. In the A box, indicate your scoring of "importance"; the B box is for your scoring of "need for new information"; the C box is for "likelihood of use". For example:

**DEVELOP TIMELY PERSONNEL PROCEDURES.**

A	B	C
3	2	1

This would indicate that the respondent thinks that it is very important to improve effectiveness in the area of more timely personnel procedures, that only some new information is needed in order to improve effectiveness, but it is not likely that research findings would actually be utilized to develop such procedures.

The specific research topics listed under each general area have a space provided to the left. Please check those research topics which, in your opinion, are the most important ones to study. For example:

\_\_\_\_\_ Determine current time required for filling vacant positions for various occupations and activities.

\_\_\_\_\_ Identify techniques utilized by Navy activities that fill vacancies most quickly, and assess transferability.

\_\_\_\_\_ Examine grievance handling procedures developed in the private sector and assess transferability.

Check as many or as few of these as you wish, and include comments or suggestions if desired.

In the line following the "comments" section, please indicate any potential funding source for the research area.

We very much appreciate your cooperation in this project. The questionnaire should not take more than a half hour to complete. Please return it within a week. If you respond to it in collaboration with other members of your staff, please indicate their names and position titles on the last page of the questionnaire.

Thank you!

A = Importance; B = Need For New Information; C = Likelihood of Use  
Rate from 1 (very low) to 5 (very high).

A B C

1. DEVELOP OPTIMUM MIXES OF MILITARY, CIVILIAN, AND CONTRACTED PERSONNEL.

--	--	--

- 1a. \_\_\_\_\_ Determine current nature and extent of contracting out. (20)
- 1b. \_\_\_\_\_ Determine cost effectiveness of contracting out. (20)
- 1c. \_\_\_\_\_ Determine current mixes of military vs. civilian personnel. (21)
- 1d. \_\_\_\_\_ Determine optimum mixes of military vs. civilian personnel. (21)

Comments: \_\_\_\_\_  
\_\_\_\_\_

Funding Source: \_\_\_\_\_

A B C

2. DEVELOP OPTIMUM RATIOS OF SUPERVISORS TO EMPLOYEES.

--	--	--

- 2a. \_\_\_\_\_ Assess current ratios, including civilian supervision of contractors. (26)
- 2b. \_\_\_\_\_ Develop standards for supervisory ratios. (26)

Comments: \_\_\_\_\_  
\_\_\_\_\_

Funding Source: \_\_\_\_\_

A B C

3. DEVELOP CREDIBLE, USABLE MODELS FOR PREDICTING CIVILIAN PERSONNEL  
NEEDED FOR ACTUAL AND CONTINGENCY NAVY SITUATIONS.

--	--	--

- 3a. \_\_\_\_\_ Review and critique existing civilian and military forecasting models. (26)
- 3b. \_\_\_\_\_ Develop most credible model. (26)

A = Importance; B = Need For New Information; C = Likelihood of Use  
Rate from 1 (very low) to 5 (very high).

3. DEVELOP CREDIBLE, USABLE MODELS FOR PREDICTING CIVILIAN PERSONNEL  
NEEDED FOR ACTUAL AND CONTINGENCY NAVY SITUATIONS. (CONTINUED)

- 3c. \_\_\_\_\_ Document current processes for projecting needs and formulating  
budgets. (27-28)
- 3d. \_\_\_\_\_ Develop strategies to integrate forecasting into the budget development  
process. (27-28)

Comments: \_\_\_\_\_  
\_\_\_\_\_

Funding Source: \_\_\_\_\_

4. DEVELOP EFFECTIVE SELECTION AND SCREENING MECHANISMS.

A	B	C
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

- 4a. \_\_\_\_\_ Develop measures of quality/performance potential. (31-32)
- 4b. \_\_\_\_\_ Assess current process and current success rates for key occupations. (32)
- 4c. \_\_\_\_\_ Identify attributes associated with high performance. (33)
- 4d. \_\_\_\_\_ Identify, develop, and test effective tools. (38-39)

Comments: \_\_\_\_\_  
\_\_\_\_\_

Funding Source: \_\_\_\_\_

5. PROVIDE ADEQUATE COMPENSATION TO ENHANCE RECRUITING, RETENTION, AND  
MOTIVATION.

A	B	C
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

- 5a. \_\_\_\_\_ Determine importance of different benefits by age and grade. (49)
- 5b. \_\_\_\_\_ Determine current retention success rates in key occupations. (46, 48)

A = Importance; B = Need For New Information; C = Likelihood of Use  
Rate from 1 (very low) to 5 (very high).

5. PROVIDE ADEQUATE COMPENSATION TO ENHANCE RECRUITING, RETENTION, AND MOTIVATION. (CONTINUED)

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- 5c. \_\_\_\_\_ Determine importance of different benefits by age and grade. (49)
- 5d. \_\_\_\_\_ Determine current retention success rates in key occupations. (46, 48)
- 5e. \_\_\_\_\_ Determine replacement costs. (48)
- 5f. \_\_\_\_\_ Analyze impact of salary and benefits on job acceptance or refusals. (49-50).
- 5g. \_\_\_\_\_ Analyze impact of salary and benefits on decision to leave or stay. (49-50)
- 5h. \_\_\_\_\_ Analyze impact of salary and benefits on motivation and productivity.
- 5i. \_\_\_\_\_ Compare Federal vs. private sector salary and benefit levels. (50)
- 5j. \_\_\_\_\_ Identify and determine feasibility of selected changes in salary and benefits structure. (56)
- 5k. \_\_\_\_\_ Test selected changes. (60)

Comments: \_\_\_\_\_  
 \_\_\_\_\_

Funding Source: \_\_\_\_\_

6. PROVIDE SATISFYING JOB ENVIRONMENTS TO IMPROVE JOB ACCEPTANCE RATES, TURNOVER, AND MOTIVATION/PRODUCTIVITY.

A	B	C

- 6a. \_\_\_\_\_ Determine importance of job content, security, and advancement potential. (49)
- 6b. \_\_\_\_\_ Determine importance of image of public servant. (49, 71)
- 6c. \_\_\_\_\_ Determine importance of physical surroundings. (50, 71)
- 6d. \_\_\_\_\_ Determine importance of flexible hours. (71)
- 6e. \_\_\_\_\_ Determine importance of perquisites for upper level employees. (61)

A = Importance; B = Need For New Information; C = Likelihood of Use  
Rate from 1 (very low) to 5 (very high).

6. PROVIDE SATISFYING JOB ENVIRONMENTS TO IMPROVE JOB ACCEPTANCE RATES,  
TURNOVER, AND MOTIVATION/PRODUCTIVITY. (CONTINUED)

6f. \_\_\_\_\_ Compare Federal vs. private sector job environment features. (50)

Comments: \_\_\_\_\_  
\_\_\_\_\_

Funding Source: \_\_\_\_\_

A B C

7. USE EFFECTIVE MARKETING STRATEGIES FOR RECRUITMENT.

--	--	--

7a. \_\_\_\_\_ Assess changes in labor pools in future. (37)

7b. \_\_\_\_\_ Identify current sources of recruits to key occupations. (37)

7c. \_\_\_\_\_ Identify current networks for finding Federal jobs. (37)

7d. \_\_\_\_\_ Identify promising sources of future recruits for selected occupations. (37)

7e. \_\_\_\_\_ Develop and test effective outreach strategies. (41)

7f. \_\_\_\_\_ Identify and test effective uses of media for target groups. (42)

Comments: \_\_\_\_\_  
\_\_\_\_\_

Funding Source: \_\_\_\_\_

A B C

8. PROVIDE SATISFYING OPPORTUNITIES FOR CAREER DEVELOPMENT.

--	--	--

8a. \_\_\_\_\_ Identify current career advancement patterns. (54-55)

8b. \_\_\_\_\_ Identify limits to advancement at upper grades and for senior  
technicians. (54)

A = Importance; B = Need For New Information; C = Likelihood of Use  
Rate from 1 (very low) to 5 (very high).

8. PROVIDE SATISFYING OPPORTUNITIES FOR CAREER DEVELOPMENT. (CONTINUED)

- 8c. \_\_\_\_\_ Compare Navy, Navy civilian, and private sector career development patterns. (58)
- 8d. \_\_\_\_\_ Determine impact of career advancement on retention. (54)
- 8e. \_\_\_\_\_ Identify needed career management information. (55)
- 8f. \_\_\_\_\_ Design central, automated system to match personnel with job openings. (58)
- 8g. \_\_\_\_\_ Evaluate impact of special training and education on career advancement and retention. (60)

Comments: \_\_\_\_\_  
\_\_\_\_\_

Funding Source: \_\_\_\_\_

A	B	C

9. DEVELOP EFFECTIVE SYSTEMS FOR CLASSIFICATION AND APPRAISAL.

- 9a. \_\_\_\_\_ Measure time and costs required for current systems. (53)
- 9b. \_\_\_\_\_ Develop position management strategies to increase challenge of jobs. (58)
- 9c. \_\_\_\_\_ Compare Navy Demo Project to alternative private sector systems. (60)
- 9d. \_\_\_\_\_ Evaluate replicability of Navy Demo Project at other activities. (60, 92)
- 9e. \_\_\_\_\_ Evaluate impact of SES bonus system on retention and productivity. (58, 61)
- 9f. \_\_\_\_\_ Evaluate impact of merit pay on retention and productivity. (61, 71, 89)
- 9g. \_\_\_\_\_ Evaluate impact of Basic Personnel Appraisal Program on retention and productivity. (61)

Comments: \_\_\_\_\_  
\_\_\_\_\_

Funding Source: \_\_\_\_\_

A = Importance; B = Need For New Information; C = Likelihood of Use  
Rate from 1 (very low) to 5 (very high).

A B C

10. DEVELOP INDIVIDUAL INCENTIVES TO INCREASE MOTIVATION.

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- 10a. \_\_\_\_\_ Develop valid measures of motivation/morale and productivity and determine relationship. (65, 66, 70)
- 10b. \_\_\_\_\_ Identify factors that affect motivation. (70, 71)
- 10c. \_\_\_\_\_ Identify and evaluate current Navy techniques (including monetary incentives, recognition, Navy Demo Project, and others). (71, 89)
- 10d. \_\_\_\_\_ Identify successful private sector techniques. (83)
- 10e. \_\_\_\_\_ Identify potential new techniques and assess feasibility. (83)

Comments: \_\_\_\_\_  
\_\_\_\_\_

Funding Source: \_\_\_\_\_

A B C

11. REDUCE BARRIERS TO INDIVIDUAL MOTIVATION.

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- 11a. \_\_\_\_\_ Determine impact of handling hazardous materials on productivity and develop and test educational strategies to overcome. (71)
- 11b. \_\_\_\_\_ Determine impact of drug and alcohol problems, evaluate employee assistance programs, and assess opportunities to combine with military programs. (71, 89)
- 11c. \_\_\_\_\_ Determine impact of consistent low performance on morale, develop procedures for handling low performance individuals. (83)

Comments: \_\_\_\_\_  
\_\_\_\_\_

Funding Source: \_\_\_\_\_

A = Importance; B = Need For New Information; C = Likelihood of Use  
Rate from 1 (very low) to 5 (very high).

A B C

12. DEVELOP EFFECTIVE MANAGERS AND SUPERVISORS.

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- 12a. \_\_\_\_\_ Identify critical skills and abilities needed. (71, 75)
- 12b. \_\_\_\_\_ Develop measures of effectiveness. (76, 86)
- 12c. \_\_\_\_\_ Develop discriminating selection criteria/procedures. (76, 86)
- 12d. \_\_\_\_\_ Determine optimum training/development strategies. (86)

Comments: \_\_\_\_\_  
\_\_\_\_\_

Funding Source: \_\_\_\_\_

A B C

13. INTEGRATE NEW TECHNOLOGY WITHIN CIVILIAN WORKFORCE.

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- 13a. \_\_\_\_\_ Identify impact of future technology on future requirements for skilled personnel. (76)
- 13b. \_\_\_\_\_ Identify knowledge, skills, and abilities needed to use new technologies. (76)
- 13c. \_\_\_\_\_ Develop and test training strategies to use new technologies. (76)
- 13d. \_\_\_\_\_ Assess impacts on management span of control. (76)
- 13e. \_\_\_\_\_ Assess opportunities for Computer Assisted Training and test effectiveness. (86, 92)

Comments: \_\_\_\_\_  
\_\_\_\_\_

Funding Source: \_\_\_\_\_

A = Importance; B = Need For New Information; C = Likelihood of Use  
Rate from 1 (very low) to 5 (very high).

14. INCREASE KNOWLEDGE, SKILLS, AND ABILITIES (KSA'S) OF CIVILIAN  
PERSONNEL.

A B C

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14a. \_\_\_\_\_ Develop task analyses for white collar jobs. (75)

14b. \_\_\_\_\_ Determine return on investment and identify techniques for mid-career  
training. (92)

14c. \_\_\_\_\_ Determine impact of training on productivity/performance. (92)

Comments: \_\_\_\_\_  
\_\_\_\_\_

Funding Source: \_\_\_\_\_

A B C

15. INCREASE THE EFFICIENCY OF SELECTED PERSONNEL PRACTICES.

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15a. \_\_\_\_\_ Measure time and costs associated with unfair labor practices/  
grievances. (87)

15b. \_\_\_\_\_ Measure time and costs associated with other personnel functions. (78, 79,  
80)

15c. \_\_\_\_\_ Identify and test/evaluate promising techniques for handling ULP  
grievances. (87)

15d. \_\_\_\_\_ Identify needs for NCPDS data and develop plan for its effective use. (88)

Comments: \_\_\_\_\_  
\_\_\_\_\_

Funding Source: \_\_\_\_\_

A = Importance; B = Need For New Information; C = Likelihood of Use  
 Rate from 1 (very low) to 5 (very high).

A B C

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16. DEVELOP ORGANIZATIONAL STRUCTURES THAT ENHANCE PRODUCTIVITY.

- 16a. \_\_\_\_\_ Identify differences between military and civilian leadership styles and impact on productivity. (80)
- 16b. \_\_\_\_\_ Identify organizational and training options to reduce military-civilian dissonance. (87)
- 16c. \_\_\_\_\_ Determine time and costs of downtime in ship maintenance. (80, 92)
- 16d. \_\_\_\_\_ Identify, test, and evaluate cross-training and work team options to reduce downtime. (92)

Comments: \_\_\_\_\_  
 \_\_\_\_\_

Funding Source: \_\_\_\_\_

A B C

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17. RECRUIT ADEQUATE NUMBERS OF QUALITY MINORITY PERSONNEL.

- 17a. \_\_\_\_\_ Determine why current minorities chose Navy career. (101, 102)
- 17b. \_\_\_\_\_ Identify potential institutional barriers to recruitment, e.g., community and educational barriers, veterans preference, exams, physical barriers for the handicapped, contracting-out. (103)
- 17c. \_\_\_\_\_ Identify current successful Navy recruiting strategies and assess transferability. (105)
- 17d. \_\_\_\_\_ Identify promising sources of recruits. (105)
- 17e. \_\_\_\_\_ Identify changes in work environment to increase opportunities for physically disabled. (107)
- 17f. \_\_\_\_\_ Evaluate cost-effectiveness of EEO structure in meeting EEO objectives. (109)
- 17g. \_\_\_\_\_ Analyze impact of minority recruiting on productivity and identify models to relate recruitment to priority manpower needs. (104, 105)

A = Importance; B = Need For New Information; C = Likelihood of Use  
Rate from 1 (very low) to 5 (very high).

17. RECRUIT ADEQUATE NUMBERS OF QUALITY MINORITY PERSONNEL. (CONTINUED)

17h. \_\_\_\_\_ Test long-run cost-benefits of concentrating recruiting resources on high quality recruits. (109)

17i. \_\_\_\_\_ Test and evaluate promising recruiting strategies. (105)

Comments: \_\_\_\_\_  
\_\_\_\_\_

Funding Source: \_\_\_\_\_

A B C

18. RETAIN ADEQUATE NUMBERS OF QUALITY MINORITY PERSONNEL.

--	--	--

18a. \_\_\_\_\_ Develop data base and profiles on minorities in Navy workplace. (98, 100)

18b. \_\_\_\_\_ Identify reasons why minorities stay or leave. (102-103)

18c. \_\_\_\_\_ Identify minority career patterns and advancement factors. (108)

18d. \_\_\_\_\_ Assess minority information, needs about career development, and test model dissemination approaches. (108)

18e. \_\_\_\_\_ Identify and examine feasibility, and test new exams or procedures to enable minorities to enter competitive and management positions. (108)

18f. \_\_\_\_\_ Evaluate cost-effectiveness of EEO structure in meeting this objective. (109)

Comments: \_\_\_\_\_  
\_\_\_\_\_

Funding Source: \_\_\_\_\_

A = Importance; B = Need For New Information; C = Likelihood of Use  
Rate from 1 (very low) to 5 (very high).

A B C

19. INSURE NON-DISCRIMINATORY TREATMENT OF MINORITIES.

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19a. \_\_\_\_\_ Identify current levels, trends, and patterns of discrimination complaints. (98)

19b. \_\_\_\_\_ Identify and test promising procedures or training programs to reduce discrimination complaints. (110)

19c. \_\_\_\_\_ Evaluate the cost-effectiveness of the EEO structure in meeting this objective. (109)

Comments: \_\_\_\_\_  
\_\_\_\_\_

Funding Source: \_\_\_\_\_

NAME AND POSITION OF QUESTIONNAIRE RESPONDENTS:

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**APPENDIX B**  
**RESPONDENTS**

**APPENDIX B**  
**QUESTIONNAIRE RESPONDENTS**  
**ROADMAP RESEARCH PRIORITIZATION PROJECT**

Mr. Bun B. Bray, Jr.  
Executive Director  
Federal Managers Association

Mr. Ronald C. Burow  
Head, Personnel Management and Evaluation Branch  
Civilian Personnel Policy Division

Vice Admiral James B. Busey  
Commander, Naval Air Systems Command  
Naval Air Systems Command

Mr. Emerson Cale  
Deputy Director, Logistics Plans and Programs  
OP-40B

Dr. James E. Colvard  
Deputy Chief of Naval Material  
Navy Material Command

Mr. Tom Cooper  
Director, CCPO  
Charleston, SC

Dr. Helen Cristrup  
Acting Assistant Director  
Office of Staff and Policy  
Office of Personnel Management

Mr. John R. Curran, Sr.  
Director, Civilian Personnel  
Headquarters Naval Material Command

Dr. Angelo J. Di Mascio  
Deputy Commander, Naval Air Systems  
Command  
Naval Air Systems Command

Mr. H. Lee Dixon  
Director, Civilian Manpower Division  
Comptroller of the Navy

**QUESTIONNAIRE RESPONDENTS**

**(Continued)**

Mr. James P. Early  
Director, Civilian Personnel  
Norfolk Naval Shipyard

Mr. Reginald M. Felton  
Head, Equal Employment Opportunity Programs Branch  
Civilian Personnel Policy Division

Mr. Terry J. Haycock  
Head, Labor and Employees Relations Branch  
Civilian Personnel Policy Division

Rear Admiral A. J. Herberger  
Director, Military Personnel Policy  
Division  
Office of the Chief of Naval Operations

Mr. Robert M. Hillyer  
Director, Navy Laboratories  
Headquarters, Naval Material Command  
(now Technical Director, Naval Ocean  
Systems Center, San Diego)

Mr. A. W. Hines  
Associate Director of Navy Labs

Mr. Allen Johnson  
Civilian Personnel Director  
Subbase, Banyor

Mr. Leonard Klein  
Assistant Deputy Chief of Navy Material  
(Manpower and Personnel)  
Naval Material Command

Mr. Conrad Lacy, Chief  
Management Analysis and  
Development Office  
U.S. Army Civilian Personnel Center (PECC-AD)

Mr. Larry Lacy  
Deputy Assistant Secretary of  
Defense for Civilian Personnel  
Policy and Requirements  
Office of the Assistant Secretary of Defense (MRA&L)

## QUESTIONNAIRE RESPONDENTS

(Continued)

Mr. Robert Lehto  
Director, Total Force Information  
Systems Management Division (OP-16)  
Office of the Chief of Naval Operations

Mr. Thomas E. Lindsey  
Head, Training and Career Management Branch  
Civilian Personnel Policy Division

Ms. Sue M. Martin  
Head, Executive Personnel and Performance  
Appraisal Systems Branch  
Civilian Personnel Policy Division

Mr. Kenneth H. McDaniel  
EEO Manager  
Naval Underwater Systems Center  
Newport, RI

Ms. Dorothy M. Meletzke  
Director, Navy Civilian Personnel Command

Captain Phillip Monroe  
Commanding Officer  
Naval Air Rework Facility  
Naval Air Station, San Diego

Mr. Marvin Moss  
Technical Director  
Office of Naval Research

Mr. Thomas R. Muir  
Assistant Deputy Chief of Naval Operations  
(Civilian Personnel/Equal Employment  
Opportunity)

Dr. Richard J. Niehaus  
Assistant for Human Resources Analysis  
Office of the Chief of Naval Operations

Mr. E. W. O'Brien  
Head, Manpower Mix Branch, OP-124

**QUESTIONNAIRE RESPONDENTS**

**(Continued)**

**Ms. Lorraine G. Ratto**  
Assistant for Civilian Personnel Research  
Navy Personnel Research and Development  
Center

**Mr. Edward G. Sherrill**  
Director of Civilian Personnel Programs  
HDQRS, United States Marine Corps

**Mr. George P. Steinhauer**  
Head, Staffing and Pay Systems Branch  
Civilian Personnel Policy Division

**Mr. Joseph K. Taussig, Jr.**  
Deputy Assistant Secretary of the Navy  
(Civilian Personnel Policy/Equal  
Employment Opportunity)

**Dr. James W. Tweeddale**  
Technical Director  
Navy Personnel Research and Development  
Center

**Mr. Alfred D. White**  
Special Assistant, EEO

**APPENDIX C**  
**METHODOLOGY**

## APPENDIX C: METHODOLOGY

### Analysis Plan

The analysis of the data resulting from the questionnaire consisted of two stages. The first was the statistical analysis of the responses while the second consisted of a feasibility analysis of each of the highest ranking areas and projects in terms of research sequencing and estimated time and cost parameters.

#### STAGE ONE: STATISTICAL ANALYSIS

The principal objective of this stage of the analysis was to identify the group of research areas and research topics within research area ranked the highest by the respondents to the survey questionnaire. Moreover, our analysis was also designed to test the hypothesis that the rankings by respondent groups are independent against the alternative hypothesis that there is concurrence by the respondents in their rankings. The statistical methods used to analyze the research area and research topic responses are basically the same and are discussed below.

**Research Area Analysis:** Completed surveys for the analysis were received from 36 respondents. Each respondent rated each of 19 research areas with a Likert score ranging from one (for the lowest rating) to five (for the highest rating). Initially we created a 36 by 19 data array containing all of the Likert score responses on the survey. There are three such data surveys since each research area was rated according to three separate criteria. We created a fourth data array that simply represents a linear combination of the Likert scores given to each research area by each respondent summed across each of the three objectives.

The column sums in each data array are the combined Likert ratings for a given research area across each of the 36 respondents in the sample. By dividing these column sums by 36 (108 by the data array representing Likert scores summed over each of the three objectives), we calculated the mean Likert score for each research area. The mean Likert ratings for the combined responses across the three objectives give equal weight to each criterion. We used these mean values (or, equivalently, the column sums) from the combined-criteria data array to establish the final set of rankings for the 19 research areas. These results are reported in table one in the next chapter. In addition to the mean Likert score across all three research areas and the associated rankings, the mean Likert score for each separate criterion is also reported.

To test whether or not the research areas can be distinguished on the basis of the rankings, we first combined the respondents into four separate groups according to their general job classification. The Likert scores were then summed across the respondents in each group for each research area and for each criterion on which the research areas were rated. In effect, this produced four 4 by 19 data arrays comparable to the data arrays described above only with respondents grouped by job classification. Our statistical test was thus designed to determine whether these four groups of respondents were rating the research areas independently or with a substantial degree of concurrence on the survey.

Since the data from the survey were ordinal data, a nonparametric statistical test was appropriate for our purposes. There were two nonparametric tests that were available to us in the SPSS statistical software package for examining the independence of rankings hypothesis discussed above. Both the Friedman two way analysis of variance by ranks and the Kendall coefficient of concordance provide Chi-square test statistics that suffice for this purpose. The intuitive explanation of the test procedures was the same in both cases but the expression for the calculated test statistic

differs. We performed the test using both packages and were reassured to discover that test results were virtually identical.

Basically, each method first ranks the 19 research areas for each group of respondents on each criterion (and for the linearly combined criteria). If in fact the respondent rankings are independent, then the likelihood of a research area receiving the highest or lowest ranking from any respondent group is a chance event. That is, the distribution of ranks in any column would be a matter of chance and we would expect the ranks of 1,2,...,19 to appear in all columns with about equal frequency. More formally, if the rankings were independent across the respondent groups (that is, no concurrence among them), then the ranks in each column would represent a random sample from the discontinuous rectangular distribution of 1,...,19 and the rank totals in each column would be nearly equal. Alternatively, if the respondent groups were "thinking alike" more so than not alike in their rankings, then the column totals would differ from one column to another. Equivalently, the mean rank from one column (research area) to another would differ from one to another.

The Friedman two way analysis of variance by ranks constructs a test statistic that utilizes the column sums to evaluate independence of rankings among the respondents. The larger the variation in the rank totals (column sums) across each research area, the larger the Friedman test statistic, and the greater the chances of rejecting the null hypothesis of independence among the respondent rankings in the four groups of respondents. The Friedman test statistic appears below:

$$x^2_r = \frac{12}{NK(K+1)} \sum_{i=1}^K R_i^2 - 3N(K+1)$$

The  $x^2_r$  statistic has an approximate Chi-square distribution with  $K - 1$  degrees of freedom. If the calculated test exceeds the look-up value of the Chi-square variate from a table, then we would reject the null hypothesis that all research areas (topics) are ranked the same at a specified level of significance.

The Kendall coefficient of concordance (W) is a measure of the degree of agreement among the respondents that ranges between zero and one. The numerator of the measure contains the sum of squared deviations of column rank sums from the mean column rank sum over the items ranked (the 19 research areas in this case). As discussed above, the larger this measure, the greater the agreement among the "judges" in their rankings. The denominator of W represents the maximum value of the numerator or the value that it would be if there were perfect agreement among the respondents. Thus, the closer to unity the Kendall coefficient happens to be, the more the judges are in agreement in their rankings. The formula for the Kendall coefficient is as follows:

$$W = \frac{S}{\frac{1}{12} N^2 (K^3 - K)}, \quad 0 \leq W \leq 1$$

where

$$S = \sum_{i=1}^K \frac{R_i^2 - i^2}{K}$$

K = number of research areas  
 N = number of respondent groups  
 and  $R_i$  = the rank sum of column i.

In both the Friedman and Kendall cases, ties among the rankings for the items ranked were each assigned to mean ranking. For example, if three research areas tied for the third highest ranking, each would be assigned a ranking of four in the calculations. A large number of ties deflates the value of W so the connection factor below, when deducted from the denominator in the W expression, offsets this effect:

$$T^* = N \sum_{i=1}^N T_i$$

where

$$T = \frac{\sum_{j=1}^{n_j} \sum_{i=1}^3 (t_{ij} - t_{ij})}{12}$$

$n_i$  = the number of groups of ties within the rankings of the "ith" respondent

$t_{ij}$  = the number of research areas in the "jth" group tied for a given rank by the "ith" respondent.

To test the significance of  $W$ , one may determine the probability of obtaining of measure as large as an observed  $S$  on the null hypothesis that there is independence among the respondents in their rankings. The test statistic below is approximately distributed as a Chi-squared variate with  $K-1$  degrees of freedom,

$$\chi^2_{K-1} = N (K - 1) W$$

and may be used to determine the probability of obtaining a value as large as an observed  $W$  on the null hypothesis of independence in respondent rankings. If this probability is very small, such as less than five or one percent, then it is safe to say that the agreement observed among the respondents is greater than would occur by chance.

We calculated both the Friedman and Kendall test statistics using the SPSS statistical packages. Table 1 reports the results of our tests and the mean ranking of the 19 research areas across the four groups of respondents. Note that these rankings differ slightly from the corresponding rankings reported in the next section. The prioritization presented in the next section gives equal weight to each survey participant in calculating mean rankings across all participants. The rankings reported in Table 1 below give equal weight to each participant group in calculating the mean values. This means that participants in smaller groups receive relatively higher weights than participants in larger groups in determining the prioritization reported in Table 1. Since the Friedman and Kendall results were virtually identical, we report only the latter test statistics in the table.

**TABLE 1**  
**KENDALL COEFFICIENT TEST RESULTS**

Mean Ranking And Statistics	Objective			
	Combined	"Importance"	"Need"	"Use"
1	Effective Managers (No. 12)	No. 12	No. 5	No. 9
2	Compensation (No. 5)	No. 5	No. 13	No. 4
3	Classification (No. 9)	No. 9	No. 9	No. 12
4	New Technology (No. 13)	No. 4	No. 3	No. 17*
5	Selection & Screening (No. 4)	No. 13	No. 12	No. 7*
6	Models* (No. 3)	No. 7	No. 1	No. 18
7	Marketing* (No. 7)	No. 1	No. 15	No. 3
8	Personnel Practices (No. 15)	No. 15	No. 10	No. 19
9	Retain Minorities (No. 18)	No. 3	No. 4*	No. 13
10	Recruit Minorities (No. 17)	No. 10	No. 15*	No. 15
11	Insure Non-Discrimination (No. 19)	No. 19	No. 18	No. 5
12	Optimum Mixes (No. 1)	No. 18	No. 17	No. 11
13	Incentives (No. 10)	No. 17	No. 7	No. 1
14	Productivity (No. 16)	No. 16	No. 19	No. 16

(Continued)

**TABLE 1 (Continued)**  
**KENDALL COEFFICIENT TEST RESULTS**

Mean Ranking And Statistics	Objective			
	Combined	"Importance"	"Need"	"Use"
15	Reduce Barriers (No. 11)	No. 6	No. 14	No. 10
16	Increase KSA's (No. 14)	No. 14	No. 6	No. 6
17	Job Environment (No. 6)	No. 11	No. 11	No. 14
18	Career Development (No. 8)	No. 15	No. 8	No. 8
19	Optimum Ratios (No. 2)	No. 2	No. 2	No. 2
Kendall Coefficient (W)	.570	.522	.560	.600
Chi-Square Statistic	41.035	37.578	40.356	43.205
Level of Significance	.001	.004	.002	.001

**SOURCE:** Calculated by SRA Technologies, Inc.

**NOTE:** \* Indicates a tie for the ranking.

The level of significance indicates the probability of achieving a Kendall coefficient as large as the observed value on the null hypothesis that there is no concordance in the respondent's rankings.

The numbers associated with each research area refer to the ordering on the survey questionnaire.

The test results reported in Table 1 demonstrate that the respondent groups tended to agree more than disagree in their research area rankings, and the degree of concordance was statistically significant. That is, on the basis of our test results, the degree of concordance among the respondent groups was greater than would occur by chance. The mean rankings reported in Table 1 represents the best estimate of the respondent group rankings, but, as we pointed out above, these rankings differ slightly from those reported in Section II in which each individual receives the same relative weight in calculating the mean values.

As a final note, the mean rankings do not necessarily establish the "best" prioritization. They instead simply represent the best estimate of the commonly agreed upon prioritization by the sample members (or sample member groups).

**Research Topic Analysis:** Survey respondents were also asked to check off projects on research topics that they consider promising from among a list provided on the questionnaire under each research area. The number of topics listed under each research area varied from 3 to 16 on the survey instrument, so we created 19 data arrays (for research topics in each of 19 research areas) of 36 by  $K^*$  dimensions where  $K^*$  varied between 3 and 16 (research topics).

Our statistical analysis focused on testing for agreement among the respondents regarding research topic rankings within the 14 research areas ranked the highest among the 19 on the questionnaire. The rank order of research topics within these 14 research areas was of no particular interest beyond its use in the statistical testing described below. Research topics receiving "checks" from fewer than one third of the respondents were not given serious consideration as "promising" projects. Section II reports the "promising" projects according to this criterion in the higher priority research areas. Below we report the results of our statistical tests to determine whether or not the four groups of survey respondents were in agreement in their research project rankings within each of the top 14 research areas.

The first step in the test procedure was to aggregate the number of "checks" given to each project over the respondents in each of the four separate respondent groups. This produced fourteen 4 by K\* data arrays which comprised the data input for the Friedman and Kendall coefficient statistical tests discussed above.

The test results are reported in Table 2 on the following page. Contrary to the research area rankings, we find that in the majority of cases, the four respondent groups were not in agreement. In only six of the 14 research areas (Nos. 1, 3, 4, 9, 17, and 18) was the level of significance in the statistical test sufficiently small to suggest that the respondent groups concurred in their rankings of the individual research topics within these areas. That is, the degree of agreement among the respondent groups measured by the Kendall coefficient was greater than would have occurred by chance. In the other research areas (among the top 14), the observed level of agreement was not inconsistent with the null hypothesis that the respondent group rankings were inherently independent. Since there was some slight differences between the Friedman and Kendall test results, we report both sets of results in the table.

These test results justify our treatment of the research topic prioritization discussed in Section II. Since in the majority of cases the respondents did not reach agreement (in a statistical sense) on a ranking of projects within the research areas, we do not report the mean rankings of projects that did result from the survey. Instead we present all but the projects receiving less than 13 check marks as "promising" research topics under the higher priority research areas, and the mid-ranked research areas.

#### **STAGE TWO: FEASIBILITY ANALYSIS**

The statistical analysis placed the research areas into priority categories based on relative importance, and indicated which specific research projects the respondents judged to be most important within each research

**TABLE 2**  
**STATISTICAL TESTS FOR RESPONDENT GROUP AGREEMENT**  
**IN RANKING RESEARCH TOPICS WITHIN RESEARCH AREAS**

Research Area	Kendall Test			Friedman Test		Degree of Freedom (K*-1)
	Kendall Coefficient (W)	Chi Square Value	Level of Significance	Chi Square Value	Level of Significance	
Effective Managers (No. 12)	.140	1.68	.642	1.42	.700	3
Compensation (No. 5)	.363	11.62	.169	11.13	.194	8
Classification (No. 9)	.605	14.53	.024	12.91	.044	6
New Technology (No. 13)	.417	6.67	.155	4.75	.314	4
Selection & Screening (No. 4)	.737	8.84	.031	8.40	.038	3
Models (No. 3)	.729	8.75	.033	7.87	.049	3
Marketing (No. 7)	.219	4.39	.495	3.57	.613	5
Personnel Practices (No. 15)	.331	3.97	.265	3.37	.337	3
Retain Minorities (No. 18)	.524	10.47	.063	8.68	.123	5
Recruit Minorities (No. 17)	.586	18.76	.016	15.87	.044	8
Insure Non-Discrimination (No. 19)	.071	.57	.751	.50	.779	2

(Continued)

**TABLE 2 (Continued)**  
**STATISTICAL TESTS FOR RESPONDENT GROUP AGREEMENT**  
**IN RANKING RESEARCH TOPICS WITHIN RESEARCH AREAS**

Research Area	Kendall Test			Friedman Test		Degrees of Freedom (K*-1)
	Kendall Coefficient (W)	Chi Square Value	Level of Significance	Chi Square Value	Level of Significance	
Optimum Mixes (No. 1)	.770	9.24	.026	8.77	.032	3
Incentives (No. 10)	.107	1.71	.790	1.45	.836	4
Productivity (No. 16)	.090	1.08	.781	.97	.807	3

**SOURCE:** Calculated by SRA Technologies, Inc.

**NOTE:** The level of significance indicates the probability of achieving a test statistic as large as the observed value of the null hypothesis that there is no agreement among the respondents in their research project rankings.

The numbers associated with each research area refer to the ordering on the survey questionnaire. See the next section for a more complete discussion of the research areas and projects.

area. The next stage consisted of a series of technical feasibility judgments. The factors considered in this process included:

- o The adequacy of existing knowledge in an area, based upon the literature review in the Roadmap.
- o The likelihood of research success;
- o The time required to complete the research; and
- o The estimated cost to complete the research.

For each of the four highest ranked research areas, a sequenced array of potential research projects was constructed. For the mid-ranked areas, the projects seen as most important by questionnaire respondents were noted.

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