3932

[redacted]

Center for
Research on
Utilization of
Scientific
Knowledge

CRUSK

Institute
for Science,
Research,
and
Development
of Washington
State University
Pullman

ISR

Research into Use:
A Study of the Forest Service Research Branch

by

David A. Lingwood
William C. Morris

Center for Research on
Utilization of Scientific Knowledge
Institute for Social Research
University of Michigan
Ann Arbor, Michigan

March, 1976

Final Report to the U.S. Forest Service Research Branch, U.S. Department of Agriculture for work accomplished under Grant #13-267, "Research Productivity and Utilization of Scientific Knowledge."

The points of view and conclusions in this report are the authors', and do not necessarily reflect those of the U.S. Forest Service.

FOREWORD

THEMES IN THIS REPORT

The "process" of science is often as important as the findings or content. This is particularly true in projects in the social sciences which have the aim of applying social knowledge to helping and changing real systems, organizations, and people.

We stress this here because this report will concentrate almost equally on the "what" of our findings in working with Forest Service research, and on the "how" of the process through which we worked.

Too often the process side of "action-research" work is not reported and becomes lost. Thus, we owe it to others who may become involved in working with R&D organizations to report on what we did. The description of the process also helps us interpret the more familiar text covering what we found. Finally, the processes or steps in the relationship are crucial in any attempts at organizational development, and are in effect the "innovation" we brought to the project. Our process comes from an "action-research" approach to solving problems, and is represented in the model for R&D lab strengthening and renewal found in the first chapter. For all of these reasons, the, the reader will find much more "process" here than one would normally expect.

The content we will present here is of equal importance for us, and may be more important than the process for readers concerned with R&D organizations. Our content base is a wide one, coming from the basic question of: what do we as social scientists have to offer in terms of content areas and perspectives which should help produce a "fully-functioning" R&D organization? Our approach is that we need to understand the levels of and interplay among a large number of factors in the R&D situation: R&D is produced by individual researchers who work in organizations; the organizations and individuals work in the present, plan for the future, and document and output work of the past.

We are also concerned with the parallels we see between ourselves and our Forest Service research clients as we both strive to produce knowledge and get it used.

ORGANIZATION OF THIS REPORT

All of these themes require explanation, and all will have their particular audience. Thus, the problem has always been whether to present the totality of our work in one document, or to split up the many dimensions for the audiences involved. The former runs the risk of swamping the reader; the latter the risk of fragmentation, together with the task of having to

explain the basic concepts, ground rules, and methods again for each group. On balance, our feeling has been that we must attempt this comprehensive document, since the major contribution of this work is, in our view, exactly the putting together of many different conceptual approaches and process skills.

We will begin with a description of the Forest Service research branch, the situations leading to our project, and the model we used in the study. This is in the first chapter, together with the literature relevant to the content areas of our model.

The model and the project follow a "problem-solving" sequence: beginning with problem formulation, then empirical description and diagnosis, followed by the use of the data in feedback to the client and attempts to help build change based on the results. The report will present the results of a full year of problem formulation work in Chapter 2, and the survey methodology in Chapter 3.

Chapters 4 through 9 look at the content focus areas we studied -- beginning with planning, then supervision, organizational conditions, and finally moving to the criteria of contribution to scientific knowledge and its applications, rewards for such work, and the research application process.

Following this we take a side journey into the work of the research Technicians. The next chapter is not the traditional summary (each chapter contains its own summary materials instead). Rather, we will move to a more "consultant" role of making a series of recommendations to Forest Service research.

Finally, we will return again to the process of the study, summarizing the work done in data feedback and problem-solving and what we have learned about the overall process.

The appendices contain a variety of more technical topics of interest to some, but not all readers.

There is a lot of material here -- the project was both longer and more complex than most efforts in social science. We will therefore give guidance to readers and a short summary at the start of each chapter.

One other procedural note involves quotes from the respondents to our survey. In many cases the quotes are related to the text in the traditional manner. In other instances quotes are put in as they apply to the topic of discussion, but without relation to the text. These are identified by a much smaller typeface and are set off toward the right of the page. They should be read as a grace note or appetizer.

ACKNOWLEDGEMENTS

If we were to do a complete job of giving credit to all of the groups and individuals who have contributed to this work this section would become a major chapter. All we can do is to list the major contributors and helpers.

Dr. Floyd C. Mann, then the Director of the Center for Research on Utilization of Scientific Knowledge (CRUSK), and Dr. Keith Arnold, then Deputy Chief for Research in the Forest Service, were the starting points for the work, providing the needs and interest on the agency side and the R&D lab model on the other. Dr. M.B. Dickerman, who replaced Dr. Arnold, also deserves credit for keeping the project going.

Next we must credit the members of the "Forest Service inside team" for helping us learn and for providing guidance at all levels. The team members were:

Dr. R.Z. Callaham
Dr. Adrian M. Gilbert
Mr. Richard L. Knox
Ms. Mary O'Hara
Dr. C.E. Ostrom
Mr. W.R. Otterson
Dr. Dean Quinney
Mr. Craig Rupp
Dr. Keith Shea
Dr. Ernst Valfer

Dr. James Murphy served capably as our project manager in the face of many competing duties, and became both an advocate and a friend.

On the CRUSK side, Drs. J. Thad Barnowe and Richard Schreyer contributed assistance beyond the recompense they received. Our thanks to them for accepting with equanimity the unavoidable "grad student rip-off" model of "if you'll do a lot of nickel and dime work we'll provide a setting and data for your dissertation." Other CRUSK senior staff members also need mention since they helped us link our project to their work, providing the scope of content needed to cover a complex organization: Drs. David Bowers, Ronald Havelock, Donald Michael, and Donald Pelz.

The leadership in each Forest Service research station (Directors and Assistant Directors), and the Forest Products Laboratory and staff in State and Private Forestry (S&PF) and National Forest Service (NFS) were gracious, tolerant of our initial dumb questions, and in many cases good friends. The help they gave during problem formulation was essential, and their openness to feedback and problem-solving work was both necessary and provided.

Research projects live or die on the skills of the support staff -- we "lived well." Ms. Judy Kaplan and Mr. Russell Stambaugh monitored, coded, handled data, made charts, and linked to the computer. Mr. Michael Dodge did the initial work in file building. Also, INTRAN Corporation gave us the optical scanning services which made it possible to collect a large amount of data on a limited budget. Any researcher knows, too, that his secretarial support is the real key to getting the work out. Ms. Janet Johnson typed reports and open-ended questionnaire comments. Ms. Rita Wiegers endured several years of report writing, producing quick and accurate text and

accepting the seemingly endless re-writes and "cut and paste" jobs. Ms. Revella Woodson and Mr. Hans Wagner kept us honest on the financial side. Also, thanks to CRUSK for absorbing the costs of much of Lingwood's time in writing this document. Also in the area of staff support come our wives, Toni and Mary Ann, who accepted the trips and long hours, and learned perhaps more than they wanted to know about Forest Service research.

Finally, we come to the most important group of all: the Researchers and Technicians of the Forest Service. Their time, interest, and responsiveness made the work possible, and it is for them that we did it. We only hope we have given something in return and that they can use the content and skills we have tried to provide them.

TABLE OF CONTENTS

	Page
Foreword	i
List of Tables	viii
List of Figures	ix
CHAPTER 1. BASIS AND BEGINNINGS	1
Introduction	1
Forest Service Research	2
Needs for the Project	3
A Problem-Solving Model for Use in Research Labs	4
Basic Approach to Organizations	4
Development of the Model	5
The Present Model	6
The Model as An Innovation	8
Overview of Previous Research	8
Studies in Planning and Goal Setting	9
Studies in the Organizational Focus	10
Studies in the Individual Focus	11
Diffusion and Utilization of Knowledge	13
CHAPTER 2. PROBLEM FORMULATION	15
Introduction	16
Methods Used	16
Interviews in Research	17
Focus on Planning and Goal Setting	17
Focus on the Organization	18
Focus on the Individual	20
Focus on Applications	23
Summary of First Year Interviewing in Research	25
Interviews with Clients	26
State and Private Forestry	26
National Forest Systems	26
Conclusion	27
CHAPTER 3. SURVEY METHODS AND INTRODUCTION TO THE ANALYSIS	29
Producing Research Questions from Problem Statements	29
Data Collection	31
Data Coding and Manipulation	32
Index Creation	32
Indices of Scientific and Applied Contribution	33
Introduction to the Analysis	34
Levels of Analysis	34
Criteria	34
The Analyses	35
The Start of An Overall Predictive Model	35
CHAPTER 4. PLANNING	37
Introduction	37
Satisfaction with Planning	40
Evaluation of Planning Processes	42
CHAPTER 5. SUPERVISION	49
Introduction to the Supervision Problem	50
Perspectives on Leadership and Supervision	51
Potential Impact of Supervisory Differences	54
Indices of Supervisory Style--Relating the Theorists	54

TABLE OF CONTENTS, continued

	Page
CHAPTER 5, continued	
Supervisory Style Related to Satisfaction with Supervisor. . .	58
Supervisor Satisfaction in Managerial Grid Terms	60
Scientists' Ratings of Their PL Related to His Characteristics	62
Discussion	66
CHAPTER 6. ORGANIZATIONAL FACTORS AND SATISFACTION	69
Introduction	69
Where is Forest Service Research on the Organizational Indicators?.	71
Physical and Support Environments	72
The Communication Environment	75
"Climate" Measures.	75
Satisfactions	78
Factors a Job Should and Does Provide.	78
Stimulation in the Job	81
Who Are the Most and Least Satisfied	81
AID Analyses of Satisfaction with the Station	83
AID Analyses of Job Satisfaction.	85
Challenge and Dedication	85
The Predictive Model for Satisfaction.	90
CHAPTER 7. SCIENTIFIC AND APPLIED CONTRIBUTION	95
Introduction	96
Discipline Differences in Contribution	99
Levels of Contribution	99
Who Contributes the Most -- and the Least?	103
Scientific Contribution	104
Applied Contribution.	106
Contribution in the Predictive Model	108
Scientific and Applied Contribution Together	113
Conclusion	116
CHAPTER 8. REWARD.	121
The Importance of Rewards.	121
Background Related to Rewards.	122
The Relation of Reward to Contribution	124
CHAPTER 9. DISSEMINATION AND UTILIZATION	131
Introduction	131
The Clients of Forest Service Research	133
Station Activities in Dissemination and Utilization.	135
Dissemination-Utilization Processes and Clients Reached .	138
Dissemination and Utilization Activities Compared with Other Measures	140
CHAPTER 10. TECHNICIANS.	147
Introduction	147
Who are the Technicians?	148
Satisfaction	148
Importance and Opportunity Ratings	152
What the Technicians Say	152
Conclusions.	156
CHAPTER 11. PROBLEM-SOLVING AND FEEDBACK PROCESSES	157
Introduction	157
Organizational Problem-Solving	158
The Relation of Problem-Solving to the Lab Model and to Feedback	163

TABLE OF CONTENTS, continued

	Page
CHAPTER 11, *continued*	
The Uses of Data in the Station Feedback Process	165
A Summary of Feedback and Problem-Solving Work in Stations	171
The Southern Station	171
The Northeast Station	172
The North Central Station	173
The Forest Products Laboratory	173
The Southeastern Station	174
The Pacific Northwest Station	174
The Pacific Southwest Station	174
The Intermountain Station	175
The Rocky Mountain Station	175
Other Visits	176
A Summary of the Process	176
Analysis of Station Feedback Activity	179
Now What?	180
CHAPTER 12. PROBLEMS AND RECOMMENDATIONS	181
Introduction	181
1. Planning	182
2. Organizational Factors	184
3. Individual Factors	190
4. Dissemination and Use of Research Products	191
Reactions to the Recommendations	198
CHAPTER 13. LEARNINGS ABOUT THE PROCESS	199
Introduction	199
The Project as Seen From the Model	200
A Design for Continuation	203
Parallels in Research and Knowledge Flow	206
BIBLIOGRAPHY	209
APPENDICES	
A. Questionnaire and Coding Materials	215
B. Development of the Scientific and Applied Contribution Indices	237
C. Differences Among Work Disciplines	255
D. Indices	275

LIST OF TABLES

		Page
4-1	Means for Planning Processes, and Correlations with Planning Satisfactions.	43
4-2	Correlations of Planning Satisfactions with Selected Organizational and Supervisor Measures	45
5-1	Correlations Among Supervision Items.	55
5-2	Oblique Rotated Factor Loadings	57
5-3	Multiple Regressions on Satisfaction with Supervisor.	59
5-4	Mean Satisfaction with Supervisor by Blake and Mouton Managerial Grid Ratings.	61
5-5	Summary of Correlations Between PL Data and Scientists' Ratings of the PL's Supervisory Style.	63
7-1	Levels of Contribution.	100
7-2	Estimates of Yearly Contribution.	102
7-3	Explaining Correlations between Satisfactions and Contributions.	112
8-1	G.S. Grade by Education, Experience, and Discipline	123
9-1	Ratings of Dissemination and Utilization Factors Compared with Other Measures.	142
10-1	Characteristics of Technicians.	149
10-2	Comparing Satisfactions for Technicians and Researchers . . .	150
10-3	"Would Never Leave" by Education Level for Technicians. . . .	152

LIST OF FIGURES

		Page
1-1	A Model for Research and Development Lab Renewall/Strengthening Processes.	7
4-1	Planning Indices -- Index Scores for Three Job Groups	41
5-1	Supervision Indices -- Index Scores for Three Job Groups. . .	52
6-1	Physical Environment Indices -- Index Scores for Three Job Groups	73
6-2	Communication Indices -- Index Scores for Three Job Groups .	76
6-3	"Climate Indices -- Index Scores for Three Job Groups	77
6-4	Satisfaction Indices -- Index Scores for Three Job Groups . .	79
6-5	Importance and Opportunity in Job	80
6-6	Stimuli to Perform Well on Job.	82
6-7	AID Analysis of Satisfaction With and Evaluation of the Station.	84
6-8	AID Analysis of Satisfaction With Own Job	86
6-9	Path Analysis of Challenge and Dedication	89
6-10	Path Analysis of Organizational Factors (Scientists).	91
6-11	Path Analysis of Organizational Factors (PLs)	93
7-1	Points for Measuring Contributions.	96
7-2	Alternative Measures of Contributions	98
7-3	AID Analysis of the Scientific Contribution Index	105
7-4	Summary of the AID Analyses of the Applied Contribution Index	107
7-5	Path Analysis of Organizational Factors and Contributions (Scientists)	109
7-6	Path Analysis of Organizational Factors and Contributions (PLs).	111
7-7	Construction of the Scientific and Applied Contribution Measures	114
7-8	Discriminant Aanlysis for Five Scientific and Applied Contribution Groups.	117
8-1	Analysis of Covariance for G.S. Grade of Five Scientific and Applied Contribution Groups.	125
8-2	Applied Contribution of PLs by G.S. Grade	127
8-3	Scientific Contribution of PLs by G.S. Grade.	128
9-1	Dissemination and Utilization Linkage Process Model	132
9-2	Ideal and Actual Audiences.	134
9-3	Contribution According to Audiences Being Reached Now	136
9-4	Ratings of Dissemination and Utilization Areas According to "Audience Groups".	139
10-1	Path Analysis of Satisfaction for Technicians	150
10-2	Importance of Opportunity for Job Factors for Technicians . .	153
11-1	The Relationship of the Lab Model, Problem-Solving, and Feedback	164
11-2	The SE Station Poll	170
11-3	Summary of Station Feedback Work.	177
13-1	Research Organization Assessment (Instrument)	204

CHAPTER 1

BASIS AND BEGINNINGS

READER'S GUIDE:

Here we give both the history of the relationship between Forest Service research and the model which guided our work. These are more or less necessary baselines for understanding what will follow. The literature section at the end of the chapter is optional and is designed as a linkage point for persons who want to learn more about the focus areas we work with.

CHAPTER SUMMARY:

We begin with a brief description of the Forest Service research branch: its mission of "solving problems," its eight research stations and two labs, its organization, and the important job roles within it. The organization became interested in this work because of continuing pressures to get its results applied, and a need to plan for and assess changes in the organization of the system.

CRUSK came to the project with a model of processes and content for "R&D Lab Renewal." The model guided the work of the project. Basically, it is a problem-solving sequence: beginning with problem formulation, then empirical description and diagnosis, leading to data feedback and problem solving based on the results, then implementation and evaluation of change. Four content areas are taken through these steps of problem-solving. These focus areas are: planning, the organization, the individual, and knowledge dissemination and application. A literature section provides linkage to previous work in these focus areas.

INTRODUCTION

This report is about a complex relationship between an R&D organization and a team of socical scientists who tried to help it. As in any relationship, before one can understand what happened it is necessary to learn who each of the participants are, what they want, and what they bring to the relationship. It is the purpose of this chapter to fill in this needed background and to give an overview of the work.

This work (and therefore this report) is complex because we are as concerned with the "how" of the relationship as we are with what we as social scientists have learned about Forest Service research. We will explore the

processes and content areas of the work later in this chapter, but first we need to describe, for readers unfamiliar with it, just what Forest Service Research is, and what the needs were which led to this project.

FOREST SERVICE RESEARCH*

Forest Service research is a "mission-oriented" R&D organization, one of the three operating branches of the U.S. Forest Service (part of the U.S. Department of Agriculture). The mission has been stated as:

> ...to generate the knowledge and methods required for tomorrow's technology. This technology is basic for formulating policy, for planning and managing resources, and for improving the environment on our forest and related lands...The mission is complete only when our findings are applied to improve the lot of man, his resources, and his environment.
>
> (U.S. Forest Service, 1970)

The mission comes down to two things: (1) being able to conduct research--often quite technical and complex analyses of resource problems and potentials, or (of increasing importance) entire ecosystems and man's impact on them; (2) applying the knowledge gained to solving resource problems.

The other two operating branches of the Forest Service should, therefore, be prime clients for the research branch. National Forest Systems (NFS) has the responsibility for managing Forest Service land under the philosophy of continual multiple use. State and Private Forestry (S&PF) works as an intermediary to state and private forest landowners to help these clients manage and protect their holdings. Much of S&PF's work takes place in the Eastern United States where there is less Federal ownership.

Forest Service research is divided into eight research stations and two special laboratories (the Forest Products Lab in Madison, Wisconsin, and the Institute of Tropical Forestry in Puerto Rico). The eight stations cover the country, but have not been organized exactly parallel to the standard Federal regions, under the philosophy that ecological rather than administrative boundaries are more sensible for a research station.

Forest Service research employs approximately 1000 researchers and about 2000 support personnel. Most of these are in the stations and labs, but program and administrative guidance is provided by staff in the Washington Office (WO).

---

*A more complete, though somewhat dated, description of the organization is available in the document "Forest Service Research: Solving Problems on Forest and Related Lands." (U.S. Forest Service, 1970)

The organization of the research stations has undergone several changes in recent years. The stations themselves centralized operations of earlier, more autonomous "research centers" in the 1960's. Each station remains somewhat decentralized, however, since the typical station will cover several states with researchers located in a number of research locations at the time of our work there were just over 80 research locations throughout the nation.*

Researchers work on a project basis. There were over 260 project at the time of our study, ranging in size from one-researcher operations to teams of ten or so. The trend has been to consolidate one-man projects into fewer, larger projects. Projects are headed by Project Leaders (PLs) who are both researchers and first-line administrators on project matters. Scientists on projects are the largest group of researchers. Technicians are also assigned to the projects.

Station leadership and administration is provided by a Station Director (who reports to the Deputy Chief for research in the WO), and a team of Assistant Directors (ADs). The AD structure has evolved, also, with a trend toward ADs for "continuing research," "support services," and "planning and applications." Some stations use research ADs on a more geographic basis, but the system has moved away from ADs assigned by content area of research.

NEEDS FOR THE PROJECT

Forest Service research has been (and will probably always be) under the twin pressures of producing scientifically-competent research also applicable to solving resource problems. Historically the pendulum of emphasis has swung between these as two poles, rather than trying to integrate and develop both capacities at once. The older research centers were located close to the resource manager clients, but somewhat remote (both physically and in work performed) from related natural resource researchers. The re-organization into research stations brought an emphasis on gaining needed scientific credibility. Many current locations are located on or near university campuses.

In the early 1970's Forest Service research became increasingly caught up in the general societal theme of accountability and applicability of science, culminated by a Government Accounting Office (GAO) "audit" of applications made of "important" Forest Service research products. The audit, though flawed on methodological grounds (in our judgment), at least provided added motivation to improve applications. At the same time there was a growing awareness of up-coming needs for station reorganization, and a desire of top leadership to get social science monitoring and help in the general process of organizational development.

This, then, was the mood of top leadership when we began our exploratory linkages with the organization. We came to the first meetings armed with a perspective which says the social scientist must also produce creditable

*See Barnowe (1973) for a study of research location effectiveness.

research, but must be concerned and skilled in addition in the processes by which his work gets applied. We also came with a content/process model which we thought might be useful in helping an R&D organization such as Forest Service research. We will turn to that model now as a way of introducing our perspective and the subsequent work of the project.

A PROBLEM SOLVING MODEL FOR USE IN RESEARCH LABS

Basic Approach to Organizations

Before we can describe the model which guided our work, we need to specify in greater detail the approach from which it comes -- our approach to organizational development. If we were to attempt to name this approach we would probably christen it "participant problem-solving." That is, we believe in the necessity of following a logical series of steps through which problems in an organization are first identified, then carefully diagnosed at a systemic level, before changes or innovations are designed, tried out, evaluated, and finally integrated into the organization. The "participant" portion of the label comes from our belief that the ultimate objective of any organizational consultant is to work himself out of a job -- to develop within the system the ability to do problem solving internally. Thus, we feel the necessity of training system members to do our job.

Another basis for our approach is one of perceived responsibility. That is, are we working for the leadership, or for the system as a whole as our client? Even though entry into most organizations comes through the top or near-top and leadership must know of and support our efforts actively, it is our belief that the whole system is our client.

A further basis for our work involves the methodologies by which we develop change or innovation in the organization. We do not subscribe to the "one cure" model of organizational development in which the consultant applies one approach (e.g., T-group, management by objectives, data feedback, etc.) in every situation. Rather, we think methodologies must be selected to fit the problems and capabilities of the organization.

All organizational development must have a goal of optimizing some end condition or "organizational output." Our approach stresses that there are legitimately many different criterion measures in any system: the more traditional output or product production, member satisfaction, and (particularly in a research system) information. Regarding the latter, we realize that information outputs may differ in quantity and quality depending on the audience to which they are addressed. Moreover, we know that these various output measures may not be positively related, leading the organization to the point where it must be able to decide what to optimize, and how such choice might affect other outputs.

Finally, we prefer to bring to any organization a multi-discipline team which can approach multi-faceted problem areas in that system. Thus, we feel we need to know about more than traditional "organizational" aspects

of the system. If the system is an organized collection of individuals producing some output over time under changing conditions, then we need to be able to assess each of these foci and how they interrelate, then be able to act with the appropriate processes.

Development of the Model

In June, 1971, CRUSK held a Summer Institute where we presented to our primary clients what we were doing collectively and individually. Since we listened to our colleagues' presentations, and got all the inputs in a short period of time, we began to see the possibility of combining many of the individual approaches into a global model of how to work with an organization to produce change, particularly through the use of scientific knowledge. Dr. Floyd C. Mann, who produced the original model, was struck by the similarities of the different approaches in one area: they all employed some notion of problem-solving. He began by integrating his own perspective with that of Pelz and Andrews (1966), and with the long-range planning, future forecasting perspective of Dr. Donald Michael. The first result, then, was a model of how to develop renewal and strengthening process in scientific R&D labs. The model carried the steps of problem solving along one side, and the topics on the other. Lingwood and Morris subsequently added knowledge dissemination and utilization of lab outputs as another topic. The model at this stage thus contained a "cell" for each of the cominbations of the following topics and problem-solving stages:

Original Model Topics - - - - - by - - - - -	Original Model P-S Stages
Organizational behavior research	Relevance-feasibility phase
Scientific lab productivity research	Diagnostic phase
Futurists	Designs for intervention
Organizational development	Intervention activities
Knowledge diffusion	Development of support systems
	Evaluation

The resultant "table" contained examples of the kinds of activities which would go on in each topic area phase of the problem-solving sequence. This, then, was the model used in our introductory work with the Forest Service.

Though it may not be apparent in the present context, one difficulty we saw in the model is that it did too detailed a job of specifying what we would do in a scientific research organization. That is, the model was written specifically for R&D labs, with cells which differed in level of abstraction of contents. The first model became the core of an idea, however, the idea that we should be able to specify the interaction of topic areas with stages of problem-solving at a level of generality which would be useful in R&D organizations.

Next, therefore, we began to think of generalizing the model to produce more descriptions of activities in each cell. At the same time, we realized such a model would be more meaningful if it contained examples which fit the organization at hand, rather than only abstract activities. We also felt some work needed to be done to clarify both the topic areas in which we could work, and the stages of problem-solving themselves.

The Present Model

The topic areas now became reduced to four foci: on the future, on the organizational environment, on the individual member, and on diffusion and utilization (D&U) of system outputs. Other potential areas were realized to be relevant (e.g., system economics), but we were building a model we could work with, and we were constrained by the skills and interests of CRUSK staff.

Problem-solving stages were modified at the action level to allow changes to be developed (on the basis of work with diagnostic data) and implemented as trial innovations. These would allow room for experimental manipulations of different change strategies, leading to eventual decision as to which innovations should be kept. The final stage would also include the last steps in developing the system's own capability to do problem-solving, through increasing dependence on staff who had been members of an "inside team" throughout the CRUSK involvement.

The result of these reformulations is a topic by problem-solving stages model containing more parallel entries in the "cells," and with more comprehensive topic areas and problem-solving stages. This is the model presented in Figure 1-1. The easiest way to understand this model is to begin with the problem-solving phases themselves, and with the results from each phase until one understands what should take place in each. Then, one may take any one of the topic areas and follow it through the problem-solving sequence, from initial mutual familiarization and problem formulation to ultimate evaluated changes in place in the system.

In working with the model, we find that there is a considerable amount of interaction among the various topic area foci: the organization affects the individual, and vice versa, and both affect what is disseminated to whom with what effects; planning processes affect all of these, and are themselves altered in turn. This is exactly as it should be. By identifying separate foci we do not intend that they be seen as independent; but rather, that the foci give us conceptual "handles" and a coherent approach to the organization which is represented by a considerable body of scientific work, a literature, and orientations of individual organizational researchers.

We also have come to see that not all topics need be at the same phase at the same time: we might be well into diagnosis or trial change in one topic while still discovering the basic nature of problems in another. Such sequencing might well make the most sense, if the organization and its consultants work to determine which focus areas are most important, present the greatest problems, or seem to be "keystone" starting points.

FIGURE

A MODEL FOR RESEARCH AND DEVELOPMENT ... RENEWAL/STRENGTHENING PROCESSES

TOPIC AREA FOCUS	PHASE I: Problem Formulation; CRUSK staff learns about system, and system about what is known in each topic area.	PHASE II: Diagnosis, Description, and Prediction of Where Lab Is/Is Going.	PHASE III: Review Findings and Identify Possible Intervention Strategies.	PHASE IV: Undertaking Multiple Processes for Change, Using Field Experimental Approach Whenever Possible.	PHASE V: Evaluation of Change Efforts, Implementation of the Effective Changes, and Construction of Permanent Problem-Solving Mechanisms and Skills.
On the Future	Long range planning and future forecasting: -How do various staff members and groups look at the future, and what do they see there? -What makes for effective planning processes?	How does the system anticipate future situations, needs, demands, and opportunities? How does the system set objectives and define criteria? Who has what kind of access to the planning process?	Look toward team building to: -clarify mission -identify specific objectives -plan how team efforts will affect the lab -increase participation in the planning process	Build new teams, and reward structure for team work; construct different models for linkage to outside planners, futurists, forecasters; try different approaches to getting more staff input in planning process.	IN ALL FOUR AREAS, IMPLEMENT THE BEST TRIAL INNOVATIONS, GIVING: —better planning and participation in it —better organizational structure, leadership —improved member productivity and satisfaction —increased concern with and activity in dissemination and utilization of outputs, and client linkage/feedback THE BETTER INNOVATIONS ARE THOSE WHICH IMPACT AS MANY ASPECTS OF THE FOUR AREAS AS POSSIBLE.
On the Scientific Lab Environment	Organizational behavior research: -What distinguishes more from less effective lab environments?	What is the scientific working environment as seen by various members of the system? How does structure and process in the system affect individual members?	From the data collected, what do we see which might be changed to improve: -organizational and personal goal attainment -organizational structure itself -identification and use of the "natural" administrators and information linkers in the system?	Structural/organizational changes. Strengthen supervisory/administrative/leadership skills in system by: -reading, discussing -training in use of new skills for leadership -motivating, counselling -building "creative dither" in lab	
On the Scientist or Staff Member Himself	Inputs and outputs: -How do scientists exchange information? -What is productivity, and what predicts it? -What is the reward structure? Individual development: -What are training opportunities? Attitudes: -What do members think of career, job, system, coworkers, etc.?	What are the activities, attitudes, motivations, and needs of system members? What are the information gathering and production mechanisms? How does the reward structure affect individuals? How does all of this interrelate?	What changes might be devised to: -increase satisfaction and productivity -improve the information system -alter reward structure to give "better" products -identify and increase effectiveness of "technical naturals" within the lab, and to the outside?	Interface structural/organizational changes above with individuals, using increased satisfaction and performance as test of these changes. Try different media for input and output of information, and for intra-system flow/retrieval (both "hardware" and human--e.g., technical naturals).	
On the Outputs Individuals and the Lab Produce, Get Disseminated, and Get Put Into Use	Diffusion research: -What are the flow patterns for knowledge--what, to whom, how? Knowledge utilization: -What is linkage and view of clients, how are they identified, what are their needs, feedback? -What are models for diffusion and utilization of knowledge?	Who are present and potential clients? What are their information needs, and best ways to reach them? How much of what is received is actually used, and for what? How do outsiders perceive the lab, what do they want from it, and how do they make needs known?	What changes might be devised to: -increase lab concern with dissemination and utilization of outputs -improve match of output media with those most used/understood by user -link lab and clients interpersonally so they get better information and lab is affected by their needs?	Try ways to build awareness of need for better dissemination and utilization, increase client linkage, and get client feedback.	THESE CHANGES ARE NOT THE END OF THE ROAD--MECHANISMS, SKILLS, AND REWARDS MUST BE BUILT TO ALLOW THE SYSTEM TO DO ITS OWN PROBLEM-SOLVING IN THE FUTURE.
	---THE RESULT: staff knowledge of each field, CRUSK knowledge of the problem areas, and mutual concensus on which areas are important for future work.	---THE RESULT: detailed empirical knowledge of state of affairs in each area, how they interrelate, and causal/predictive conditions; leading to discussion of what can/should be changed, and how.	---THE RESULT: Trial changes developed from understanding of results; a better understanding of the system by both insiders and CRUSK.	---THE RESULT: Evidence of effectiveness of different trial changes. Demonstration to system members that system is "alive" and vitally concerned with constructive change.	---THE RESULT: An organization which has improved its present structure, process, and output; and one which has the capability to change and adjust in the future.

One area not well captured in the model is the interaction of planning and change activities in other topics. An organization must have some idea of its goals to be able to integrate data on where it is now and what its members do/want as a first step in designing trial change. That is, trial changes must have a purpose of attempting to reach some known, desired end condition. Either the development of planning capability must, therefore, be up with or ahead of the work in other foci; or existing planning processes and specified goals must be used -- a condition which might result in an organization using last year's plans and goals to understand today's data in an attempt to solve tomorrow's problems.

The Model as An Innovation

As we said, this model was born in the middle of 1971. We have never before attempted to put together the type of integrated, coherent project it defines. We have seen many studies tied to specific topic areas which underly the rows of the model; but most of these remain within a single orientation and tell us nothing about how these topics interact. The best interaction in existing work is found between organizational and individual characteristics in the system. We have no studies which include a future focus, or knowledge D&U in this paradigm.

Obviously, there are many areas of knowledge in the model rows which have a strong literature, even though they might not have been previously integrated in the way our model suggests. At this point, we will turn to this literature, primarily in an introductory manner for readers who might want to improve their knowledge of the focus areas.

OVERVIEW OF PREVIOUS RESEARCH

The model presented earlier is complex in the number of concepts and relationships it contains. Thus, we should suspect that there would be a large number of research studies relevant ot the topic areas which would help us to understand both the topics themselves and what we should expect to find within the Forest Service organization. Indeed, there are more relevant studies than we have space to cite here. Instead, we will identify major approaches used in the literature, indicating only the most important developers of each, or summary pieces of integrative value. In later chapters of this report we will bring in more detailed information as appropriate.

We should reiterate that while there are many different pieces of research covering the topic areas, few studies have included more than one or two approaches (with the organizational and individual focuses being the most common combination). Indeed, this project is the first we know of which combines all four of these topic areas, and in a way intended to lead to problem-solving.

Let us begin, then, with the major approaches and concepts represented in the literature for each focus area.

Studies in Planning and Goal Setting

Planning as a social process has generated distressingly little theoretical analysis, and even less empirical research. More specifically, while there have been many studies which collect empirical data to do some specific planning task, there have been few works which study the planning process itself empirically. We have, however, borrowed extensively from one of the few authors who has examined planning both from a theoretical and empirical (case study) approach: Donald Michael of CRUSK. We have drawn our comments here from points made by Dr. Michael (1968, 1971, 1973), and from other authors he cites (who we will reference below).

The difficulty with planning and goal setting is that it is a "macro-process," in which the planner must make abstractions about the organizational or individual reality whose future he must plan. The difficulty is compounded when we seek to study and theorize about the planning process itself; we must develop a macro-process about macro-processes. Nevertheless, let us list the requirements for planning, as set out by Michael and others, indicating the ways these must be evaluated in the organization whose planning processes we wish to study. (This synthesis is ours, not Michael's; he should not be held responsible for our oversights.)

The starting point for planning, and hence for a study of an organization's planning process, would appear to be the extent to which members feel that planning is, indeed, possible. This would bring into play the impact of constraints on the system, and individual factors such as the concepts of nature's dominance over man or vice versa (Kluckhohn and Strodtbeck, 1961), fatalistic orientation, and internal-external control (Gurin, et al., 1969; Rotter, 1966). We are dealing here with the individual's and organization's beliefs regarding the amount of power they have to influence both the future itself, and where they will be within it. Next we come to the belief in the need for planning, assuming it is perceived to be possible -- that is, is planning desirable? Relevant concepts here would be "openness" and/or "dynamic resistance" to planning (Schon, 1967).

Assuming the person or organization does decide to plan, what are the models or processes through which planning is done, and what data are used in the process? Here we find the concepts of the time base used, adequacy or surveilance of the "turbulent environment" (Emery, 1967), the number of "alternative futures" generated; and in the data area, the proportion of data which is internally vs. externally generated, the extent to which data from the past can be used (i.e., can we plan from simple projections which assume a stable environment, or will there be changes in the "rules of the game," which invalidate projections). Also important are the areas and amounts of uncertainty which enter into the calculations.

Once the process is defined, we come to the area of who is involved in the planning activity, and what these individuals bring with them in terms of skills, expectations, attitudes, and values. Also, we need to know how much they desire to and are permitted to actually use their skills, values, etc. We also need to know the individual's and organization's ability to

tolerate errors in past plans, or even more importantly, to "embrace errors" in any plan they now make. This includes their ability to evaluate progress and make "midcourse corrections" once the plan is implemented (cf. Rosenthal and Weiss, 1966).

Beyond the planning process, it would be extremely helpful to have data on the content and fate of past plans, i.e., the success with which the organization has done its planning in the past and individual reactions to past plans and planning. The result, when all of these factors are combined, would be an adequate description of the planning process which can be analyzed in its own right, and contrasted with other system characteristics. Michael (1973) summarizes all of this into an approach to planning as "future-responsive social learning," and (Michael, 1971) outlines the kinds of activities involved (see the chapter on "Planning" for more detail).

Studies in the Organizational Focus

Research in this area has extended over several dimensions; most investigators concerning themselves with predictions about some form of organizational effectiveness as their criterion, or, as in the case of Pelz and Andrews (1966) mentioned below, the influence of the organization's climate on individual performance. Using the organization as the focus, then, defines effectiveness as more units produced, fewer items wasted, more services rendered, higher quality, or in some cases, greater satisfaction of those who work for the organization. In the case of scientific organizations, the output measures usually concern themselves with quality, quantity, etc., of the knowledge produced.

Several research traditions have been underway in this area. One studies effectiveness in relation to structural or technical states of being and makes recommendations for change in these areas. Trist and Bamforth (1951), and Rice (1958) are representatives of the Tavistock group in London who study the influence of technical or restructured work flow processes on organizational outputs. People and their problems are considered fully in this process of change. Others, such as Chapple and Sayles (1961) follow a similar program of study, except that they avoid proposing organizational groupings around similarity of function. Rather than dealing with "people" problems, they propose, through structure changes, to eliminate or avoid them. Thus, they assume that behavior will be modified (or not changed) by modifying structure or the property of work flow.

Another research thrust focuses on the patterns of interaction within an organization, and attempts to change and strengthen these patterns over time, believing them to be highly influential on total system effectiveness. Likert's two major works, New Patterns of Management (1961), and The Human Organization (1967), represent this field of study. Others have followed similar lines of investigation: Seashore and the internal group cohesiveness process (1954); Tannenbaum and the perceptions of control over decisions being made (1968); and Bowers (e.g., Bowers and Franklin, 1976) of the CRUSK staff with his continuing studies of organizational functioning -- each has contributed significantly to Likert's original focus on interaction and organizational satisfaction.

Another tradition finds Mann (1967) first emphasizing the importance of leadership as an influence on effectiveness, and then developing an expanding interest in the effects of human and work processes of solving problems on total organizational effectiveness. This latter is not strictly a research focus, but more in the vein of organizational development, with continuing measurements of the effects of various organizational interventions.

Thus, there are several research traditions that focus on the organization: those of structure, leadership, human interaction, technology, organizational development, and other processes such organizational problem-solving. It is our belief that all of these approaches are useful, but that integration is needed among them.

Leavitt (1965) is a good introductory reference to these various traditions of organizational study, organizing them as structural, technological, and humanistic approaches.

In summary, then, as we look at a knowledge producing organization such as the Forest Service, we must be sensitive not only to the effects of its structure and work and knowledge flow processes, but also to those processes by which scientists and potential users of knowledge interact to produce and evaluate solutions to problems.

Studies in the Individual Focus

Relevant research in this area covers a broad range: from individual relations to the organization, information seeking/giving (here, the study of scientific communication), to productivity and performance of persons in the organization. To organize this diversity we will divide the field into two parts. First, we will look at those studies which relate the individual scientist to his organization, predict his performance, or his attitudes and motivations. Second, we will look at the field of scientific communication.

Scientists in relation to the organization. The basic thrust of previous research in this area is that of determining those characteristics or conditions which lead to better performance of the scientist, improved working relationships and "system tolerance," and general satisfaction. Clearly, the most important work in this area is Pelz and Andrews' (1966) Scientists in Organizations. Although the subtitle of this work is "Productive Climates for Research and Development," which by itself would place this research in the organizational focus, many of the findings pertain to individual communication, motivation, creativity, etc., as the criterion variable. We will not review the findings themselves, however, since this book should be required reading for anyone interested in scientists. The approach and concepts dealt with are most important at this time.

The approach used by Pelz and Andrews was socio-psychological in the aggregate, with individual analyses ranging from sociological (the group or work team's performance as dependent variable) to psychological (the individual scientist's performance, etc. as dependent variable). Thus, the

environment (organizational focus) can be used to predict scientist performance (individual focus), or individual characteristics used to predict organizational ones, demonstrating the close interrelationship of the two foci.

What were the most interesting concepts to emerge from this work? Perhaps the most interesting is that of "creative tensions" (see Pelz, 1967, 1970). This is the mixture of both freedom and constraint, security and challenge which relates to maximum effectiveness. For example, the most effective scientists were those who were self-reliant, had moderate to high autonomy (depending on departmental coordination level), but who also worked on several kinds of activities, with others, and on topics of organizational importance.

In the area of personal growth and development, Pelz and Andrews found that the most effective scientists reported better opportunity for growth, even though they were not necessarily completely satisfied with their situation. The reward structure is important here, together with factors stratifying researchers into over-and under-rewarded groups (Cole and Cole, 1973). Both individual ("self-actualization") rewards and status/monetary ones relate importantly to productivity. There is some evidence, however, that some dissatisfaction may be inevitable, and may enhance creativity (Pelz and Andrews, 1966, p. 139; Weick, 1969).

The scientific environment, especially as it provides stimulation through diversity, co-workers, task mix, etc., has been shown to be important in predicting performance. But, individual factors of the scientist are preconditions. For example, the age-related concept of the "creative years," background characteristics relating to training and contacts, etc., all exhibit important effects on productivity.

Scientific communication. The largest area, in terms of amount of research available, is that of how scientists get and produce information. There is so much here, in fact, that we will reference primarily the reviews of the field rather than individual pieces of research. This field may be divided into three parts: (a) studies of scientific communication media themselves (e.g., their growth, distribution, integration, users); (b) studies in the information seeking tradition, oriented to identifying all of the ways scientists get and use information; and (c) studies in which information sought, found, and used is applied to predict research productivity. The first of these three is less important for our purposes than the latter two. All three perspectives are included in the excellent annual reviews of "information needs and uses" (see, for the past few years' output: Paisley, 1968; Allen, 1969; Lipetz, 1970; and Crane, 1971), and in more comprehensive reviews such as Paisley (1965).

In the information seeking tradition there has been a gradual expansion of concern from use of formal scientific media to consideration of informal, interpersonal information gathering, as researchers found that formal sources contribute only a portion of the information scientists get. Price's (1963) revival of the concept of the "invisible college" (communication networks which

carry the most recent information to members informally) has received considerable attention (see Crawford, 1971; Crane, 1969, 1972; Lingwood, 1969). The approach has also been extended to look at the informal "gatekeepers" of knowledge or "information influentials" by Morris (1970; the concept based on work such as Coleman, Katz, and Menzell, 1966).

Relating information gathering to production, there are several studies which show that the amount of input predicts the amount produced (e.g., Paisley and Parker, 1968), but informal inputs are often more important predictors than formal media use (Parker, Lingwood, and Paisley, 1968). Integration in informal networks also predicts information production (Lingwood, 1969).

In summary, then, we must be sensitive not only to use of formal media, but to interpersonal information sources used by the scientist, and to the uses or functions (Menzell, 1958) to which it is put. We must also pay attention to the scientist's integration in informal networks of other scientists, or conversely, note the effects of professional isolation.

Diffusion and Utilization of Knowledge

Except for studies of the flow (diffusion) of information, there is relatively little known in this area for scientific populations, at least as compared with the organizational and individual focuses. This, in our opinion, reflects more the newness of this area and traditional insensitivity to it among scientists, than it does on the importance of this focus in applied science. Most of what we know is collected in a few places, making this overview an easy task.

This field may be divided into components of the D&U-linkage process: (a) how researchers sense what clients' needs are, (b) client orientation, (c) dissemination or diffusion activities, (d) utilization acts, and (e) actual research-client linkages.

There have been literally thousands of diffusion studies over the past twenty years, many of them based in the traditions of rural sociology (e.g., assessing the diffusion of agricultural practices, new seeds, etc.), and education (the diffusion of new curricula, for example). The most comprehensive source for this approach is Rogers and Shoemaker (1971). However, only a subset of diffusion research deals with the diffusion of knowledge (as opposed to "things"), and only a small portion of this with the dissemination of scientific, research-based knowledged. This topic, plus the work on how knowledge and other innovations are actually put to use is exhaustively covered in Havelock (1969). Both what the knowledge producing agency does, and how it perceives the process, may be fit within the broad models Havelock developed to contain the studies covered in his review. These models or perspectives range from a "source oriented" R&D model to a very "receiver oriented" problem-solving model, with the intervening model of "social Interaction" (which holds most of the diffusionist's approach to knowledge utilization). The model an agency chooses affects the problems it considers, how

they are approached, and the mechanisms built to cope with them. For example, the R&D approach assumes that if the innovation is correctly designed, then use will follow easily on the heels of mass production, packaging, and dissemination. Conversely, the problem-solving model turns the whole process around, beginning with a need perceived in some population; the expression of this need triggers information seeking until some innovation is found to fill it, or more likely, until one can be found which is adaptable to the local situation.

There are a number of important "linkages" between client, researcher, and back again which are needed before knowledge can be useful and used by the client. These are presented by Havelock and Lingwood (1973) in a "linkage process model" we will adopt for this study. Concentration on the links between producer and user, user and change-agent, system and system opens the whole dissemination and utilization process to the possibilities of analysis as a communication system, permitting identification of message, media, source, and receiver at each step from knowledge production to knowledge use. Linkage also contains the feedback concept so vital to understanding how clients make their evaluations and needs for further information known to the knowledge producer. The chapter on Dissemination and Utilization will cover this model in detail.

Thus, in looking at knowledge producing agencies, we must be sensitive not only to what is disseminated to whom over which channels, but must look closely at interpersonal linkages (i.e., the social interaction and problem-solving perspectives), the transformations the information undergoes, and the ultimate type and level of adoption. Beyond this we must come full circle again to look at the process by which clients communicate with and affect the knowledge producer. And behind the linkages lie the systems of supports and rewards which control linkage behavior and relate it to organizational factors, goals, leadership, etc.

CHAPTER 2

PROBLEM FORMULATION

READER'S GUIDE:

Here we present what we learned first and informally about the organization. These materials are of interest as a check on what we did later, and contain observations which seem to remain current. Thus, this chapter makes good background, and will serve to help readers see what we found in a textual rather than numerical format.

CHAPTER SUMMARY:

We spent a full year interviewing about 200 researchers (and some clients) in the Forest Service to get their perspective on issues, problems, and priorities related to the focus areas of the model.

The researchers had less access to planning than did ADs, and there were many unclarities about plans and objectives, and perceptions about lack of integration among the branches of the organization. Most researchers were very positive about the organization, but there were many specific problems relating to distance, leadership, facilities, etc. The PL role is seen as the "action point" by researchers, but the job gets mixed reviews from both Scientists and PL, primarily because of the mix of administration and research required, and perceived lack of rewards for the former. Rewards were seen as being tied to written products aimed at the scientific audience, the most favored client group. There was a general interest in becoming more involved in getting findings put to use "on the ground."

Limited interviewing with NFS and S&PF clients showed these groups to have rather realistic views about problems in both these branches and in research which limit the application of results. Lack of staff capacity, clear goals, and time seem to be limits from these organizations. Researchers were seen as often uninterested, locked into other work, or unskilled (particularly in their writing) in becoming more active in helping to solve real problems.

The results of this phase could not be used to give a complete description and diagnosis of the organization. The intent was to guide us in moving to the next step by providing a good familiarity with the system. We got this, but in looking back we also see that the problem formulation interviewing provided interpretations which hold up well against the later empirical results and comments obtained during feedback work.

INTRODUCTION

Good problem formulation is the key to good (and useful) research. The model stresses this, and we were fortunate to be able to spend a year in the process to be discussed in this chapter. Basically, we talked to a lot of Forest Service people -- primarily researchers, but to "clients" as well.

The task was that of filling in the four focus areas of the model with data about the real organization. Beyond facts and opinions, however, the interviewing helped us to see the priorities and needs among the four foci. This was the first step in building the analytical approach for the later work: what are the important criteria, what produces them, how do all of the areas interrelate?

METHODS USED

The data collection strategy employed in the problem formulation interviewing was that of relatively unstructured group interviews. A typical interviewing session, lasting two hours, would include anywhere from four to eight respondents. With only one exception, we interviewed peer groups, that is, ADs, PLs, and Scientists separately at a given location. This was done to allow respondents to build on each other's comments (since they share similar experiences, etc.), and to encourage full participation since no job status differences were involved among the men in the room.

Each interview began with a general introduction from the two CRUSK members, outlining our purpose and needs -- that of familiarizing ourselves with the research system, learning about problems, etc. The atmosphere was kept as informal as possible. Interviews were recorded.*

In the first few interviews we worked from question topic sheets, bringing us a specific topic as it seemed appropriate in the context of discussion. These topics followed the four areas of the model, with specific items for planning and goal setting, the organizational environment, scientist job activities, training opportunities, and satisfaction, and dissemination and use of lab outputs, and who clients are. Over time, as we became more familiar with both the system and our items, we dispensed with the question sheets, working instead from what we had already learned.

The tapes were transcribed verbatim (several hundred pages in all). What we judged to be important parts of the transcriptions were then distilled into direct quotes or paraphrases, and these finally organized by broad topic areas for reporting to the Washington inside team and to the stations. In the form presented below, we have omitted all but the most crucial, succinct, and typical responses, depending instead on our own

*We introduced the recorder at the start of each session as only our way of keeping notes. Respondents were assured of their anonymity, and that they could signal for the tape to be shut off at any time. This rarely happened, and we lost little important substantive information when the tape was off.

synthesis of the results. This whole process, then, helps us to integrate our findings while at the same time honoring the anoymity guarantees given our respondents.

Let us again use the topic focus areas of the model to outline broad divisions in these preliminary findings, detailing specific questions as they fit in each.

INTERVIEWS IN RESEARCH

Focus on Planning and Goal Setting

This area, in general, received less interview time, and yielded fewest unsolicited comments of any of the four focuses. We did, however, get some feel for levels of participation in the planning process across levels of the system. As could be expected, perceptions of influence increased as one moves from Scientists, through PLs, to ADs.

Even among ADs, though, there were many comments indicating feelings of uncertainty about the way Forest Service research conducts long range planning, and preparation for problem solving. They did mention, on the other hand, that they serve on advisory committees, talk informally with people, and so on; but they still seemed to feel they were ultimately obliged to accept priorities sent down from Washington. We also found some frustration in the lack of flexibility to "move people around" or to train people to work on important problems. One paraphrased response might serve as a typical indicator of what ADs had to say in this area: "We could use a lot of help in problem selection, planning, and goal setting. We need to know how to work with many restraints we have on us; and we also need much better mechanisms for establishing priorities within the present system." The need for change, then, was seen by many; however, we found few specific recommendations as to how participation in the planning process should be increased (this comment applies to PLs and Scientists, as well).

Moving on to PLs, we heard many comments which would lead us to believe this group feels it has less involvement in problem selection or long-range planning than the ADs. Most PLs say they have freedom in setting and carrying out specific objectives within broadly defined areas, but they have fewer degrees of freedom in determining what the broad areas should be. Instead, they mention that their goals are set by others in administration, in industry, and in "higher echelons" in Washington. PLs seem unaware of the reservations expressed by ADs as to their planning activities, feeling instead that ADs and Directors are highly involved in fund-getting and in building outside contacts and support.

On the level of the individual Scientist, we find a stronger feeling of being removed from the planning process. Scientists tended to accept the goals established by leadership, even though they sometimes question the direction of effort. They seem to know best the goals of their individual research projects, only generally what the goals of other disciplines are, and show confusion regarding what total station goals are and how their work relates to these. Relatedly, Scientists said they knew where they were going

in the short run, but felt at a loss for long-range projections. They also expressed fear that long-range goals, since externally set, might change without their input, and that overall "missions" might not be realistic In summary, one Scientist capsulized his frustration over lack of influence in goal setting with the comment: "We have Scientist meetings each year, and during the last one someone asked what station goal setting was in relation to Forest Service goals. No one answered then or since; we still don't know what they are in concrete terms in relation to overall Forest Service goals."

Given the nature of our method and respondent selection, we cannot say yet that there is a universal tendency for those further down in the structure to have increasing frustration and unclarity with planning and mission/goal awareness, but we have at least found that such problems do exist.

We get the impression of an organization which, probably because of its immersion in organic, systemic, and ecological thinking, is completely committed to the need for workable long-range plans. It is our impression that the "typical" 10 or 20 year plan at the Forest Service level tends to be done in relative topic area isolation (e.g., timber needs and cut requirements), allowing different plans to specify incompatible uses for the same land. Even when there is an attempt at coordination between multiple uses, the system seems to lack methods by which plans can change as the end targets become redefined by the society somewhere in mid-course. That is, plans seem to tell what to do go get "X", but not what to do when, halfway there, we decide we do not really want "X" but "Y".

We also saw a gap between research planning and NFS-S&PF planning. This is highlighted by the low level of research participation in NFS planning activities. As outsiders it is obvious to us that research has two important reasons for linking with overall Forest Service planning. First, an NFS group worked on "plans for planning" which, if successful, may be adopted Forest Service-wide. Therefore, research should have inputs in the overall design in order to help achieve a product it can and wants to adopt. Second, knowledge produced by the research system should be a cornerstone for <u>any</u> long-range planning effort, and research must work for development of mechanisms by which its findings may be plugged in, and ways it can gear up to produce additional knowledge for plan developments on the horizon.

<u>Focus on the Organization</u>

This is a broad topic area, one with many facets in the questions we asked. Let us start with more global reactions to working in the Forest Service and in research, and then move on to more particular sub-topics such as leadership, support, etc.

<u>General</u>: We found a generally positive feeling among respondents about working for the Forest Service. (Self selection obviously enters here, though -- those who were dissatisfied have probably moved out of the system.) Many

are attracted to the working situation: quite a few mentioned the pluses of the town they were located in, university affiliations (where present), and the working environment itself. The latter of these is of course the most important. Specific comments in this area stressed the feeling of working on important problems, good scientific environment with helpful peer/leadership openness to communication, informality of the working environment, and enhanced creativity through the interaction of many researchers with different perspectives.

Even if the general tone of these respondents was positive, they did mention some specific problems. Many of these revolved around support facilities such as editorial and statistical services, and difficulties of administration at more remote lab locations. There was great diversity among the locations we visited in the extent to which universities were used to aid the structure -- from good utilization of personal and institutional resources to locations at which researchers perceived the leadership as saying they should not become involved.

Leadership: The area of leadership in general, at an abstract level, is a difficult area to probe or respond to. We found ourselves instead tracing two main themes: that of separation from leadership at remote labs (or the converse for those researchers working at station headquarters), and the role and performance of PLs, a group we found increasingly important as our interviewing progressed.

The area of distance from leadership gives an interesting picture of perceptions of and impact of ADs in particular, since these individuals (together with support services) form the main link from Scientist and PL to higher levels of administration. Those who were located at some distance from their AD tended to agree that this was a good thing since they had more freedom to work, solve problems, and do things their own way. Most wanted to have good, quick linkage when they need it, however. On the other hand, Scientists, and PLs in particular located at the same location as their AD said they had an advantage in being able to influence him for quick decisions, and had more impact on general program directions because of this. On the minus side, from their viewpoint, they said the AD was more likely to involve them in administrative details if all he had to do was carry some papers next door, or meet the PL (usually) in the hall. On the topic of support services, we found few advantages claimed by those further away from station headquarters, while those at headquarters often mentioned the ease in getting editorial or statistical help. The remote locations often expressed a need for better support in general, with some local administrative representative high on the list.

Distance: Since the topic of distance appears so important here, we might digress a bit to note that we heard distance-related comments about all kinds of linkages and communication. We have seen, above, that distance may lend some advantages inside of the hierarchy, but our tentative conclusion at the time was that it is a monumental problem in peer communication and in linkage to users of information. Among peers what we found here supports what we know from other studies that the imposition

of any barrier at all (even moving part of the staff to the building next door) reduces opportunities for informal communication, forcing use of more formal methods, and as a result, lowering the total over-all flow of information in the system. This hits particularly hard at the informal, "over coffee" discussions, particularly across disciplines, which are so important to creativity. With client linkage, we found the same problem at a higher level of magnification. When client groups are across town they might as well be out of town -- the media and effort needed to communicate remain the same, and both much greater than if the client were in the same building. This is particularly telling with linkages between research and NFS and S&PF.

"Where the action is": Returning to more organizational problems, we should say that one effective way to analyze any system is to find out where the action is. That is, we should find the key job role, then spend a great deal of attention on this group. To most of our respondents, and increasingly to us, much of the "action" in Forest Service research seemed to occur at the PL level. This is understandable when we note that the PL is the one man who has his feet firmly in both the world of knowledge production and in administration and goal-setting. Our respondents at all levels indicated this requires some sophisticated balancing at times, however.

Focus on the Individual

We have arrived here on the verge of a discussion of the PL as the swing point in the research system. After this is accomplished, however, we will move on into other individual-focused areas such as rewards, training, and scientific communication.

The PL role: Let us look, first, at the PL as others see him. From above, ADs see the PL role, which many have come through themselves as the road to advancement in the system. On the other hand, there is a realization that the PL role is a difficult one requiring a self-sacrificing individual willing to put in many hours on his divided responsibilities, often without adequate reward for his administrative activities. ADs use the PL as an administrative training role, and seem clear on the view of this as the decision point in the researcher's career. We did sense, at times, a degree of wistfulness among some ADs in looking back at the PL. We would suspect that the more wistful ADs were those who themselves retain an active interest in doing research, and who may have some regrets they can no longer do it themselves. (PLs did mention problems with the occasional AD who tries to be part researcher, exerting influence seen as interference by those below.)

Scientists, on the other hand, had more diverse views of the PL. Most were thankful for the PL's work in taking "administrative junk" off of their own backs. They also recognized the difficulty of the position: they said the PL is still rewarded as if he were a full-time Scientist, even though administrative chores take more than the assumed "normal" amount of time. Administrative time, then, detracts from the effort the PL could put into being a Scientist, even though Scientists said he is rewarded on the same basis as they -- in terms of papers and products produced. The Scientists also perceived the PL job to be an essential one in guiding research directions, perhaps not seeing the PL's feeling of restirction in planning participation mentioned earlier.

There was an interesting division among Scientists themselves as to whether or not they would like to be a PL. Some told us clearly that they could not take the administrative burden which would reduce their capacity to produce scientific knowledge. On the other hand, others saw the PL role as an action point they themselves might like to try, indicating that this is the road to advancement. We could not tell if this attitudinal difference separates the "comers" in the system or not, particularly if we conceive of development in both administrative and scientific competence.

Among the PLs themselves we found many of the comments already surfaced from ADs and Scientists. Most found the role a challenging one, but one which carries more administrative work than they had bargained for, and certainly more than they felt they were rewarded for. We also heard about difficulty in linking with clients given the reward and time pressures; this will be discussed in detail below. In general, there was a relatively high frequency of mention of difficulties in the job, as compared with the benefits. Some felt they would never have taken the job if they had known what it would entail, others that the job should be rotated among project Scientists every few years. We suspect the positive aspects are indeed realized by the PLs, however, typified by such comments as the PL role being one in which the man can learn things about himself, make decisions about the thrust of his program as well as his own career line, and so on.

Reward structure: We have mentioned the "reward structure" several times above. It is time now to take a closer look at what system members saw as the things for which they get rewarded, and how these square with what they want/have to do.

The written word appears to be the primary output of research. In every interview session both researchers and research managers discussed the place or importance of publications in the evaluation structure of the station and of the Forest Service. In almost all cases they agreed that this was the main (and many said only) criterion for evaluation and promotion. Even though many Scientists (in particular) were unclear as to the guidelines by which their work was evaluated in review panels, they thought that publications were much more important than any other activity. This was a particularly distressing point to PLs, as we have seen above, who saw their time for research limited by administrative duties. Within the strongly-held "publish or perish" perception of the reward system, some channels were seen as more prestigious, and therefore likely to produce rewards, than others. The traditional scientific journals were perceived to be the medium with highest payoff for the author. Many mentioned that station publications were not weighted as highly in evaluation panels, even though these outputs often could do a quicker job of reaching the intended audience than the journal.

The evaluation panels came in for more criticism than praise from all levels, but particularly from the researchers. There was a general feeling that the panel could not know all of the worthwhile activities the Scientist or PL accomplished, and so must become over-dependent on publication criteria.

The two areas most often mentioned as under-rewarded by panels were PL administrative work, and linkage with clients or "extension" work. As we move up the hierarchy the remoteness of panels increases, since G.S. 14's and above are evaluated in Washington, rather than by local evaluation teams. There was a general feeling that this procedure made it even more difficult to take into account the activities of an individual who might not fit in the traditional mold.

It was obvious that many of these comments were based on misunderstandings about what panels do, and how they operate. Panels were new in some stations then, and as staff had gained more experience with panels they appeared to become more satisfied with this format. The panel system seems to be understood better now than when these problem formulation data were collected.

Scientific communication: In this area we will examine three different aspects: input and output of information, and intra-system communication of an informal nature. (Client system linkage, a special type of output, will be covered later.)

Information gathering in science is a crucial activity. Many mechanisms are employed by the effective researcher in addition to the more traditional print media. We know, too, that researchers who input more information produce more information (although the direction of causality is not clear). Thus, we were interested in learning how information was gathered, and about any problems in getting it. By and large, we heard few mentions of problems in keeping up with the progress of science through the written literature. Our observations of library holdings, and what we learn about utilization of university resources, tended to bear this out. We do not, however, have enough data from those labs not located on campuses to determine information needs, if any, in these locations.

Earlier research in scientific communication has also shown the importance of informal information gathering, and our questioning here surfaced a mixed picture. In general, most researchers were happy about the opportunities for and openness to informal conversation among staff, and the willingness of knowledgeable researchers to give information to others. Thus, we saw few problems (other than those of distance among parts of the station structure) with informal communication inside the research setting. The inside-outside information gathering link did display a few problems, however, in the area of attendance at scientific conventions. Several respondents mentioned two different types of restrictions on convention attendance which would serve to limit rapid access to most recent knowledge: first, regulations restricted the number of official station representatives to any given convention, and beyond these, there were mentions of researchers who attended meetings on their own leave time; this was coupled with the policy of paid attendance only if the researchers served on a committee or gave a paper. Researchers also mentioned that official station representatives often are ADs, staff who do not make optimum use of the convention as an information gathering device. Second, restrictions on international meeting attendance hindered participation in Canadian conventions, which are important for stations in the Northern tier of states since ecosystems do not recognize political boundaries.

We heard several comments in the area of information production. One area dealt with the effects of publication time lag for journals, coupled with a reward structure which was perceived as playing down the more rapid station publications. Internal to the system we heard some mention of difficulties in working through station editorial policies: in some cases station editors reworked documents into forms not acceptable by the journal to which the paper is destined, and in whose style the author had originally cast the work. A related output problem faces some researchers, particularly those in behavioral sciences or economics, whose statistical treatments were not cleared by support service staff trained in natural science statistical presentation. As a general comment, however, we saw not so much a hindrance of written outputs, but on the contrary, an overdependence on the written word.

Training and continuing education: There appears to be considerable variance across the sites we visited in the extent to which researchers were allowed or encouraged to take part in educational opportunities. It would be difficult to describe in detail the differences researchers saw in their ability to take courses with or without pay, leading to a degree or not, or in their option or need to take time off work to attend, etc. By and large, however, most researchers saw the system as concerned with their individual development, and realized the constraints of available funds which may stand between them and all of the educational opportunities in which they might like to take part.

Some researchers also mentioned the yearly educational plan they develop with their supervisor. We received no distinct impression about researchers' views of this service and what might be done, if anything, to improve it.

Focus on Applications

In our interviews, respondents seemed to want to spend more time talking about getting their research used than about anything else. As a result we collected an impressive pile of statements about what goes to whom, how, the effects it all has, and some of the problems in the process. To simplify these as much as possible, we separated the comments according to the particular client group mentioned, and within each, into three categories -- (a) how the client is reached, and who has responsibility; (b) effects noted, and how feedback if gained; and (c) needs and problems expressed by our respondents in reaching/working with this client. Some of the data here have been mentioned earlier (e.g., communication), but they fit here too, as part of the overall dissemination and utilization perspective.

The client group coding was easy: respondents almost without exception mentioned only five clients for their work: other parts of the Forest Service (NFS and S&PF), business and industry, the public sector, represented by "public" and environmental groups, other scientific researchers, and finally, policy or decision-makers. In general, the first group (NFS and S&PF) was seen by most as their most important client, followed by industrial users. On the other hand, however, scientific researchers appeared to be the group which gets the most information from our respondents, or the group they reach

the best; perhaps because (as we have noted) of the emphasis placed upon writing for professional journals. Contacts with other user populations were much more limited.

In addition, many comments were coded which could not be tied to one specific population, but which made reference to conditions in general in reaching clients, or stressed the individual "models" respondents had in their heads about how to do the job of client linkage. So, we have added a "general comments" section to our discussion. Let's begin a detailed look at what Scientists, PLs and ADs have been telling us with these general comments.

General comments: First, across stations, we saw a division between the sending of information and actually reaching clients with things which really affect them and what they do. In general, then, respondents indicated they disseminate information primarily by printed materials; but when they talked about reaching clients, it is almost always in terms of interpersonal contacts -- meetings, site visits, groups coming in, researchers going out, and so on.

If we consider these comments in terms of models of client linkage, most respondents appeared to have a belief in the "extension" concept -- definitely for the purposes of translating results into the user's own terms and context, and perhaps for the initial contacting or communicating job as well.

By and large, we were told there was a great lack of feedback materials which would help researchers evaluate the job they are doing in reaching their clients. All levels in the system mentioned this lack, although Scientists were inclined to see this as the PL's responsibility (not that he particularly fulfilled it).

Most of the general needs and problems centered around the differences between dissemination and use of research, and on the apparent lack of emphasis/reward/support Scientists and PLs receive for doing the latter. The PLs in particular felt this pressure, typified in the comment about the impossibility of being a good researcher, administrator, and linker at the same time. Most researchers would probably invite any help they could get in getting their information to the user (though we got a feel that client linkage helps produce better research); but one main "extension" part of the system -- S&PF -- was not (in the view of many researchers) doing its job. Some problems were internal to the stations, however -- lack of researcher interest and ability to link, publication lag, and review mechanisms. The nature of the research produced also was mentioned as a problem.

Specific client groups: Moving on to the largest client, other parts of the Forest Service, we found many of the above comments still apply. In fact, many of the general comments gave us the impression that respondents had this population in mind at the time. Interpersonal media were mentioned again more often as the effective ways of getting utilization. Feedback did

not code out as nicely for this population as in the general comments, but there were many very specific problems and needs surfaced. Lack of opportunity for interpersonal communication again surfaced, as did problems in getting together with S&PF and in their level of activity as an extension arm.

Business and industrial clients were generally perceived as much more eager and willing to make use of research findings; in fact, overeagerness was mentioned. Again, S&PF was mentioned as being less than effective in linking between research and smaller commercial users who could not or should not contact the stations directly.

When we move on to the public and conservation groups we get the feeling of very little actual communication, and minimal use of findings, at least directly. The point was made that the public benefits from research output indirectly (i.e., through improved quality of environment and services). Some researchers did, however, express a perceived holding back from great contact with conservationists; but we could say if this is an accurate perception on the respondents' parts, or simply overinterpretation of a reserved, more passive communication practice.

Our respondents indicated very good print communication with other scientific researchers. The print channels they use are, after all, part of the scientific communication network designed by and for such persons. Print media are not the only mechanisms of effective scientific communication; in fact, they tend to lag behind research cutting edges. Our respondents were, as we have seen earlier, rather perturbed at convention attendance policies, particularly those limiting attendance at meetings held in the United States, and at the difficulties in attending meetings in Canada. At some (but not all) locations improvements might also be made in linkages to university scientists where Forest Service personnel are located, and with students.

Finally, we got the sense of very minimal linkage directly between the research producer and the policy-maker. We feel researchers saw this as part of the job of station and Forest Service leadership.

In conclusion, we should refer back to comments about rewards. Both there and here we got the feeling of many respondents that there was an inadequate match between what they felt must be done to get their results out and used what they were actually rewarded for doing. This, plus the needs for strengthened relationships with intra-Forest Service clients such as NFS and S&SF were probably the most valuable suggestions out of these problem formulation data, and as we will see later, are important conclusions of the survey phase, as well.

Summary of First Year Interviewing in Research

In trying to pull all of our learning from the first year together, we want to make several observations. First, we were impressed by the openness of the system and its members to this activity, and the frankness with which individuals described their work, opportunities, and difficulties. This openness also relates to what we saw as an earnest desire at all levels to improve and change to meet new demands.

Within the four areas of the model we need to note the degree to which the focus areas interrelate. Organizational structure and process affect individual performance and satisfaction, and vice versa. Both the organization and its policies, and the desires of individuals affect how much of what kind of information is passed along to which clients. Planning reacts to each of these areas, and will in turn affect them in the future.

INTERVIEWS WITH CLIENTS*

We tried to look at the context of needs and uses for Forest Service research by conducting some interviews with staff members in NFS and S&PF. This effort was by no means extensive, but it did give us some good insights.

State and Private Forestry

S&PF respondents saw themselves as linkage and information providers for state and private owners, and not primarily as clients for research. They did depend on researchers for input in the workshops, meetings, etc. they sponsor. S&PF staffing was, they thought, too little to allow their branch to do the extension work they saw as important. Thus, their role was more one of coordinating than in-depth involvement. Though the research and NFS branches recognized this limitation, they had not picked up much of the extension burden.

S&PF comments clearly show that there was a desire to have the researcher be (1) more involved in extension and implementation; (2) more helpful in developing materials for S&PF's clients; and (3) more accepting of S&PF as an important professional link in the dissemination process.

National Forest Systems

NFS respondents were a bit more critical about the impact of research perhaps because they are more truly clients and less in the linkage role of S&PF. Many of their comments dealt with problems internal to NFS -- capacity, skill, lack of clear plans, etc. -- which limited their ability to use research outputs. On the other hand, they saw in NFS the managerial and operational skills, plus a better touch with needs, which they felt research could both make use of and benefit from.

Several comments stressed the need for research help on human rather than resource problems. The reorganization of research was seen as being potentially useful in making research more open to working on what NFS saw as real problems. There were many comments about the time-lag in getting research done. Respondents wanted help on short-term problems with a quick response time. They also saw researchers as unwilling to take a risk on a recommendation without ".01 level" certainty.

*This section is a much shortened version of material contained in Morris and Lingwood (1973a).

Research publications often went unread because they (a) were not routed correctly within NFS, or (b) were simply uninterpretable. There was a clear need for rewritten, "de-jargonized" materials.

In summary: Both client groups saw a need for improved dissemination and use of research, and realized that (a) no one branch can do the work or take the blame for, and (b) the job was not getting done due to problems in all three branches. The researcher needed to be more concerned, skilled, and motivated in helping get applications; the "clients" needed better procedures, capacities, and linkages.

CONCLUSION

The problem formulation data gave us important leads, together with a great deal of familiarity with the people, organization, and work of Forest Service research. Because of the open and non-representative methodology employed, the "results" of this phase could not be depended on to describe the state of the organization. The phase did help us identify crucial areas for the formal data collection.

These results do, however, stand up very well with those from the survey which we will discuss in later chapters. In the spirit of "convergent validation" we would hope that we would learn the same thing from both approaches. The researchers themselves provide another source of validation during the feedback phase -- they have the chance to compare all of our results against their own experience.

CHAPTER 3

SURVEY METHODS AND INTRODUCTION TO THE ANALYSIS

READER'S GUIDE:

This chapter will cover the methods used to collect data. It is of archival and technical interest in the area of "how we did it." Readers interested in the findings and implications of the study may well skip this chapter after reading the summary below.

CHAPTER SUMMARY:

After the first project year of "problem formulation," we merged what we had learned with our knowledge of theory and previous studies of scientific organizations to produce a questionnaire. After pre-testing and correction the instrument was sent (in March, 1973) to all ADs and researchers in Forest Service, and to a 1/3 random sample of Technicians. Our response rate was 93.8 per cent. Our analyses will be done (primarily) with data from the individual researchers. We will look at satisfactions and contributions of researchers, and also at what kinds of contributions get rewarded.

PRODUCING RESEARCH QUESTIONS FROM PROBLEM STATEMENTS

This chapter takes up where the first year of our project (and the last chapter) ended: that is, after extensive work in getting to know Forest Service research and its problems. After a full year of familiarization and problem focuses interviewing, we had developed a list of problem areas and possible relationships among them, and a notion of factors which might be causing them. We also had some idea of what the priority problems were. To quote from the first year report (Morris and Lingwood, 1973a):

> "Even with...cautions [about the impossibility of turning problem statements into descriptions of the organization] we feel we have done an adequate job of identifying the major problem areas and factors in the research system which must be included in the comprehensive diagnosis we plan for the second year of work. We will discuss our synthesis of concerns coming from both the data and Forest Service leadership...We would conclude from our interviewing that client system linkage and knowledge D&U are the primary concerns of scientists and administrators in the organizational structure, though these are probably different perspectives on the same general area. Planning activities did not receive the same frequency or intensity of discussion in the interviewing, but it is our impression that such work must underlie any other change."

Thus, we saw the need to include coverage of all of the areas of the "R&D Lab model" presented earlier, though the priorities, and to some extent the ordering of criterion concepts and their predictors, was ordained by the needs of the Forest Service.

Our task, then, was to turn these statements into a form which would allow us to do a comprehensive diagnosis of the total research organization. We were trying to merge the problem statements and general learnings we had gathered with our knowledge of previous work in research systems, organizations, and dissemination and use of scientific knowledge.

We knew that some concepts, such as "contribution to applications," "reward system," etc. would be difficult to assess from our only available vantage point within the research system itself. On the other hand, we decided together with the Forest Service "inside team" that self administered questionnaires were the only feasible method of collecting the amount of data we needed. In two stations, however, we did seek to validate the important "contribution" measures against data external to the study (see the end of Appendix B).

We then began a process of comparing our lists of needed concepts, taken from the problem statements and our knowledge, with available survey items from previous research. In particular, we drew on questions from Mann's (1968) study of government scientists, Pelz and Andrews' (1966) instrument for study of scientists in organizations, and an instrument under development by UNESCO (1973) for the study of research units. The paired polar-opposite format for many of our items was taken from the UNESCO instrument. Where no precedent items existed, they were created.

The instrument then underwent two stages of pre-testing and revision. First, we got the reaction of the "inside team" and made some modifications. Second, we drew a random sample, stratified by research station, of 40 Scientists and PLs, 20 Technicians, and 20 Support Services staff members, and sent these individuals the revised instrument. The responses from this mini-survey were coded and rudimentary statistical analyses were performed, paying special attention to the frequency distributions of the items. We also noted the marginal notes respondents had been encouraged to make. Finally, another revised instrument was created and submitted to the "inside team" for a last round of suggestions on item wording, etc.

The final instrument is included in Appendix A. It was designed for optical scoring, since we did not have enough staff time or money to code responses manually. This meant that responses would have to be multiple choice or fixed-format, so a supplemental section was added to the instrument, with respondents encouraged to add any additional comments they might have in each questionnaire area on the appropriate "green sheet."

In summary, we need to stress the interplay among the following forces in producing the final instrument.

(1) Our problem-identification interviewing results.

(2) Our notions of relevant concepts, taken from our knowledge of previous work.

(3) Precedent studies and instruments.

(4) The "inside team" which reacted to items, and made valuable suggestions.

(5) The pre-test respondents themselves, who made many good comments about poor or ambiguous items.

The interaction and reworking which resulted from the combination of these forces did take more time than we had originally planned, but it left us, we felt, with one of the strongest and most complete instruments ever created to assess the complexities of an operating R&D organization.

DATA COLLECTION

By the end of February, 1973, we were ready to take the instrument into the field. We obtained lists of all station personnel, and included all Scientists, PLs and PMs, and ADs in our census; plus a 1/3 random sample of Technicians, stratified by station. By agreement with the "inside team" support services personnel were omitted from the study. Identification of whether a person was classed into the professional census or the technician sample was done on the basis of information available on the station personnel records from which we worked.

Individual questionnaires were placed in envelopes, along with a return envelope, and shipped in batches to each station. Before stations distributed the questionnaires, however, a support letter was circulated from Washington, through station directors, to all personnel. Stations then distributed the questionnaires through their channels, and respondents mailed their completed instruments directly to ISR. In total, 1,255 instruments were distributed to the field.

Though there may have been some differences across the stations as to the date the questionnaires were distributed, we arbitrarily assumed March 1, 1973 as the distribution date. The first questionnaires arrived at ISR on March 9. A first reminder letter (see Appendix A) was mailed to non-respondents on March 28, and a second letter (again, see Appendix A) on April 16, together with a replacement questionnaire.

Returns stopped coming by the end of the first week in May, when the questionnaires were pre-coded (for training and work discipline, etc.), and shipped to Intran Corporation for machine scoring. The final number of cases included in the data, excluding a few individuals who defined themselves out of the study (too new on job, temporary assignment, etc.) was 1,178 or 93.8 percent of the total of 1,256. There was some difference in response rate across the stations, ranging from a low of 85 percent to a high of 98.4 percent. All identifiable research projects were heard from.

Verbatim responses from the "green sheets" were typed onto cards, by section number, and also coded with individuals' identification numbers, for later matching with the numerical data. We will use these comments (anonymously) to illustrate points made in this report.

We were pleased, though not especially surprised, by the high response rate for the study. Professionals typically respond well to such instruments, compared with the general population, and the same is true within organizations. We also feel that the supporting letter from Washington, together with the amount of work that went into producing a relevant instrument, both combined to increase the level of response. For this reason we feel relatively secure in treating the data from professional (scientific and administrative) staff as a census of Forest Service research. We also feel that the Technician sample is a valid cross-section of this group.

DATA CODING AND MANIPULATION

While we had tried hard to insure that the instrument was as closed-ended (i.e., multiple choice) as possible, there were still three items which required hand coding before the instruments were shipped away for scoring. Two of these involved academic fields -- that in which the individual was trained, and that in which he or she was now working. The coding schemes used for fields were developed by Richard Schreyer, and are included in Appendix A. Also hand coded was the rating of the status of the university in which the respondent received his or her highest degree. These ratings were taken from Cartter (1966) and Roose and Anderson (1970), and since university quality varies by discipline, the ratings were taken separately for the various fields. Some fields not included in the two source works were rated by experts in the various disciplines (again, see the Appendix A for this code structure). Departmental ratings were used for the year 1964, under the assumption that this date is the best guess we have as to quality at the time most researchers were receiving their education.

Once all of the data arrived back at the Institute for Social Research on computer tape, the responses were checked against the original instruments (laboriously), and errors were corrected. The data tape was then read into the MIDAS statistical software package (Fox and Guire, 1973), to create a self-descriptive data file, with item labels and missing data codes set as appropriate for each item.

INDEX CREATION

The process and results of index creation are covered in detail in Appendix D; here we will just hit the highlights.

The task in index creation was to reduce the large number of questions to a smaller and hopefully more valid and reliable set of indices, each one composed of items meeting two criteria: (1) they should make conceptual sense, and (2) they should "hang together" empirically -- that is, they should form natural factors or clusters. After removing a roadblock due

to the fact that items were presented in sets (e.g., "station," "location," etc.), we clustered and factored the items, then compared the results with our knowledge of the organization, and the lists of concepts we used when writing the questionnaire. The result was a set of over 50 indices -- a large number, but necessary given the scope of the instrument.

INDICES OF SCIENTIFIC AND APPLIED CONTRIBUTION

This was the most difficult and important index creation task. It is covered in detail in Appendix B.

Our concern here was to create roughly parallel measures of the individual researcher's contribution both to his scientific discipline, in terms of new knowledge communicated to his peers; and to applications of research knowledge "on the ground." Our final decision was to include three different kinds of information in each index: (1) number of written outputs in last five years (for either peer or applied audiences, depending on the index); (2) number of events (either scientific or researcher-user) attended in the last two years; and (3) the individual's opinions about past and future levels of contribution from his work (again, in either scientific or applied areas). The three components of each index were standardized so that each one contributed equally to the index.

From there we went on to divide researchers into five groups, based on the two measures: those high in both, low in both, high in either one "pure researchers" and "appliers," and a group moderate on both. This five-way split was used heavily in our data feedback work, and will be used here as well (particularly in looking at the relation of contribution to G.S. Grade rewards).

Finally, we compared our contribution measures with data collected from the files, and from ratings made by ADs, in two stations. We found only a moderate degree of agreement among any of the measures -- even those collected from the files. Quoting the summary in Appendix B: "Our measures do seem to fit a bit better with the supervisor's [annual performance review] ratings, even though we say ... that our measures are not independent ... More distressing ... is the fact that there is not a great deal of agreement among the [evaluation] panel, AD, and supervisor scores." We cannot claim that our measures are the best ways to assess Scientific and Applied Contributions, especially since they are measured from within the organization by self-reports of the researchers. Still, the measures seem to give us indicators which, at the worst, are as good as any available in the Forest Service, and at best, may (due to comments we've received during data feedback) give results which we know we should find with certain measures -- thus increasing our confidence about their power in analyses where we do not know the relationships at the outset.

INTRODUCTION TO THE ANALYSIS

One of the consequences of a comprehensive study of organizational and individual factors in the production, dissemination, and use of knowledge in research is that we become rapidly submerged in the amount of data and analysis perspectives generated. The purpose of this section is that of a roadmap or signpost which will point to the sections to follow, and to other analyses of the Forest Service research data not included in this report.

There are two main dimensions which will cut through almost all of our analyses: (1) the levels of analysis -- that is, individuals, projects, etc., and (2) the criterion measures analyzed -- that is, the different things we are trying to learn about.

Levels of Analysis

The Forest Service research study allows us the rare opportunity and challenge to analyze the data from more than one level of analysis. Most studies, the small number of individuals, or limited analytical interests confine the analysis to only the level at which the data were collected; we have sufficient cases (around 1,000) to be able to aggregate the data into larger units such as the research project and the research location, and still have sufficient units (projects or locations) for analysis. This permits us to examine effects operating at the level of the individual respondent, at the research project level, and at the research location level. These three levels are also important in understanding the total organization.

Barnowe (1973) has covered the location level of analysis, and we will not duplicate his work here. Our analysis at the project level is limited also, but for reasons of available time rather than previous coverage. We will do some project-level analyses around the topic of supervision. Most of our work will, therefore, focus on individual researchers and Technicians.

Criteria

The model we have used in this project gave us four potential areas from which criterion measures could be derived: planning, the organization, the individual, and research dissemination and utilization. Our year of problem identification work led us to the realization that dissemination and utilization and individual productivity and satisfaction were important things we should be learning about. Ratings of the organization, personal characteristics, etc. would be important predictors of these outcomes or criteria. Another area for exploration was developed as we discovered that different kinds of research contributions may or may not be getting rewarded within Forest Service research; thus we added the notion of the "reward system" as another criterion to be explained.

Underlying our decision on which should be our criteria, we were also strongly guided by previous research and models of organizational functioning in general, and research production in organizations in particular. These

studies and models were, however, not directly applicable to the amount and variety of data vailable in the present study. We felt we had the opportunity to develop more comprehensive models of a research organization than had ever been done in the past. In working for model development, therefore, we tried to include measures of what we felt are the most important outcomes of and for an individual or a group in such an organization.

If we consider outcomes, previous studies of organizations have shown the importance of measuring both "hard" and "soft" factors. An organization produces a product be it cars, collarbuttons, cardboard, or in the present case, knowledge; but the organization also "produces" human outcomes for those within it -- satisfactions or dissatisfactions, personal rewards or brickbats, etc. We can gain a better picture of the organization if we measure both. In research the "hard" product is or should be the new knowledge produced by scientists. The "soft" outcomes involve the individual scientist's satisfaction with his work, his professional rewards, and so on.

The particularly strong concerns felt both by the Forest Service and by ourselves about research applications also have led us to expand the usual notions of what the hard or knowledge products of research should be. We became particularly concerned with producing comparable measures of the amount of contribution the scientist was making to his own technical field or science on one hand, and to applications of his knowledge on the other. Thus, much of our analysis will deal with twin measures of "scientific contribution" and "applied contribution." Since these two measures will be so crucial to our analysis, and since these concepts depend on mutual agreement between ourselves and Forest Service personnel that we are indeed measuring the correct things, we will spend a considerable amount of time and attention (in Chapter 7 and Appendix B) in discussing exactly how our measures were constructed, and how they relate to other potential measures of the same things.

The Analyses

In the next six chapters we will move down the columns of the model, presenting results on planning, supervision and organizational conditions and satisfactions, scientific and applied contributions, rewards (an area not explicit in the model), and dissemination and use of research products. Our final analysis chapter steps outside the model topic areas to look at Technicians as a group.

The analyses present more detail in the area of predictive models than was provided to stations during feedback. Some of the more descriptive analyses or comparisons of job and contribution-level groups are similar to the presentations made in the stations.

The Start of an Overall Predictive Model

We have been attempting for some time to develop a general model to predict the major criteria of satisfaction and contribution in Forest Service research, and how these criteria are interrelated. We will develop this

model as the central theme tying the chapters of this report together. In each analysis chapter, we will use what we learn about the topic under discussion and to add to the formation of the model.

The model will be set up as a path analysis, meaning that it is subject to the assumptions of multiple regression, and cannot handle the interactions among predictors which we will discover using a different analysis method. Even with these limitations, however, we feel the path model will provide continuity through the report, plus a vital understanding of how the many components of this study fit together.

CHAPTER 4

PLANNING

READER'S GUIDE:

This chapter on planning covers the exploratory items in the questionnaire with which we tried to get an overview of the area. It is not an in-depth study of planning. The contents are of major interest to staff who are grappling with problems of how to plan, and to station leadership in terms of what problems exist in researchers' access to planning processes.

CHAPTER SUMMARY:

We begin here with Michael's perspectives on what good planning, or "future-responsive social learning." *should* be. This perspective guided us to look at "techniques," or how planning gets done (as our respondents see it), and satisfactions with planning and individual participation in the process.

We find that information about, access to, and satisfaction with planning decline as we move from ADs down to Scientists. Also, the "better the processes (in Michael's terms), the more satisfied researchers are with planning. Satisfactions with individual levels of participation in planning are higher when an open information environment keeps researchers informed about what is going on and changing in the station, and when supervisors are more open, supportive, and facilitating.

There seems to be a general lack of information about planning, and the constraints within which it takes place. Beyond this, we see the organization struggling with plans which change too often, on one hand, and the difficulty of planning time-consuming research for unknown future conditions on the other.

INTRODUCTION

There are two basic questions about the planning done by Forest Service research. One involves the content of plans: that is, what is the basic direction in which the organization is heading, its mission, how wide and how far into the future should plans look, and what research is needed to get there? The second concerns the process of planning: who is involved in planning, what techniques of planning are used, and who is responsible for turning plans into achievable objectives and making sure the objectives are needed?

We have heard all of these issues discussed and have sensed a frustration with the answers which seems to typify that of most organizations that tackle the unknown future using concepts and processes which are themselves untested and unfamiliar.

It would take more effort than that expended in our whole project in order to evaluate fully the planning of the Forest Service research branch. First, we would need to be experts on the content--the knowledge, needs, resources, and limitations of the research branch, the Forest Service as a whole, and the clients of the organization, and the physical environment of the nation. This area, then, is obviously beyond our competence. On the other hand, we can comment on the planning process. More accurately, we can report the reactions of Forest Service researchers to the planning process, using the comments they have made to us throughout the study, and some data from the questionnaire.

Before we get into this, however, we need some guidance as to what planning should be. This brings us face to face with a field which is still being developed: the theory of social planning. At present this field is still at the stage of developing concepts and hypotheses based on case analyses of (usually) the disasters of imperfect planning, contrasted with the thinking of far-visioned individuals about what planning should be like. Fortunately, one of those individuals, Dr. Donald N. Michael was available to us early in the project, at a time when he was just finishing a work on the subject of social psychological resistances to long-range social planning (Michael, 1973). We had the opportunity to ask Dr. Michael what would be the indicators of "good" planning processes -- the dimensions on which planning must be analyzed. He helped us develop measures based on the dimensions and hypotheses in his work and in the field as a whole.

What is effective long-range social planning? To Michael it is a process synonymous with "future-responsive social learning." In this process carefully scrutinized assumptions are used to develop images about the nature of a social system (or organization) and its environment, the know-ability of the future and its connection to the present, and about the effects and effectiveness of activities purporting to chart a path to the future:

(1) The environment:

- The relevant environment for the organization* is uncertain and "turbulent" -- it constantly changes itself and makes demands on the organization that are beyond that organization's ability to control.

- Nevertheless, the organization must make a useful response, or provide services to the environment both now and in the future.

*We will use the term "organization" in place of "society" or "system," though the points apply at all levels.

(2) The future and getting there:

-The future is not simply a projection of the present, since unknown (and possibly presently nonexistant) forces will affect it. Thus, "game plans" to reach the future must be flexible and self-correcting if the "rules of the game" change.

-Present activities have unavoidable (good or bad) effects on the state of the future. Effects are not so much first, second or nth order -- they can be classed better by whether or not the organization can anticipate them. Because of the point above, often it cannot.

-Planning must, therefore, be open to all imaginably-relevant points of view, and must continue to be so as time passes. For the organization this means participation is mandatory from all levels within and from its environment as well.

(3) Activities in planning:

-Michael (1971) sums up the requirements as follows:

> The criteria offered by Melvin Webber present an excellent conceptualization of the long-range planning technology. They have been used in our study as the reference against which to assess the nature and extent of organizational resistance to long-range planning:
>
> 1-analysis leading to goals setting in conjunction with
> 2-forecasts of future setting (differentiating exogenous and endogenous factors) for which the working out of the plan over time is relevant and desirable;
> 3-evaluation of alternative plans;
> 4-tracing out the consequences for plan of pertinent circumstances;
> 5-laying out sequenced chains of actions that define the plan, and
> 6-evaluation of how the plan is working out on the basis of environmental feedback that permits recycling of the above steps.
>
> Of central importance for the social-psychological issues involved are three factors:
>
> 1. the requirement that present actions be deeply influenced by estimates of relevant future societal contexts;

2. the requirement that, at all stages of moving from present actions into the future, the environment be scanned and the feedback from it be controlling in the unfolding of the future-oriented movement of the plan;
3. the requirement that goals and the implementation of programs to realize them are intertwined conceptually and operationally. Goals are process guides rather than rigid end points.

In other words, the cybernetic concept of the relation of the organization to its environment must be reflected in the operations of the organization that derive from its long-range planning activity.

All we can measure within the constraints of the present study are researchers' evaluations of items assessing whether processes fitting this framework are now used by the organization. Further, we can assess the individual's satisfactions with (a) Forest Service and station planning as a whole, and (b) own participation in the planning process.

SATISFACTION WITH PLANNING

The biggest story here is a very simple one: with satisfaction how much participation the individual has in planning, and with station and Forest Service planning as a whole, drop dramatically as we move from ADs to PLs to Scientists. Scientists, for example, show up as having somewhere between "a little" and "some" satisfaction with these two areas, while ADs show "great" satisfaction. (See Figure 4-1.)

While these results are very predictable, given the way plans are made in any organization, we would hope that improvements can be made -- particularly in researchers' access to planning. What we ask from a researcher in terms of creativity and solution-building would seem to require that he have access to or at the very least good knowledge about where the organization is going.

These results form a basis for what will follow below: satisfaction will be found to relate to how planning is done, and to conditions within the organization and activities of supervisors. These correlations will suggest some things which could be done to improve satisfaction with planning for researchers. Following Michael, participation seems to be the key dimension to work on.

FIGURE 4-1

PLANNING INDICES

INDEX SCORES FOR THREE JOB GROUPS (1=Scientist, 2=PL & PM, 3=AD)

Mean Index Scores

EXTENT SATISFIED WITH:	1 To No Extent 1.5	2 A Little 2.5	3 Some 3.5	4 Great 4.5	5 Very Great	ANOVA
SATISFACTION WITH OWN PARTICIPATION IN PLANNING In research projects and station long-range planning			$\bar{x}$ 1	2	3	F=58.0 $p \leq .0001$
SATISFACTION WITH SYSTEM'S LONG-RANGE PLANNING (In station, FS Research, and FS as a system)		$\bar{x}$ 1		2	3	7.6 .0005
OVERALL SATISFACTION: OWN PARTICIPATION AND SYSTEM COMBINED			$\bar{x}$ 1 2	3		25.8 .0001

EVALUATION OF PLANNING PROCESSES

The planning process items taken from Michael are listed in Table 4-1, together with the means for Scientists, PLs and ADs. We asked for ratings of the extent to which the station emphasizes each factor during planning. We have ordered the items by their overall means for the Scientists and PLs within two headings: (a) planning processes, and (b) participation.*

The plus and minus notations refer to how each of these items are seen from the standpoint of the long-range planning theory. The most definite minuses are those in participation: depending on WO plans and using special planning units detract from possible participation. Projecting the future (item d) sounds valuable, but really means a single-short style of planning that cannot be "error-embracing" and self-correcting.

There are strong differences here across levels within the organization, all of which indicate that ADs are most positive about the processes and participation items Scientists are always least poistive. On one hand, this is to be expected due to the responsibilities of leadership in the organization. On the other hand, though there are some cautions to leadership coming out of item a in particular: ADs think there is much more participation at all scientific levels than the researchers do. There is also a clear difference between Scientists, who see greater dependence on plans made in Washington, and the PLs and ADs who are lower on this item. So, even though planning is a privilege related to rank, there seem to be mismatches in perceptions as well. What this may point to is a need for greater information about planning to flow both up and down the hierarchy.

Another fact pointing to lack of information is the large number of Scientists (and PLs too, for that matter) who had to answer "I don't know" to many of these items. For example, 40% of the Scientists (and 25% of PLs) could not rate how well interpersonal conflicts are handled in planning; from 25% to 29% of Scientists (and from 11% to 20% of PLs) could not rate how well the organization learns from past mistakes, uses special planning units, uses high-risk/high-payoff plans, or even depends on plans made in Washington.

Let's turn to the way the planning items correlate with satisfaction (a) own participation in planning, and (b) station/Forest Service planning as a whole (on the right side of Table 4-1). Since we are concerned primarily with researchers here, ADs have been omitted. For all but one of

*Factor analysis shows a strong first factor on which all but two of these items have their highest loading. The items which load highest on the first factor are "examining assumptions," "learning from mistakes," and "integration with Forest Service plans." The items "depending on WO plans," and "changing plans in mid course" form a second factor. We have chosen not to organize our presentation of the items according to these results.

TABLE 4-1

Means for Planning Processes, and Correlations with Planning Satisfactions

	Mean Extent Station Emphasizes Each Planning Factor			CORRELATIONS Satisfaction with: Own Participation		Station/FS Planning	
	SCI.	PLs	ADs	SCI.	PLs	SCI.	PLs
PLANNING PROCESSES							
+ h. Integrating research plans with broader FS plans	3.15	3.21	3.55	.31	.29	.37	.53
+ k. Changing plans in mid-course to meet new conditions	3.05	3.09	3.10	.10	--	.12	--
- d. Projecting the future based on present needs	3.07	2.95	3.30	.25	--	.34	.39
+ e. Specifying long-range goals	3.00	2.97	3.45	.27	.21	.40	.49
+ f. Examining the basic assumptions on which plans are based	2.90	2.89	3.24	.31	.26	.44	.49
+ m. Using adequate time frames in planning	2.76	2.81	3.11	.27	.27	.40	.48
+ j. Learning from mistakes made in past plans	2.72	2.84	3.28	.35	.32	.44	.41
+ g. Handling interpersonal or conceptual conflicts which arise during planning	2.43	2.53	2.88	.35	.28	.44	.42
+ l. Using plans involving high risks, but great payoff potential	2.15	2.30	2.70	.22	.28	.31	.39
PARTICIPATION							
- i. Depending on plans made in Washington office	3.36	3.00	3.00	-.16	--	--	--
+ a. Participation of all scientific staff levels in planning	2.58	2.93	3.47	.53	.43	.37	.43
+ c. User group participation in planning	2.58	2.69	3.00	.26	.22	.20	.34
- b. Use of special planning units	2.51	2.36	2.73	--	.22	.19	.29

the planning items which theory says should be present in good long-range planning, we see positive correlations for both satisfaction measures, for both Scientists and PLs. The exception is "changing plans in mid-course," a process which is rated (compared with other processes) as occurring rather frequently according to the mean scores. This question may be interpreted as vacilation, rather than as flexibility.* So, with this one exception, things theory says are "good" relate positively to satisfactions with planning.

There is less agreement on the "negative" factors. The researchers who are more satisfied with planning as a whole are more likely to rate "projecting the future" and "using special planning units" higher as well. This may point to lack of knowledge about problems these two courses of action can create.

On the other hand, "depending on WO plans" relates negatively to Scientists' satisfaction with their own participation, and "participation of all levels" draws high correlations with satisfactions for both groups. Researchers also seem to be calling for better use of most of the planning processes--perhaps a general call for more attention to planning as a whole.

In sum, only the ADs gave strong positive means to any items at all; those researchers who knew enough to answer rated the factors lower--and in particular those items dealing with participation. Further, in most cases the items theory says are important relate positively to researcher's satisfactions.

It seems then, that greater activity in most planning processes would be applauded, and in particular, those allowing greater participation for researchers.

We have seen, also, that the flow of information about planning, the necessary step for any of the above changes, may be less than optimal (remember the amount of missing data for Scientists). The scope of this problem is illustrated further when we correlate satisfaction with own participation in planning with items reflecting communication in the station, and activities of supervisors (see Table 4-2). Those who get more information, or who rate their supervisors more positively on all dimensions (particularly those of facilitating and supporting) are more positive about their participation in planning.

Verbal comments on the questionnaire amplify the concerns about planning processes, information, and participation, though most are realistic about the constraints when they appear to know about them. Below we have put together a composite of these statements (from several respondents) which typify the train of thought.

> Flexibility must be a watchword in these changing times.

*Particularly since it forms a factor with "depending on plans made in Washington," a "negative" process.

TABLE 4-2

Correlations of Planning Satisfactions with Selected Organizational and Supervisor Measures

Correlates:	Satisfaction with Own Participation in Planning: SCIENTISTS (N=647 - 687)	PLs (N=200 - 247)
Satisfaction with Amount of Information about what is going on in station	.42	.48
Location makes contact with rest of station easy	.10	.23
Informed about changes involving unit	.40	.45
SUPERVISOR: task orientation	.24	.25
Job facilitation	.34	.27
Support	.37	.36
Interaction facilitation	.38	.44
Skills	.28	.26
Satisfaction with supervisor	.41	.32

all *rs*: $p < .01$

The station to my knowledge has no stated objectives or goals.

Forest Service planning has been good--implementation has been poor ... outside constraints control planning results.

...based on the ability of ADs to garner support where the dollar is...

...becoming more and more political ... of course, shortage of financing has led us down this political path...

Everything is number one priority, which doesn't work.

Tends to be low in creativity--risks to the organization too often receive emphasis.

...we are kept so busy keeping up with crises that there just isn't time to do what's really needed...

More foresight in anticipating public interest. FS is often in a defensive position.

...poorly informed about user needs...

...a better information "extension" service could provide feedback for planning...

New Planning and Application AD should help.

The AD for continuing research and AD for Plans and Application should be coordinating...little evidence [yet].

We are in the process of changing our planning procedures...the RD&A*program concept...To my knowledge no RD&A programs have yet been chartered.

I prefer a work situation where there is active participation in the planning process. At the very least I prefer knowing what the planning process is and its results. Let there be light.

I would like to know more about what is going on in the way of research planning.

[referring to station planning] not very many Scientists have overview to respond...

More team planning taking into account all the disciplines.

No coordination between plans of various research groups.

Could be done by holding meetings about project or division problems.

My supervisor and I discuss, on a short range basis, what we will do.

Participatory management and planning requires a high level of training to implement...not very evident at the WO level...

...just an academic exercise because decisions are apparently made in WO...

*Research, Development and Application.

> In recent times there has been a big effort in this station to make people think they participate in planning. This is all eyewash.
>
> Results of a brainstorming session were ignored.
>
> Usually when Scientists are asked for input, it appears to be a method of placating them without sincere consideration of their ideas.
>
> We were told we had complete freedom...What it turned out was that we had no freedom...A completely meaningless, frustrating exercise for all of us.
>
> ...Scientists must see tangible results of their input...
>
> Planning is in the process of change. Nearly all of the "good" aspects implied in the questionnaire are in the process of implementation.

The last comment strikes a hopeful chord, but the general feeling we got in our work in stations was a wait-and-see attitude, and in some places not much willingness to expend individual effort until individuals are sure that past instances of ignoring their inputs are not to be repeated.

Finally, we need to note that satisfaction with Forest Service planning as a whole will prove to be (in a later chapter) a strong predictor of satisfaction with the station. We keep seeing the interrelation of participation, information flow, and satisfaction.

A good wrap-up for this chapter comes from comparing what the data, comments, and our observations say with the Michael perspective on what long-range planning should be like. The first general comment is that Michael sees only rare instances in which the future-responsive, error-correcting, participative approach has been applied in the society as a whole. We see many instances in which constraints from outside the organization force re-planning and re-direction -- often just about the time the "old" plan trickled down to the researcher's level. Knowing that research takes time and that re-directions of public concern will continue, we are tempted to argue for "contingency research planning" -- covering all the bases about which research might be needed in the future. This can waste valuable resources, however. The alternative of trying to do good projection of the future, even with good client and researcher input, suffers from problems of low flexibility of the game rules change -- as history shows they probably will. So, we see in operation the forces which make students of planning like Michael less than optimistic.

Perhaps the best we can do would be to cut loose some thinkers to take the long-range view, making sure researchers, administrators, and clients know of the work and can make inputs to it. In the meantime, researchers should be made aware of constraints, and then be allowed to exercise all of the degrees of freedom to participate in planning which the constraints permit.

CHAPTER 5

SUPERVISION

READER'S GUIDE:

The topic of supervision has always generated heat in our data feedback and other meetings. It seems to be a core item in looking at individual satisfactions, and as such this section deserves some emphasis on the reader's part. The section of this chapter on integrating indicators of supervision taken from differing theoretical perspectives is optional, but could be useful for readers lacking any background in management.

CHAPTER SUMMARY:

The two main concerns here are (1) how different styles of supervision relate to how satisfied subordinates are with the supervisor, and (2) at the project level, how Scientists' ratings of their PL's supervision relate to characteristics and opinions of the PL himself.

Most Forest Service researchers are very favorable about their supervisors, though there is less positive evaluation of ADs by PLs than between Directors and ADs, or PLs and Scientists. The trend to move ADs away, both technically and physically, from their projects may have produced these ratings. Over 80 percent of researchers rate their supervisor as highly concerned with both production of work and personal support -- a mix theory tells us is desired. Still, PLs say their supervisor is only moderate in showing concern for work and helping facilitate it by making suggestions.

At the project level, PL's who are more concerned with career growth and professional development or "self-actualization" are seen by their Scientists as more satisfactory supervisors, and as leaders who are more task-oriented, personally supportive, and facilitative in offering suggestions and being interested in the Scientists' work. PLs who say their AD is more task-oriented are in turn rated by Scientists as more task-oriented, but also as more facilitative of work and of interactions in the team. PLs who have greater technical and managerial training opportunities are rated by Scientists as being more supportive and facilitative in the job, and Scientists are more satisfied with these PLs.

These results are bolstered by the concerns we have heard and and worked with during feedback to stations about two main areas: (1) how to improve the AD-to-PL link in the supervisory chain, and whether the recent reorganization has cured problems of difficult communication; and (2) how to insure that supervisors at the PL level (and perhaps at the Scientist level, too) get the kind of managerial training they seem to need in order to become leaders who are high in all of the dimensions of leadership. In the first area, it is our general impression that reorganization has cured only some of the AD-PL communications problems by moving some program ADs into the field. On the other hand, the decision to make ADs administrative and not content experts over the projects they supervise leaves the PL without a higher-up expert in his field. The problem of leadership training seems to remain a serious one.

INTRODUCTION TO THE SUPERVISION PROBLEM

Bluntly stated, there is a great range in ratings of supervisors in Forest Service: many think that their supervisor talks with the angels, others are sure he talks only to himself. Overall, though, most researchers seem to rate their supervisor very favorably. In our work, we have tried to concentrate on helping reduce factors which make the supervisory task more difficult, we have heard about problems of physical or intellectual distance, credit-hogging, lack of managerial skills, etc. On the other hand, we have the instances of supervisors who gain the unabashed admiration of their subordinates. It is our impression that more of the former criticism was directed at ADs by PLs, and most of the adoration occurs from Scientists to the PL. The growing trend to remove ADs from a position of technical competence and make them "pure administrators" might have something to do with this.

Before we turn to the task of trying to integrate the many possible analytical perspectives on supervision, we feel it would be good to let the researchers talk about supervisors in their own words.

Comments about highly-rated Supervisors	Comments about poorly-rated Supervisors
"Excellent and congenial to work with. However, I feel he is not as critical of my work as he should be."	"Not a supervisor! He will never fathom the difference between a research organization and a military hierarchy."
"...young and energetic and obviously wants to go far. He listens but some times that 'I'm in a hurry' message cuts off adequate discussion of topics."	"He lacks integrity, technical capability and leadership ability... He has shallow short-term goals."
"...has been assigned a heavy burden of planning and coordinating..."	"AD...is a nitpicker, obstructionist, and generally a problem rather than an expediter and supporter."

"The qualities of my supervisor are the only reason I have remained in F.S. Research."

"A bright spot in an otherwise bleak picture."

"Ten feet tall (at least)."

"A good man, but overworked and sometimes discouraged by lack of upper echelon direction."

"My supervisor allows complete freedom for project leaders..."

"...dictatorial in his approach..."

"...he tries to take credit for others' work or their ideas..."

"...a pompous, overbearing ass, who places most of his emphasis on form and little on substance...his exagerated sense of self importance and love of posturing and internal political intrigue have completely ruined any cooperation between the...project and [the region]."

A very important description of supervision is provided by the summary data in Figure 5-1. We see that ADs are very satisfied with the supervision provided by Directors, rate Directors very positively on all of the dimensions of supervisory style. Scientists and PLs are always significantly lower on both satisfaction and the style measures. These style measures are described in detail below, but one is important enough to mention here, that of the extent to which the supervisor is interested in the work of the subordinate, and facilitates getting the work done by making suggestions. PLs rate their supervisors (the ADs) lower on this dimension than do Scientists -- PLs are almost at the neutral or intermediate point on the scale in data where ratings this low are very rare. The gaps between the researchers and full-time administrators on all the dimensions, and the gap between PLs and ADs on job facilitation/interest in particular, point to a definite problem in supervision ADs provide to the field.

So, not surprisingly, there seem to be both very good and very poor supervisors in F.S. research. The questions are, then, what defines a good or poor supervisor, and how does supervision relate to satisfactions with the organization?

PERSPECTIVES ON LEADERSHIP AND SUPERVISION

There has been a great deal of research on leadership in general, and supervisory practices in particular in recent years. While we will not undertake a review of this literature here, we do need to identify the general themes or approaches, and to outline the measures of supervision we used in the study.

First, we need to note that the concept of, and research available on, "leadership" is much broader than for "supervision." In general, supervision implies the impact of formal organizational control on individual performance and rewards. Leadership, on the other hand, implies the ability

FIGURE 5-1

SUPERVISION INDICES

INDEX SCORES FOR THREE JOB GROUPS (1=Scientist, 2=PL & PM, 3=AD)

"A" END OF ITEMS IN EACH INDEX

Mean Index Scores

	1 A Applies 1.5	2 Tends to A 2.5	3 Intermediate 3.5	4 Tends to B 4.5	5 B Applies	ANOVA
WORK AND GOAL EMPHASIS My supervisor is concerned with getting work done, and about maintaining standards of performance	3	$\bar{X}$ 2 1				9.3 .0001
JOB FACILITATION AND INTEREST My supervisor shows interest in my work and offers suggestions on job problems	3		$\bar{X}$ 1 2			19.0 .0001
INTERPERSONAL SUPPORT My supervisor is concerned that I grow professionally and about keeping his subordinates happy; he's friendly and approachable	3	$\bar{X}$ 2 1				6.0 .005
INTERACTION AND OPENNESS My supervisor encourages us to exchange opinions and uses general supervision; I can influence his decisions which involve me	3	$\bar{X}$ 2 1				7.5 .001
SUPERVISOR SKILLS My supervisor keeps us to date on both his scientific skills and on rules and regulations	3	$\bar{X}$ 1 2				4.6 .01
SATISFACTION WITH MY SUPERVISOR (Item o) I'm very satisfied wit' ny supervisor	3	2 1				.0001

of an individual to motivate, rally, or otherwise change or control the behavior or opinions of others. The press of much of the organizational leadership literature is that of finding ways to make the formal or supervision dimensions of organizations overlap more completely with the (often informal) patterns of leadership, making much use of the concept of "leadership style" (see Golembiewski, 1965, p. 113).

There seem to be no universal principles of leadership style which always relate to greater performance and satisfaction -- the twin criteria in most organizational research. Modern "enlightened" leadership theory points to the general superiority of leaders who are participative, balanced (between task and interpersonal emphasis), etc. A scan of the literature on style or "types" of leaders would produce a long list of usually paired-opposite characteristics of leaders which have been examined (see, for example, Bass, 1960, p. 86 cf.). Clearly, we cannot afford to duplicate such work here. Perhaps there are some dimensions which are (a) reasonably well supported in many situations, and/or (b) of particular import in past studies of research organizations.

For example, Baumgartel (1957) studied the effects of laissez-faire, participatory, and directive leadership styles on satisfactions with job and leadership at the research laboratory level. Participatory leadership was related with higher ratings on dimensions of attitudes toward lab director, satisfaction with leadership, and importance of and extent job provided for a "research orientation." Directive leadership showed the lowest ratings. Pelz and Andrews' (1966) major work on scientists in organizations approached supervision style in such areas as the effect of availability of supervisor to research groups, and his importance as an idea-generator for younger research groups and as a neutral sounding board for older groups (p. 254). Another area was the effect of leadership on maintaining effective research environments -- with the right levels of freedom, responsibility, etc. In other words, they used leadership measures in their analyses, but did not organize their work to look at the effects of leadership in detail.

The work of Mann is also important here. His concept of the "skill mix" of supervisors (Mann, 1967) stresses technical, administrative, and human relations skills needed by supervisors. Mann's work on government research installations (1968) showed that more effective sections had supervisors who were more willing to tolerate risks and changes, were more interpersonally understanding, and were similar to their subordinates in education and age, though more professionally oriented.

Two other traditions in leadership or supervisory research seem valuable here. First, is the work of Blake and Mouton (1964) on the "managerial grid." This concept, familiar to most graduates of management training seminars, contrasts supervisors in terms of (a) their concern for production (task accomplishment) and (b) concerns for people (interpersonal orientation), claiming that high concern on both dimensions is most effective.

The second additional perspective is that of Bowers and Seashore (e.g., 1966), which integrates several different perspectives to derive the following four factors of leadership:

--job facilitation
--support
--interaction facilitation
--goal emphasis

The "support" and "goal emphasis" dimensions are close to Blake and Mouton's people and production concerns, respectively.

POTENTIAL IMPACT OF SUPERVISORY DIFFERENCES

One primary concern of leadership/supervision research has been that of the effect of style or activity differences on production and satisfaction of subordinates, or at the work group level. We share these concerns here: what is the ultimate impact of different ratings of supervisors on the job and organization satisfaction of the researcher, and on his ultimate contribution to science and applications?* We also need to demonstrate the more basic effects of style differences on satisfaction with the supervisor himself. Another important dimension is to identify characteristics and opinions of supervisors which relate to the supervisory styles they use, and to how satisfied their subordinates are with this supervision.

INDICES OF SUPERVISORY STYLE -- RELATING THE THEORISTS

The questionnaire was constructed so that the section on supervision contained ratings drawn from the approaches of Blake and Mouton, Bowers and Seashore, and Mann. The first task was that of examining how these different approaches fit together. Previous research by Butterfield (1968) has attempted to relate various leadership theories. Four of the five clusters obtained parallel those of Bowers and Seashore, and the fifth reflected a "systemic perspective" of the manager, as posited by Katz and Kahn (1966). The Blake and Mouton perspective was captured by items assessing the supervisor's orientation to getting the work done (task) and concerns for keeping people satisfied and happy. The Bowers and Seashore approach was measured by items assessing each of the four factors listed above. Mann's perspective on the supervisory skill mix was measured by items covering scientific-technical and administrative skills; we did not add a separate item from Mann on human relations skills, since this area seemed well covered in items from the other two approaches.

Several different analytical approaches were tried in the task of attempting to examine how the three approaches fit together. The first was that of simply correlating the items which represent each approach. The correlations are in Table 5-1. We have also added those other supervision items which we added to the questionnaire in an attempt to fill gaps in the three approaches, or fit the Forest Service situation more closely.

*Discussion of how supervision relates to productivity will be deferred until the chapter which deals with contribution.

TABLE 5-1

Correlations Among Supervision Items

	A	B	C	N	E	G	I	K	D	F	H	J	L
Blake & Mouton													
A. My supervisor is very concerned with getting work done													
B. My supervisor is very concerned with keeping his subordinates satisfied and happy	.42												
Mann													
C. My supervisor keeps up-to-date on the scientific and technical skills he needs in his discipline	.51	.52											
N. My supervisor is always up-to-date on policies, rules, and regulations of the FS and of the station	.41	.36	.37										
Bowers & Seashore													
E. My supervisor frequently offers new ideas for solving job-related problems	.50	.54	.63	.33									
G. My supervisor is very friendly and easy to approach	.26	.67	.38	.28	.43								
I. My supervisor encourages people who work for him to exchange opinions and ideas among themselves	.37	.60	.46	.33	.48	.54							
K. My supervisor is highly concerned with maintaining high standards of performance	.64	.51	.60	.42	.54	.38	.50						
Other Items													
D. My supervisor does a good job relating to outside groups, agencies, and "clients"	.43	.49	.49	.40	.53	.46	.31	.48					
F. My supervisor is very concerned that I grow and "get ahead" professionally	.41	.72	.48	.35	.59	.59	.56	.54	.49				
H. I can influence the activities and decisions of my supervisor to a great extent on matters that are of concern to me	.20	.54	.32	.17	.36	.54	.55	.33	.31	.53			
J. I am kept well informed of my supervisor's assessment of my performance	.38	.60	.43	.34	.46	.52	.56	.56	.45	.65	.44		
L. My supervisor uses very general supervision; e.g., I am definitely on my own to carry out the basic tasks of my job	.11	.32	.16	.13	.06	.35	.32	.24	.20	.27	.43	.24	
M. My supervisor shows interest in my work and periodically discusses it with me	.48	.62	.52	.35	.63	.52	.61	.58	.50	.63	.48	.62	.22

Correlations for Scientists and PLs
N's range from 1,056 to 1,167.

First, we notice that the level of correlation among most of the items is moderately strong and positive. Within this, however, there are some interesting relationships:

(a) There is, in general, better correlation across the three areas, than within them. The theories have tried to isolate factors which are different, on one hand, and the three perspectives have elements in common, so this should be expected.

(b) The Mann skill-mix items seem to tap a somewhat different dimension from the areas contained in Blake and Mouton and Bowers and Seashore. The scientific and technical skills seem to relate equally well with an orientation toward getting work done and that of facilitating work. Administrative skills do not show a preference for fitting with some perspectives from the other theorists and not others.

(c) The Bowers and Seashore perspectives of support and interaction facilitation appear to be more detailed elaborations of the Blake and Mouton personal orientation, while goal emphasis fits with the Blake and Mouton work orientation. Job facilitation seems to span both the Blake and Mouton areas.

(d) Several of our added items relate very strongly with the items from the theories. In particular, the supervisor's concern that his subordinates get ahead fits very well with the Blake and Mouton personal orientation, but it doesn't fit into any one of the Bowers and Seashore categories better than with the others. Among the added items, there seems to be a cluster of three: concern that subordinate gets ahead, the supervisor keeping the subordinate informed of his assessments of progress, and showing interest in subordinate's work.

The next stage in our work was to turn these items into a smaller set of indices. For this we turned to factor and cluster analyses. The Mann items were eliminated first, however, since skills seem to be pre-conditions for supervisory actions, but are not necessarily reflected in what the supervisor actually does. The Mann items were then pooled to produce the general "skill" index. Blake and Mouton's and Bowers and Seashore's items were then put together with several from the set of added items, and factor analyzed first. The most meaningful approach seemed to be to allow the program to produce rotated factors which could be inter-correlated (an oblique solution), since we cannot make the claim that dimensions of supervisory style should be unrelated to each other. The results of the analysis are summarized in Table 5-2.

TABLE 5-2

Oblique Rotated Factor Loadings*

	Factor 1	Factor 2	Factor 3	Factor 4
K. My supervisor is highly concerned with maintaining high standards of performance	.75			
A. My supervisor is very concerned with getting work done	.62			
E. My supervisor frequently offers new ideas for solving job-related problems		.78		
M. My supervisor shows interest in my work and periodically discusses it with me		.72		
F. My supervisor is very concerned that I grow and "get ahead" professionally			.74	
B. My supervisor is very concerned with keeping his subordinates satisfied and happy			.68	
G. My supervisor is very friendly and easy to approach			.57	
J. I am kept well informed of my supervisor's assessment of my performance			.37	
I. My supervisor encourages people who work for him to exchange opinions and ideas among themselves				.69
H. I can influence the activities and decisions of my supervisor to a great extent on matters that are of concern to me.				.63
Label Given to Factor:	Goal and Work Emphasis	Job Interest and Facilitation	Interpersonal Support and Growth	Facilitation and Openness Interaction

*Only the highest loadings for each variable are listed.

The first factor will be called "work and goal emphasis"; it draws together the Blake and Mouton work orientation with Bowers and Seashore's goal emphasis. The second factor puts the added item of interest in the subordinate's work together with the Bowers and Seashore's item representing job facilitation, producing a factor we will call "job facilitation and interest." The third factor combines the Blake and Mouton personal orientation with Bowers and Seashore's support dimension, plus the added items of concern for subordinate advancement and keeping subordinates informed of the supervisor's assessment of progress. This we will call "interpersonal support and growth." Finally, the fourth factor, which we call "interaction facilitation and openness," adds the notion of openness of the supervisor to subordinates' attempts to influence him to Bowers and Seashore's dimension of interaction facilitation. These, then are the dimensions shown in Figure 5-1, and which we will use below.

These factors have a certain intuitive appeal, but we could construct several other groupings of items which would give the same feeling. The only way we can evaluate the utility of these indices is in terms of how they relate (and hopefully relate differently) to other measures as we attempt to identify how supervisory styles relate to satisfaction, communication, and contribution.

SUPERVISORY STYLE RELATED TO SATISFACTION WITH SUPERVISOR

The question here is simply, "how do the different supervision style ratings relate to how satisfied researchers are with their supervisor?" We included in the analysis only those Scientists who indicated they were thinking of a PL as their supervisor, and those PLs who rated ADs; thus, when the analysis is done for these two groups separately, we get those style factors which predict satisfaction with PLs as supervisors (of Scientists), and with ADs as supervisors (of PLs). Multiple regressions were done for each of the groups, standardizing the data so that the co-efficients produced (beta weights) can be interpreted as path co-efficients (see Table 5-3). The subordinates' experience in Forest Service research was also used as a predictor to give a partial control over biases introduced by either selective retention (e.g., people who didn't like their supervisor and left) and other experience factors. This measure had not predictive power over satisfaction with the supervisor, however.

For Scientists, interpersonal support the PL provides is the strongest predictor of satisfaction with the PL as a supervisor, followed by job facilitation and interest, and interaction and openness. Independent of the other predictors, the supervisor's work and goal emphasis is just barely a significant positive factor in the satisfaction ratings.

When PLs rate their AD supervisors, the picture is slightly different. Interpersonal support is still the strongest factor, followed by interaction and openness and supervisor assessments of individual performance, but job facilitation and interest doesn't relate to satisfaction. Work orientation doesn't fit into the prediction of satisfaction for PLs, either.

TABLE 5-3

Multiple Regressions on Satisfaction With Supervisor

PREDICTORS	Beta Weights: Satisfaction with Supervisor* SCIENTISTS	PLs
Work and goal emphasis	.06[a]	--
Job facilitation and interest	.20[d]	--
Interpersonal support	.41[d]	.32[d]
Interaction and openness	.19[d]	.20[d]
Supervisory skills (Scientists and Administrators)	.10[c]	.12[a]
Supervisor good job relating with outside	.09[c]	--
Supervisor keeps me informed of his assessment of my performance	--	.16[b]
Subordinates number of years in Forest Service research	--	--
R^2 =	.76	.75
N =	570	174

*Cases selected so that Scientists included were those who were rating a PL as their supervisor; PLs included were those who rated ADs.

In summary, supervisors at either the PL or AD level who show more interpersonal concern and support for subordinates (in areas such as trying to keep them satisfied, being concerned with their professional growth, and being friendly and approachable) are likely to be rated as more satisfactory supervisors by their subordinates. The same is true for supervisors who facilitate the interactions (exchange of opinions) of subordinates, are themselves open to influence from subordinates, and use very general forms of supervision. PL supervisors (but not ADs) get higher satisfaction ratings if they are more active in offering ideas for solving problems and in showing interest in the work of Scientists.

...he had no interest in any of my research and provided no quality guidance.

Thus, personally-supportive, open, and facilitating supervisors get better ratings at both levels. This fits easily if we consider that satisfaction with the supervisor is sensitive to attitudes more about the man and how he relates with others, than to the man's orientation to getting out the work.

The difference between Scientist and PL ratings of supervisors as a function of job facilitation and interest also needs some comment: What this probably represents is the inability of most ADs to be close enough, either physically or technically, to be able to show interest and offer suggestions. We know from the supervision data in Figure 5-1 that Scientists rate their supervisors higher on facilitation and interest than do PLs, though there are no real differences between Scientists and PLs in the amount of stimulation to perform well that they get from their supervisor. Another reason might be that PLs are more capable technically, or better "self-starters" than Scientists.

SUPERVISOR SATISFACTION IN MANAGERIAL GRID TERMS

A quick summary of style, in a format familiar to many readers, is provided by constructing our equivalent of the "managerial grid" from Blake and Mouton. We are interested in two things: first, what percentage of the supervisors fall into the corners of the grid -- that is, the combinations of low and high concern for both personal factors and production? Second, what is the satisfaction rating supervisors receive from subordinates, depending on the part of the grid in which the subordinates classify them?

Table 5-4 tells the story, again separating the data from Scientists and PLs (that is, the ratings are of PLs and ADs, respectively). First, we need to note that we divided the five-point scales used in rating the items so that the mid or three-point was omitted. Then, we classified the supervisor as to whether he was rated as "A applies or tends to apply," or "B applies or tends to apply," where A and B are the polar opposite statements reflecting high (A) and low (B) concern with each item. (See questions V-2a and b in Appendix A.) Thus, we divided cases based on the logic of the scales, not on the actual distribution of responses produced. This results

TABLE 5-4

Mean Satisfaction* with Supervisor
by Blake & Mouton Managerial Grid Ratings

Key: Mean*
(no. of cases)
% of Total

SCIENTISTS

Concern for People (satisfied & happy)	Lo	Hi
Hi	4.14 (7) 2%	1.49 (334) 82%
Lo	4.12 (16) 4%	3.94 (48) 12%

Concern for Production (get work done)

$F_{3;401} = 228.1$
$p < .0001$

PLs

Concern for People (satisfied & happy)	Lo	Hi
Hi	[1 case]	1.57 (122) 85%
Lo	4.29 (7) 5%	3.78 (13) 9%

Concern for Production (get work done)

$F_{3;139} = 56.3$
$p < .0001$

*Lower mean scores equal higher satisfaction with supervisor.

in some almost-empty cells in the grid, since most supervisors in Forest Service research tend to be rated as concerned with both production and personal factors.

In the ratings of PLs, 82 percent of the Scientists who made ratings said their supervisor was moderately or quite concerned with both personal and production factors. Eighty-five percent of the ratings made by PLs identified their AD as concerned with both. In both the Scientist and PL ratings, the remaining small percentage of ratings is scattered around the grid, with some concentration among supervisors rated as high in production concern but low in concern for people (12 percent of the ratings by Scientists, and 9 percent of the PL ratings).

In each of the cells in the tables we have listed the mean satisfaction ratings given supervisors by their subordinates. The scores range between one and five, with one meaning highest satisfaction with the supervisor. The tables show clearly that supervisors who are rated as having high concern for both production and people get more positive satisfaction ratings as well. The magnitudes of these differences are as great as any we have found in any analysis.

So, not only are the vast majority of supervisors in Forest Service research rated as high on both concerns -- the equivalent of the "9-9" style of supervision which Blake and Mouton hold out as the ideal -- but the subordinates of these supervisors are more satisfied with them on the whole.

SCIENTISTS' RATINGS OF THEIR PL RELATED TO HIS CHARACTERISTICS

The question for this section is a simple one, but one which requires wading through a great many correlations. What we are looking for are those characteristics or opinions of PLs which relate to: (a) how satisfied Scientists are with the supervision the PL provides, and (b) the Scientists' ratings of the PL's supervisory style. We have to concentrate on the research project here, since we must link together data provided by subordinates and supervisors, and the only identifiers we have to do this are common project numbers. To get project-level data for Scientists, we averaged the responses of all Scientists to get index values for the project. There were 213 projects for which both PL and aggregated Scientist data were available.

We are casting a broad, exploratory net in this analysis, and to simplify presentation of the results we will create "profiles" of PLs in Table 5-5. We need to note that none of the correlations between the data from PLs and their Scientists' ratings were very strong. There are several things worth noting in these results.

First, the frequency with which the measures of importance and opportunity for scientific career growth show up as correlates of the satisfaction and style indices. PLs who say growth chances are more important get rated as more work oriented, supportive, and job-facilitative; and their Scientists are more satisfied with their supervision, as well. The PLs

TABLE 5-5

Summary of Correlations Between PL Data and Scientists' Ratings of the PL's Supervisory Style*

(1) SATISFACTION

Project Scientists who are more satisfied with the supervision their PL provides work for PLs who--

- --say they have greater chances for technical and managerial training (.18)
- --say scientific career growth is an important factor in evaluating a job (.17)
- --say they have more opportunity for scientific career growth in their job (.16)

(2) SUPERVISORY STYLE OF THE PL

WORK EMPHASIS: PLs who are rated as higher in work or goal emphasis by their Scientists--

- --spend fewer hours in university course teaching (-.18)
- --are more satisfied with their station and own jobs (.14)
- --see more support from the station for linking with clients (.19)
- --say they have greater chances for technical and managerial training (.14)
- --get more stimulus to perform well from their own work, standards, curiosity (.18)
- --say scientific career growth is more important (.16)
- --say they have more opportunity for career growth (.23)
- --say job stability and salary are more important (.16)
- --say they have more opportunity for salary and job stability (.14)
- --say they have more opportunity for interaction with competent co-workers and chiefs (.14)
- --rate <u>their</u> supervisors are more work-oriented (.19)

SUPPORT: PLs who are rated by Scientists as giving more interpersonal support are those who--

- --say they have greater chances for technical and managerial training (.17)
- --get more stimulus to perform well from their colleagues (.14)
- --say scientific career growth is more important (.16)
- --say they have more opportunity to interact with competent co-workers and chiefs (.14)

JOB FACILITATION AND INTEREST: PLs who are rated as helping to make work easier, and interested in it are those who--

- --say scientific career growth is more important (.16)
- --say <u>their</u> supervisors are more work-oriented (.19)

Table -5, continued

INTERACTION FACILITATION AND OPENNESS: PLs who are rated by Scientists as open to influence, and interested in helping subordinates communicate among themselves--

--are younger (-.16)
--have fewer years' experience in FS research (-.22)
--say their supervisors are more work-oriented (.14)
--say their supervisors give more personal support (.14)

SUPERVISORY SKILLS: PLs who are rated by their Scientists as being more skilled on scientific/technical topics and on rules and regulations are those who--

--spend more hours giving scientific/technical help to scientists (.16)
--spend fewer hours on university course teaching (-.18)

*Correlations are based on between 197 and 213 project-cases for which data exists for both the PL and Scientists' ratings of that PL's supervision. Correlations of .14 are significant at the .05 level; .18 at the .01 level. The following item sets from PLs were correlated with supervisory style and satisfaction: (1) ratings of the "man-in-organization" factors; (2) sources of stimulus to perform well on the job; (3) importance of and opportunity for factors on the job; (4) the PL's ratings of his own supervisor's style; (5) the number of hours per week the PL spends on various scientific, administrative, and teaching activities; and (6) characteristics of the PL himself. Only the significant correlations are noted in this table.

who say they actually have more opportunity for such growth are seen as more work oriented, and their Scientists are also more satisfied with their supervision. The concern for career growth measure might also be titled "professional self-actualization," since it taps such factors such as chances for making use of skills, learning, advancing in professional respect, working on challenging problems, freedom, and contribution to the technical field. It is difficult to sort out the ordering of effects here; about all we can say is that it seems most likely that a concern for growth or "self-actualization" factors should precede, and perhaps affect the researcher's advancement into a supervisory role, where this concern then may generalize to a concern on the part of the PL that his staff grow and advance. This ordering can only be speculation, however.

Second, and related to the above, is the impact of the chances the PL has for continued technical and managerial training: PLs who say their training opportunities are better get rated as more supportive and better at facilitating work; their Scientists are also more satisfied with the supervision these PLs provide.

The third interesting set or relationships in the table involves what might be called "supervisory modelling," or "relay" of supervisory style. We are referring to those instances in which there is a correlation between the style ratings a PL is given by his Scientists, and those ratings the PL makes of his supervisor (usually an AD). Most interesting here is the fact that PLs who rate their supervisor as more work-oriented are in turn rated by their Scientists as more work-oriented; perhaps this demonstrates a "trickle-down" of management concern for production. On the other hand, there is no correlation between the ratings the PL makes and in turn receives on the other supervisory style dimensions. For example, it is not the case, as a simple "modelling" notion would predict, that supportive or facilitative PLs see the same characteristics in their AD. There may be some (though very slight) evidence that a high work-orientation on the part of the AD may result in the PL being more job and interaction facilitating in order to meet the production emphasis. That is, the PL may realize, under some pressure from the AD to get the job done, that he has to maintain and aid project working relationships in order to do this.

Fourth, there is no relation between the total amount of time the PL spends on administration and supervision and the ratings he receives from his Scientists -- what the PL does with the time he does spend seems, from the results earlier, much more important. The only effects of time spent

...contents himself with mundane administrative chores he claims occupy his time so that he can 't get research done.

which we found involve (a) consulting with Scientists to give scientific and technical help, and (b) teaching university courses. The more time

the PL spends teaching at the university level, the less work-oriented he is seen, and the lower the skill rating he receives. On the other hand, PLs rated as having higher skill levels are those who spend more time giving scientific and technical help to their Scientists. It may be that teaching represents a division of energy and interest for some PLs -- or that those who teach do so because they need to give less emphasis to work and helping in their situations. The causal directions are unclear for the relation between giving help and skill ratings, as well: one is tempted to say that more-skilled PLs are more able to help their staff, and thus spend more time at it; but it may be that those who do spend more time helping make their skills more visible to their staff, and hence get higher ratings in this area.

DISCUSSION

We have put our quick summary of this chapter into the section at the beginning, and see no need to duplicate it here. What is needed, though, is a discussion of what we see as some of the enduring problems in supervision, coming out of the data and our station feedback work.

First, the relationship between projects and ADs, particularly in terms of the leadership the AD provides to the PL, remains a difficulty. Forest Service research has attempted to solve some of these problems by reorganizing to move some of the ADs with program or "continuing research" responsibility into the field to be closer to the projects they supervise. Had our data been collected after this reorganization, we feel the ratings of ADs by PLs, particularly in the area of job facilitation, might have been higher -- but not too much. At this point in time there seems to be some confusion about what the AD and PL roles are under the reorganization, and continuing leadership communication problems, as evidenced in the following quote taken from the problem statements and recommendations resulting from feedback work in one station:

> What are the roles of the Assistant Directors for Continuing Research and for Planning and Application? What purposes does the Associate Director perform? Is the Project Leader now a research administrator or an active researcher, or both? Can he be both and do the two jobs well? How can the lines of communication between the Director, Assistant Directors, and Project Leaders be improved?

So, there seems to be work here for the planned study of station reorganization: has reorganization solved the purely communications problems between ADs and projects; can the AD help projects if he has no substantive expertise in the project areas; if not, where does the PL then turn for such help?

Under reorganization, the PL role seems to be increasing in terms of the pressures for both administrative work and substantive leadership. This trend seems to be at odds with three factors: (1) the lack of desire

> [my AD] tends to want me to go into research administration and has not been very helpful in working toward fulfilling my wish to get out of research administration.

of many PLs to become administrators, and (2) the fact noted in many feedback groups that there are not enough opportunities for managerial training, and (3) what seems to be a lack of rewards for leadership and administration on the part of PLs.

> Director and WO [should] decide if Project Leaders are to emphasize their research abilities or their administrative abilities. If administration of research is emphasized, the rating guide standards for Project Leaders must be changed. [from one station's recommendations after feedback work]

Finally, selection of new PLs should consider both administrative and technical skills, with emphasis on the candidate's concern for personal growth and development of his subordinates and of himself.

So, even though most researchers in the Forest Service rate their supervisors as very satisfactory, and concerned about both production and personal relationships, there are still sufficient problems in the area of supervision, job roles, communication, and rewards to keep working on for a long time to come.

CHAPTER 6

ORGANIZATIONAL FACTORS AND SATISFACTION

READER'S GUIDE:

This chapter contains data at the national level for measures which have proved to be very important in feedback with stations, where researchers express a great deal of interest about the state of their working organizational environment and how to improve it. Therefore, this chapter is, more or less, required reading. In particular, the reader should pay attention to those measures which relate strongly to satisfactions with work and organization.

CHAPTER SUMMARY:

Measures of organizational conditions show that, by and large, there is a reasonably good research environment in the Forest Service. Most researchers are fairly satisfied, though satisfaction is greater on most measures the further up one goes in the organizational hierarchy. Improvements seem warranted in developing and using channels through which leadership can communicate with, and listen to, researchers.

In looking at who are most satisfied with their job and station, we found that the amount of challenge and dedication to work the researcher sees, good informal communication within the station, and feelings of good opportunities for career growth are the most important predictors of satisfaction.

INTRODUCTION

Our introduction will be short in this chapter, and we will not dig into the theory of organizations in any depth. We do need to point out, however, that this Forest Service study has benefitted from at least twenty years of research about organizations; ranging from worker satisfactions, competency of supervisors, structural influences on outputs, factors of efficiency, to human relations training and the use of different skills in management and goal setting. Our concerns are relatively simple here, but very important at the same time and they do build on past research. We want to produce meaningful categories or cutting points to use in studying the Forest Service research organization, then go on in the analysis to report how these dimensions look to researchers, and how they relate to each other.

One approach to looking at organizations is the "impersonal" view of the organization as an ordered set of roles, tasks, procedures, inputs, work flows, and products.* We choose, however, to include a more human approach: that is, the organization in terms of, and from the point of view of, the members within it. It seems almost absurd to keep pointing out that organizations are made up of people, not inanimate objects. But in fact, this is just exactly the way organizations of all kinds used to be viewed; and consequently, studied with the same view in mind. One needs only to remember the time and motion studies, the heyday of the efficiency experts, and the view that if only "we had the right control mechanisms," highest output would be achieved. People as people were forgotten. Unfortunately much of the classical management thinking is still with us today. It is still very easy to treat people as if they did not exist. But of course, we know now that we have to look into two areas thoroughly when improvements need to be made: the structural-mechanistic processes, and the human-organic processes of our organizations.

This more modern approach is particularly important in looking at a research organization where the product, new and usable knowledge, is produced by individuals working either alone or in small groups; further, the product of research is not a common one across all "workers," nor could researcher "A" be put on the line in place of researcher "B" and the same product emerge at the end.

Seen from the human vantage point, then, what does the organization look like, and what does it do for (or to) the researcher? First, it provides guidelines, regulation, control leadership, and some sense of mission for work. Further, it provides interactions: vertically within the organization, horizontally among researchers, and externally -- opportunities for linkage with other researchers, clients, the public, policy, etc. Part of the interaction involves the substantive knowledge base of shared information and research perspectives, and part is interpersonal or "process related." In this area we also include friendliness. That is, the organization must be a "good place to live." It provides all kinds of informal networks and outlets for non-work-related behaviors. Finally, the organization provides supports and services: financial, physical, and production-related (e.g., statistical, computational, etc.).

An important part of the organization, for the individual, is that concept called "organizational climate." As we see it here, climate is the individual's perception of the less tangible aspects of the organization, what Franklin (1973) has called the "internal social psychological environment." We will choose to break up the many (and usually not exhaustively defined) attributes of climate into less abstract indicators,

* Those interested in pursuing these lines of thought might like to read Daniel Katz and Robert Kahn (1966).

ones which are also more amenable to analysis and attempts for improvement within stations.* The indices we produced by logical and empirical examination which we would consider part of the more abstract concepts of climate are as follows:

a. Feelings of challenge in work and dedication to it by researchers in station and location.

b. Perceptions of freedom given individuals.

c. Perceptions of individual chances for advancement within the organization.

In part, indices reflecting informal communications also overlap with climate, as would the individual's reactions to supervision covered in the previous chapter.

Depending on which research one reads, the notion of individual satisfaction with the organization may or may not be part of climate. We prefer to keep it separate, treating it as the human outcome or output of the organization. As such, it becomes an important criterion measure to be predicted by factors in the physical, informational, and psychological environments, plus individual characteristics of researchers. The notion is, also that satisfactions should relate positively with productivity. The question of just how positively is an open one, however; we can think of two equally productive researchers; one quite satisfied with his work and the organization in which he does it, and the other dissatisfied as a result of questioning high standards of excellence (perfectionism) unmeetable in any research environment. It may be that satisfaction has less relation to production in research than in an industrial setting, for example. However, we must take the point of view that some minimal level of satisfaction is necessary to insure that individuals do not leave the research organization to seek employment elsewhere.

Toward the end of this chapter, and in the next one, the considerations above will be blended into an overall predictive model of satisfaction and production in Forest Service research. In the meantime, however, we need to move on to the prior question of where the organization is on the various organizational indicators.

WHERE IS FOREST SERVICE RESEARCH ON THE ORGANIZATION INDICATORS?

Second only, perhaps, to the data on research applications, the measures of organizational conditions have been the most "busy" and popular discussion generators during feedback work with the various research stations. This is because they contain a high level of "action potential" for researchers: these are indicators which are very close to home, which

*As James and Jones (1974) point out, researchers have tried to view "climate" as an attribute of the organization or of the individual within it, using either "multiple" (attributes) or "perceptual" measures. They make a convincing case that there are serious conceptual or methodological difficulties with all approaches except that of "psychological climate," the individuals' perception of his own reaction to the organization.

affect the working environment, and most importantly, are factors which researchers feel they can -- and should -- have some control over.

Perhaps the most useful presentations of these data have been comparisons of where each station is, in relation to the nationwide results we will talk about here. As part of this comparison, we contrasted responses of ADs, PLs; and Scientists. One thing we will note as we go along is that ADs are almost always more favorable to the organizational factors than are the researchers. Sometimes the differences are enlightening. While we cannot present the station data here, the averages for Forest Service Research as a whole tell us some interesting things about the organization, and give us some implications for action, many of which have already been plowed into feedback and our recommendations to Forest Service research.

The organizational measures cover a wide range -- from the physical to the group, and to psychological reactions of individuals to their station and job. Communication processes are important parts of the package, as well. In general, as we will see below, the more external or physical factors seem less important than those tapping attitudes of researchers or interactions among them.

Perhaps the easiest way to present the averages for these measures is to repeat the figures included in an earlier work (Morris and Lingwood, 1973b). The format is a simple one: we plot the averages for each job group (AD, PL, Scientist) on the five-point scales which make up the measures, labelling the "positive" end of the scale in terms of the meanings of the items which were put in each index. So, we can compare across groups and/or across index areas. The first set of measures involves the physical environment, and is in Figure 6-1.

Physical and Support Environments

The physical work environment and statistical and editorial services get very positive ratings from all three groups. ADs needs may be met better in these areas than researchers due to the more central physical location of most ADs at the time the data were collected.

On the other hand, we have gotten individual comments and have heard heated discussions among researchers about inadequacies in the physical and support areas. We need to remember that we are looking at averages for the whole organization here, and that poor conditions in the individual case are likely to be even more noticeable and verbalized because of the general high level of satisfaction with these areas. Perhaps we should let some of the individual dissatisfactions show through in the written comments made in the questionnaire. By the way, all of these are from people who are relatively dissatisfied with their job or the station in general:

> "My unit is poorly equipped in terms of support personnel--NO technicians."

> "It seems as though RSS* is a cancer that has permeated the whole station structure and is so intent on 'administering' that it no longer serves the group it was created to serve..."

*Research Support Services.

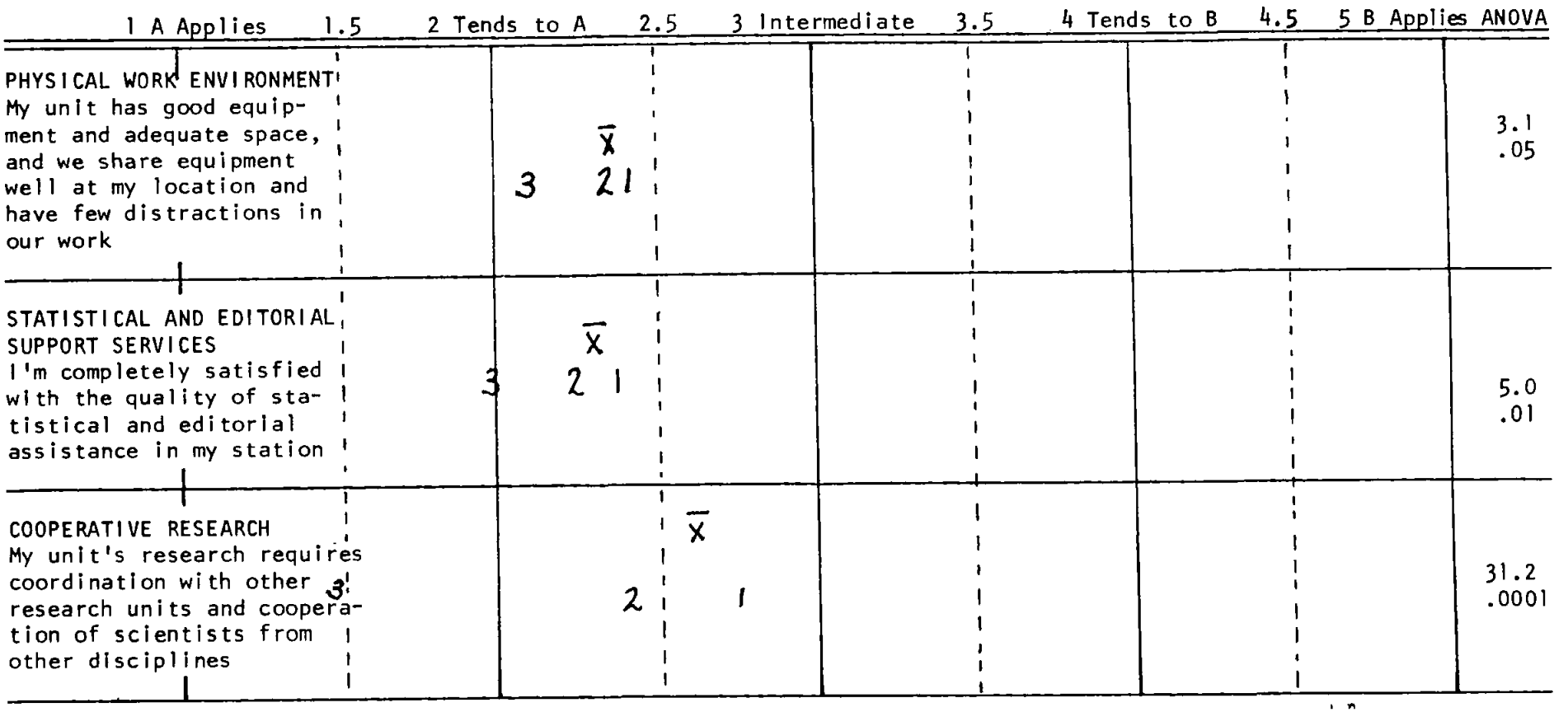
FIGURE 6-1

PHYSICAL ENVIRONMENT INDICES

INDEX SCORES FOR THREE JOB GROUPS (1=Scientist, 2=PL & PM, 3=AD)

"A" END OF ITEMS IN EACH INDEX

Mean Index Scores



"...statistical assistance is not satisfactory because all study plans and paper must be reviewed and approved by station statisticians. Their workload is consequently overpowering..."

In the area of the physical research environment, we have hear in our meetings and visits a generally high level of satisfaction consonant with the data. Again, however, there are individual instances of researchers working in sub-optimum conditions about which they are also very verbal.

One of the areas our questionnaire did not cover well enough is that of the financial resources and supports projects receive. A great many written comments pointed this lack out to us very forcefully:

"[the ability of my unit] to have an effect is negligible because of insufficient funding...and staffing...I know of many university professors who, themselves, have more to work with than three of us."

"...the failure to recognize the overwhelming effect of 'nearly absolute' *limiting* factors such as reduced operating budgets and manpower restrictions will, I believe, also doom this present organizational structure to ineffectuality in terms of long-term contributions."

"[heavy administrative overstaffing] results in tapping off huge percentage of research funds. Ratio of scientists to technicians of about 4 or 5 to one resulting in effective utilization of personnel and waste of money."

"The money, people, and authority to do things must be put in the field and not consolidated at the stations, regions, or WO. If it is not, FS research will continue to dwindle and it will eventually die."

"We definitely need more help at the technician level and less administrative harrassment."

Many of the comments involving resources are tied directly into the difficulties some researchers mention in communicating with leadership, and with unclarity about goals and plans, in particular. Researchers resent reorganizations which impact their programs and/or funding, without -- at least as they see it -- forcing equal reductions in the size and costs of administration. So, immediately, the resource question gets tied into questions of planning, and administration-to-staff communication about priorities and external requirements.

Again, however, we need to stress that on the whole Forest Service researchers are fairly positive about the support factors, and, as we will see below, about their job and station as well.

Activity in inter-project, inter-discipline research is a trend within the organization, one we see as healthy in the stimulation it provides for researchers, and in the increased relevance possible. ADs seem to think this is the rule, but the researchers rate the work lower on this factor. Perhaps the coordination is (or was) taking place at administrative and not production levels.

The Communication Environment

Figure 6-2 plots the group means for organizational factors relating to communications: the more "formal" scientific communication environment, the "informal" communication within stations and projects, and communication outside to clients. The differences among the three job groups are greater here than they were in rating the physical/support environment, again with ADs being most favorable, and Scientists least favorable.

The scientific information environment comes across best in this set, and this fits with what we have seen to be relatively good access to the normal, formal scientific communication channels. The complaints we have heard about information services seem to get verbalized well -- this is simply an aspect of science in which it is very legitimate for a researcher to demand and get good service.

The informal environment is a bit different. It is rated less positively than the scientific network by PLs and Scientists, in particular. Part of the content of this area relates to leadership's openness in discussing changes with researchers, and this is something which Scientists, in many cases, see as lacking. Simply put, the further down the organizational pyramid one goes, the less of this kind of information there is. If we were to look at the single item of satisfaction with the amount of information the individual gets about what is going on in the station, we would find that ADs are still very high, while PLs are just above the midpoint on the scale, and Scientists are below it. Again, this relates to the communication behavior of leadership. The lowest item making up this index is, however, the frequency of scientific-technical staff meetings. The mean for both PLs and Scientists on this item is down toward the "tends to be" very rare point of the scale (about 3.6, where 1.0 is "very frequent," and 5.0 is "very rare"). There are some definite needs for improvement in this whole area -- communication downward about what is going on, plans, constraints, procedures -- from leadership to research staff, and probably from researchers to Technicians, as well. Communication "upward," in terms of leadership's responsiveness to the desires and inputs of researchers has also generated considerable comment during our work with stations and seems in need of improvement.

The third communication area involves linkages with applied clients. The index score is not exceptionally high or low, and on the surface, the means give us no indication to the importance of this factor. Looking ahead, though, a component of this, the extent to which researchers think the organization supports them for linking to clients, will prove to be the single biggest predictor of levels of Applied Contribution. Much more will be said about this factor, and how it might be improved, during the course of the contribution analyses to come.

"Climate" Measures

In Figure 6-3 we look at the measures which tap the psychological reaction of the researcher to his work and the organization.

The first we call "Challenge and Dedication." It combines the ability of the work to challenge the researcher, with time pressures, and perceptions that researchers in the station and location are dedicated to their

FIGURE 6-2

COMMUNICATION INDICES

INDEX SCORES FOR THREE JOB GROUPS (1=Scientist, 2=PL & PM, 3=AD)

"A" END OF ITEMS IN EACH INDEX

Mean Index Scores

	1 A Applies 1.5	2 Tends to A 2.5	3 Intermediate 3.5	4 Tends to B 4.5	5 B Applies	ANOVA
SCIENTIFIC INFORMATION EXCHANGE It is easy for me to keep in touch with personal scientific information sources both inside and outside FS; my information services are good and I'm not isolated from good intellectual/research environment.	3	2 $\bar{X}$ 1				25.1 .0001
INFORMAL INTERNAL COMMUNICATION I'm well satisfied with the high degree of informal information exchange with both scientists and technicians--interpersonally and in meetings--about changes, developments, and things related to my job.	3	2 $\bar{X}$ 1				43.3 .0001
CLIENT LINKAGE We are encouraged to get our unit's results applied and we often serve as users' consultants, and our location makes this easy.	3 2	$\bar{X}$ 1				21.0 .0001

FIGURE 6-3

"CLIMATE" INDICES

INDEX SCORES FOR THREE JOB GROUPS (1=Scientist, 2=PL & PM, 3=AD)

"A" END OF ITEMS IN EACH INDEX

Mean Index Scores

	1 A Applies	1.5	2 Tends to A	2.5	3 Intermediate	3.5	4 Tends to B	4.5	5 B Applies	ANOVA
CHALLENGE AND DEDICATION My work's exciting, sometimes challenging my capabilities, and I work under strong time pressures. We in the station and at my location are dedicated to our work.			3	2	$\bar{X}$ 1					27.2 .0001
FREEDOM My station overlooks deviations from policies when done to improve things and imposes minimal restrictions.				3	2	$\bar{X}$ 1				9.3 .0001
PROMOTION I've made great career progress, with good chances for advanced training and promotion, and I like the way evaluation panels are working.			3	2	$\bar{X}$ 1					32.4 .0001

jobs. The correlations across the challenge and dedication components were so high that we could not create separate indices. The means, which again hover around the 2.5 point of the scale, look in the "normal" range for indices. We continue to find also the "normal" differences from AD to PL to Scientist. This is another case where the generally-satisfied mean score cannot give us clues to the importance of this factor in predicting satisfactions with the organization, and to some extent, contributions. For this we will need to look at how this measure varies with the others -- this comes later.

Finally, in this set, freedom is seen as only intermediate by the research staff. Among the items going into it, the "minimal restrictions" item gets more agreement than the "overlooks deviations" one.

Progress and promotion is seen as relatively low by Scientists, particularly in comparison with PLs. Evaluation panels, of course, were under development in some stations when the data were collected, and Scientists were not at all sure they understood or liked what they involved; this item was relatively low for Scientists. More on this later in the section on contributions.

Satisfactions

Here (in Figure 6-4) we find two of the major criteria in the study: satisfaction with the individual's own job, and satisfaction with and evaluation of the station. Not too surprisingly, the job gets a higher satisfaction rating than does the more distant and abstract station. Particularly important is the fact that the researchers are close to the intermediate point on the station satisfaction index. The items in this index dealing with station adaptation to change and coherence of the research program are the factors which pull the score down.

Summary

By and large, the organization gets generally positive ratings on these measures, but there are areas where Scientists, and sometimes PLs too, are only lukewarm. Before we can do a great deal with the lower items, however, we need to know how these factors fit together, and which are the important ones in predicting criteria like satisfactions and contribution. We will begin this task in a later section of this chapter.

FACTORS A JOB SHOULD AND DOES PROVIDE

A part of the questionnaire which has provided very useful data for feedback has been that which asked respondents to indicate, for each of several factors ranging from career growth to job stability, how important to them that factor would be in seeking the "ideal" job, and how much opportunity they have for it in their present job. The levels on the "importance" and "opportunity" dimensions are important, as well as the gap between the two dimensions. Figure 6-5 tabulates the results for ADs, PLs, and Scientists.

FIGURE 6-4

SATISFACTION INDICES

INDEX SCORES FOR THREE JOB GROUPS (1=Scientist, 2=PL & PM, 3=AD)

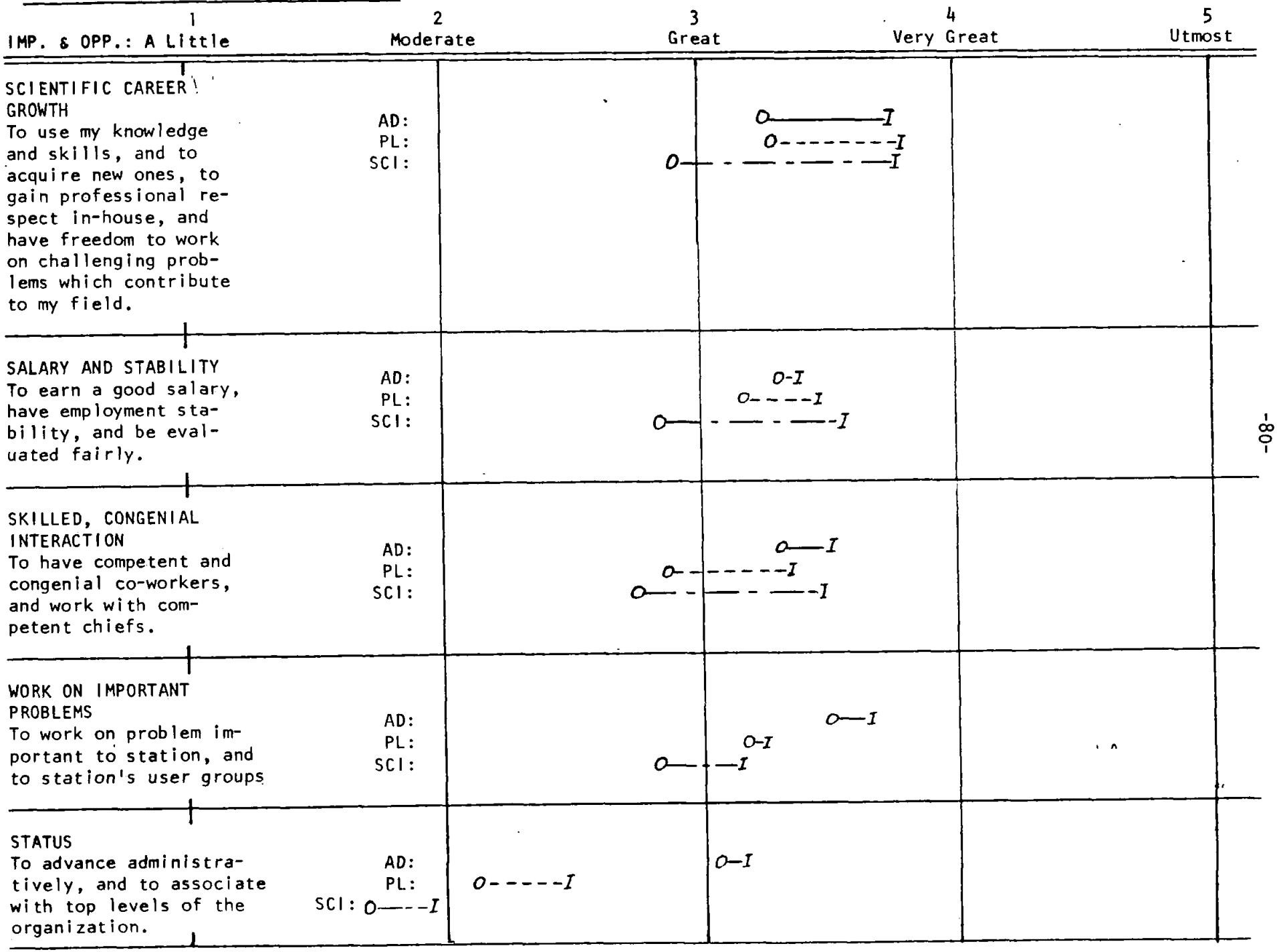
"A" END OF ITEMS IN EACH INDEX

Mean Index Scores

	1 A Applies	1.5	2 Tends to A	2.5	3 Intermediate	3.5	4 Tends to B	4.5	5 B Applies	ANOVA
SATISFACTION WITH MY JOB I like my job and feel secure in it, and I wouldn't leave FS research; this is a good place to live.			3 2 $\bar{X}$ 1							23.7 .0001
SATISFACTION WITH THE STATION I'm very satisfied with the way our station organizes and carries out research, adapts to changing circumstances and achieves its goals.				3	$\bar{X}$ 2 1					8.2 .0005

FIGURE 6-5

IMPORTANCE AND OPPORTUNITIES IN JOB



The most important job factor for all groups (and with no differences among them) is that of chances for career growth and use of knowledge and skills. Second most important is job stability and a good salary; then comes chances for skilled and congenial colleagues with whom to interact (for the researchers, at least). In these three dimensions, however, there are increasing gaps between the "importance" and "opportunity" ratings as one moves down the organizational ladder from AD to PL and then to Scientist. This is particularly true for the salary-stability and skilled colleague interaction dimensions. It is also of interest that PLs think their opportunity for status (advancement and to associate with leadership) is higher than the importance they give it.

Research in other organizations has been consistent in showing that where there were large gaps between importance and opportunity there were also problems that needed to be dealt with. However, identifying gaps and planning actions to close these gaps are often worlds apart. More often than not, gaps can only be closed by considering human variables, not structural ones -- a much more difficult task. Despite this, past research has shown that improvements can be made and gaps can be closed in these human variable areas.

Much of our work with these data in Forest Service feedback has been to explore the reasons for gaps, using data for the station only, and comparing these data with the national norms presented here. There are differences across the stations in the ordering of the indices and in the width of the gaps. The "opportunity" measures have also shown themselves to be important in looking at satisfactions, as we will see below. In particular, the "self-actualization" dimension of opportunity for own career growth relates to satisfactions and to Scientific Contribution of Scientists, as we will see.

STIMULATION IN THE JOB

The final organizational section we will discuss involves a series of questions which asked researchers to rate the amount of stimulation they get to perform well from various sources, such as supervisor, peers, own previous work, clients and their problems, etc. The means for indices created from these measures are plotted in Figure 6-6.

For all three groups, and for researchers more than for ADs, the greatest stimulus comes from the individual's own past work, standards, and curiosity. PLs are also higher than Scientists on this dimension -- what we would hope to find if the "self-starting" capabilities of PLs are to be important in guiding the development of research. The supervisor is a great stimulus only for the AD; he has only "some" impact on the researchers. Colleagues and clients fall in between the internal and the supervisor's stimulus, though it is interesting here that PLs are more client- and colleague-oriented than are the Scientists. Again, these measures will show up in our overall predictive models.

WHO ARE THE MOST AND LEAST SATISFIED?

Modern management theory stresses that organizations have human as well as physical products (or in the case of research, the knowledge product). The measures of satisfaction with the job and station become,

FIGURE 6-6

STIMULI TO PERFORM WELL ON JOB

INDEX SCORES FOR THREE JOB GROUPS (1=Scientist, 2=PL & PM, 3=AD)

EXTENT EACH FACTOR STIMULATES ME:

Mean Index Scores

	No Extent 1	A Little 2	Some 3	Great 4	Very Great 5	ANOVA
INTERNAL, PERSONAL STIMULI My own work, standards, and curiosity			3	$\bar{x}$ 1 2		7.6 .0005
SUPERVISOR AS STIMULUS (Item b) My supervisor			$\bar{x}$ 1 2	3		9.2 .0001
COLLEAGUES AS STIMULI Stimulation from my colleagues in the station, and elsewhere			$\bar{x}$ 1 3 2			18.6 .0001
CLIENTS AS STIMULI Stimulation from clients inside the FS (NFS, S&PF), and from clients outside; also from problems which arise in applications			$\bar{x}$ 1 3 2			22.8 .0001

then, important criterion measures. The question here, therefore, is which researchers see their jobs as more or less satisfying? Stated another way, the question is, what are the personal and opinion factors which distinguish the more from the less satisfied?

In preliminary analyses (not shown here) we looked at the relation of the satisfaction measures to a large set of personal characteristics and indices coming from the organizational measures. Both bivariate and multi-variate analyses were used in an attempt to select those indicators which has some relationship with satisfaction. A great deal of thought went into selecting measures which both (a) had some theoretical relation to satisfactions and (b) showed some empirical relationship in the data. The attempt was part of a more general model-building effort -- the model which we have said will be used to tie the sections of this report together.

One type of analysis, in particular, sensitizes us to the importance of the measure of "challenge and dedication" we explored earlier. Let us begin with this anslysis, then move on to examine what the factors are which relate to greater or lesser feelings of challenge and dedication, and then move one, in conclusion, to the overall analysis of satisfactions.

AID Analysis of Satisfaction with the Station

The analytical model we will use here, "AID,"* identifies interactions in predictor variables by constructing groups of respondents through combinations of characteristics or levels on the predictors, with the groups being maximally homogeneous on the criterion variable. In Figure 6-7 the vertical scale represents the index of satisfaction with the station, while the asymmetric branches across the predictors, and the groups so defined, are clearly visible.

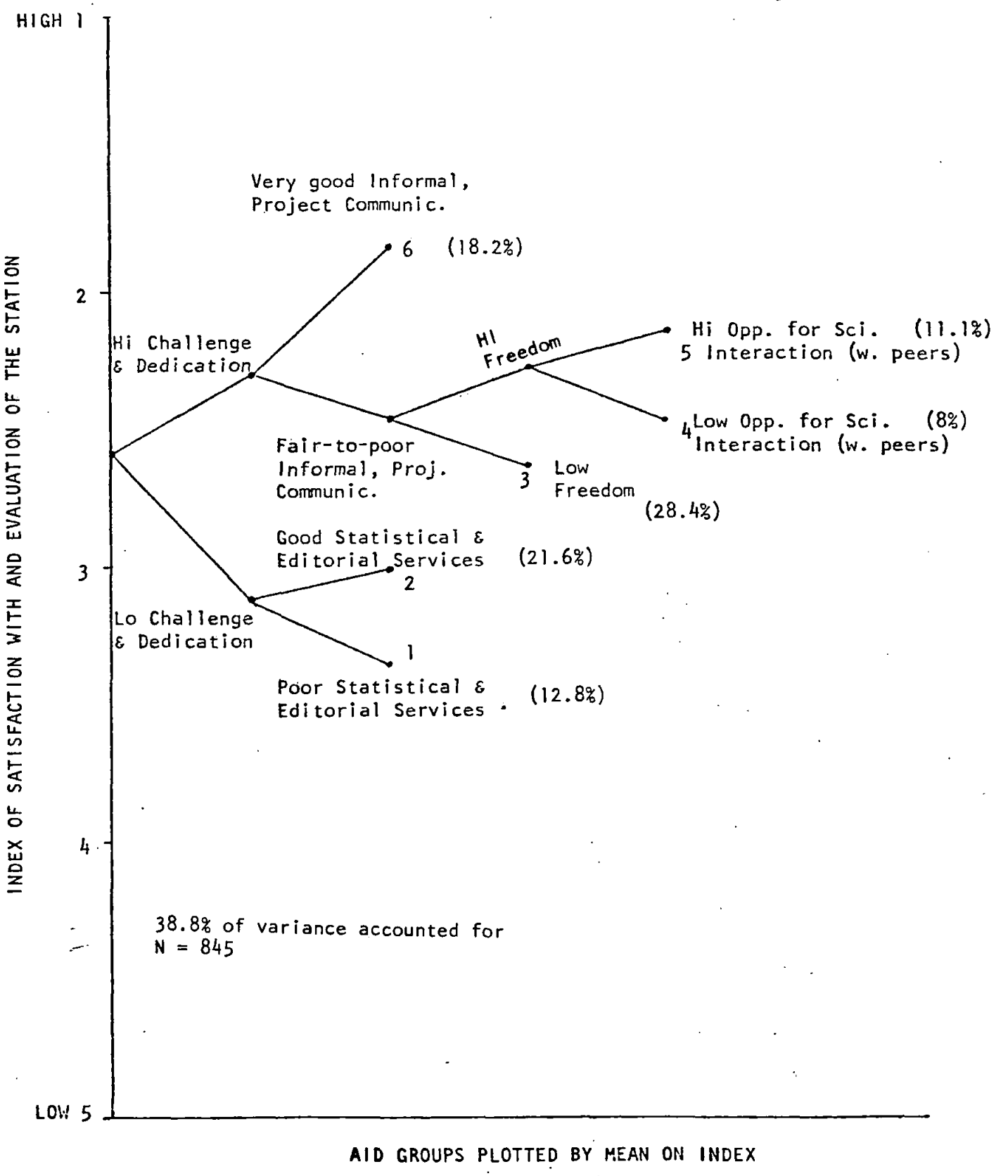
We can see that the most satisfied researchers in Forest Service are those who report high challenge and dedication and good interpersonal communication within projects. This is 18% of all researchers. If challenge and dedication are rated high, but informal communication are poor (a total of 47% fall in this group), satisfaction with the station is lower. For this group, freedom and opportunities for scientific interaction can overcome some of the satisfaction gap created by lower informal communication (creating groups 4 and 5 in the figure). At the bottom of station satisfaction, the 34% who fall here because of ratings of low challenge and dedication can be further divided on their ratings of statistical and editorial support services, a division which may be a meaningful reflection of station supports for researchers, or may be just a minor quirk of the analysis.

*Automatic Interaction Detection (AID) produces groups of cases by successive splits on dichotomous predictor variables so as to do the best possible job of accounting for variation on a continuous criterion variable. Two decision rules are applied repeatedly to make splits: (1) select the group with the largest error variance (all cases at the first step); (2) split the group in two on that predictor (not already used) which does the best job of accounting for variation in the selected group. The analysis stops when groups reach a specified minimum size, and/or when splits produce below-minimum explanation of error variance. See Sonquist and Morgan (1964).

FIGURE 6-7

AID Analysis of Satisfaction With and Evaluation of the Station

(Data from Scientists and PLs)



The interactions here are important. Assuming the researcher has feelings of high personal challenge in work, and sees high dedication to work among those around him, his own satisfaction with the station can be reduced if there are poorer opportunities for informal communication, freedom, or scientific interaction. It should be a good motivator to the system to improve informal communication in projects that almost half (47%) of all researchers are high in challenge and dedication but rate informal project communications as fair to poor, and more importantly, that this group is substantially below those who report good internal communication in terms of their satisfaction with the station.

AID Analysis of Job Satisfaction

In Figure 6-8 the picture changes somewhat, keeping challenge and dedication, but bringing in some of the job opportunity factors. Researchers most satisfied with their jobs are those who: see high challenge and dedication, and higher opportunities for personal career growth, and high opportunities for stable, well-paying jobs. This is only about 9% of all researchers, however. The largest group of researchers says challenge and dedication are high, as is growth opportunity, but opportunities for salary-stability are low (about 47%, putting together the further split on ratings of the scientific information environment, groups 4 and 5). At the bottom of job satisfaction are researchers for whom challenge and dedication, and growth opportunities are see as low.

It seems, then, that challenge and dedication and career growth opportunities are the most important predictors, and that they operate in a linear fashion (since growth opportunity further splits both of the challenge and dedication groups). If we stopped here, and looked at researchers who rate both of these factors high, we would have 57% of all researchers. This looks reasonably good, particularly since the subsequent splits do not make a great deal of difference in terms of lowering the satisfaction menas for the "low" split groups. On the other hand, low challenge and dedication seems to be the death knell for satisfaction here, just as it was in the case of satisfaction with the station.

CHALLENGE AND DEDICATION

The challenge and dedication factor which proves so important can be underscored by comments taken from the respondents themselves.

High Job or Station Satisfaction

"it [it is a] new, challenging assignment that will require (and allow) me to drop my professional obsolescence and take on new continuing education."

"I am proud to be associated with the scientists and staff here."

Low Job or Station Satisfaction

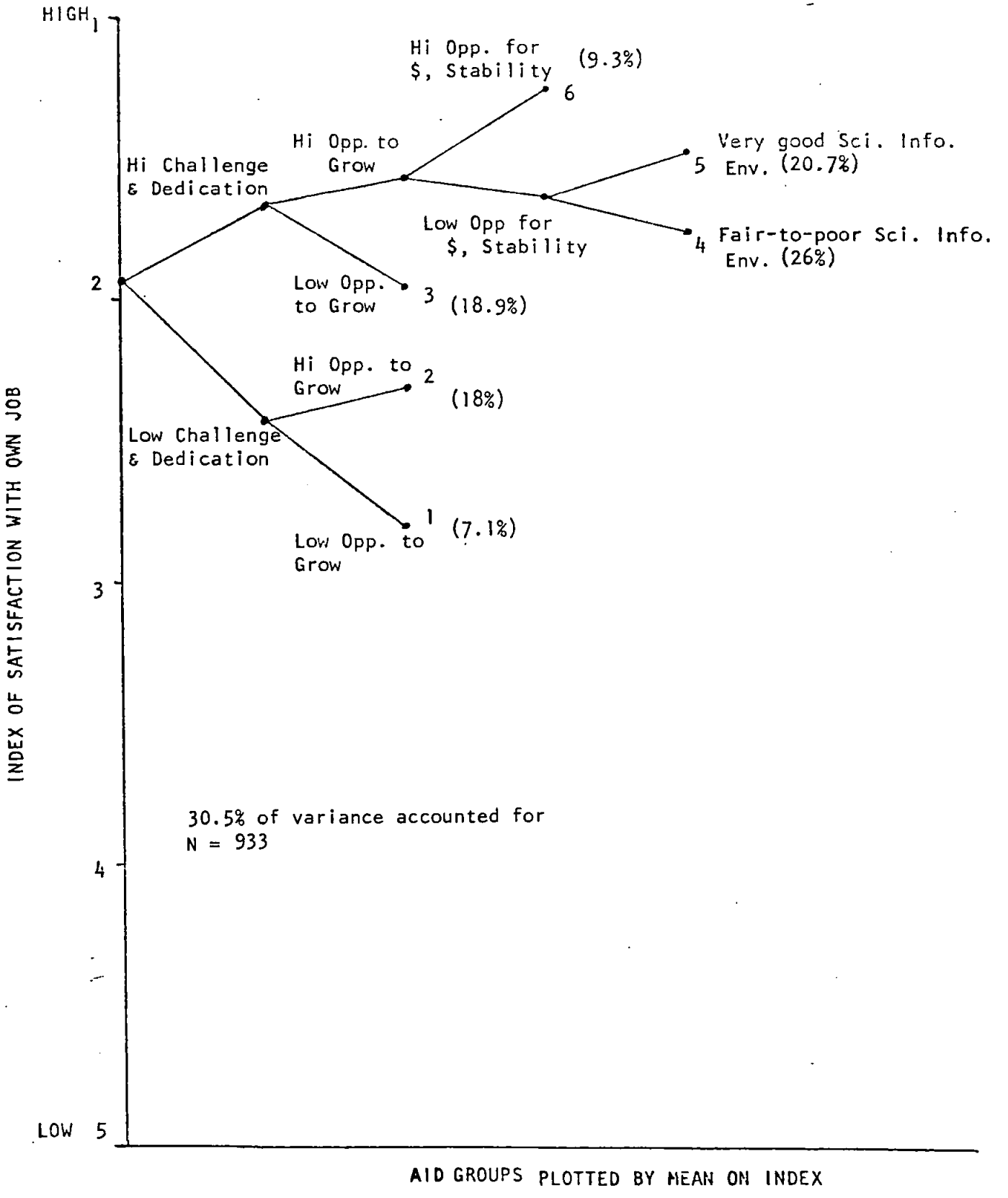
"Because of a lack of challenging work...I am looking for a position outside the FS."

"What is hardest is to keep my dedication, drive, and commitment 'up,' in the face of seriously limiting job conditions, primarily in the areas of budgeting and manpower!"

FIGURE 6-8

AID Analysis of Satisfaction With Own Job

(Data from Scientists and PLs)



High Job or Station Satisfaction, continued

"Most challenging to my career."

"I am very satisfied and like my job. I dedicated all my talent to work for the U.S. Government and FS."

Low Job or Station Satisfaction, continued

"Stimulation to dedicate oneself to the job is lacking -- the overall system does not provide the professional zeal one developed in graduate school. It is difficult to strive for excellence when it is unrecognized when achieved."

"The scientists by and large are dedicated to the work. There is an apparent lack of leadership and direction at the higher levels, therefore, few scientists are truly dedicated to the station. Most would like to be."

There are some valuable clues in these quotes about what makes a job and/or station a more challenging place to work, and one which evokes feelings of dedication to work among staff. Challenge is provided by newness, and with the stimulation received from colleagues. Dedication probably is earned by the organization in the way it treats the individual (for "organization" we might be tempted to substitute "leadership").

The work of Pelz and Andrews (1966) also highlights the role of "dedication" in predicting performance, something we will turn to in a later chapter. They also drew together some implications for factors which might improve dedication levels in an R&D lab:

> "Scientists who are given a genuine share in the decision-making process -- and by this we mean not simply left alone to pursue whatever they like, but brought into genuine policy decisions -- thereby become more involved in, and committed to, the technical goals that are being decided." ... The outstanding scientist is excited about his own work, but it also helps if other people are excited too. The supervisor who can see meaning and significance in the work his subordinates are doing thereby helps to reinforce their own enthusiasm. ...We suspect that a deliberate and mild amount of diversity in the work content can be one of several means to build a sense of personal involvement."

Thus, opportunities, stimuli, and interactions seem important relatives of challenge and dedication, at least from the written comments and the work of Pelz and Andrews.

The question is, then, what factors relate to the researcher's feelings of greater or lesser challenge and dedication. The comments and Pelz and Andrews' work give us some guidelines, and we have a ready predictor set in

some of the indices created from the questionnaire: First, we have the assessment of the importance of peers, own ideas, supervisors, and clients in stimulating researchers to perform well; second are the ratings of how much opportunity researchers saw for achieving various factors in their jobs (things like personal career growth, status, salary and job stability, interactions with peers, working on important problems). Finally, we covered personal interactions by adding the index of interpersonal/informal communication within the station and unit. Preliminary analyses led to the removal of some of these measures as unimportant, before we got to the analyses shown in Figure 6-9. The results are presented in what will become the first step of our overall predictive model.* Let's begin with a look at the results for Scientists, and then go on to the PLs.

For Scientists, it is clear that opportunity for personal career growth is the most important predictor of challenge and dedication, followed by access to a good interpersonal communication network within the station and work unit. Stimulus provided by the supervisor also contributes a little.

For PLs, the interpersonal communication network the most important predictor, followed by growth opportunities, and of lesser importance, stimulus received from colleagues inside or outside the station.

So, both Scientists and PLs appear to need to feel that they can grow in their careers and have linkages to important groups. Scientists and PLs are similar in that the informal communications network in the station and unit provides much of this linkage. They are different in that Scientists seem to get their important linkages closer to home (the supervisor is somewhat important), while PLs are a bit more "cosmopolitan," in stressing "colleague" relationships either in or out of the station.

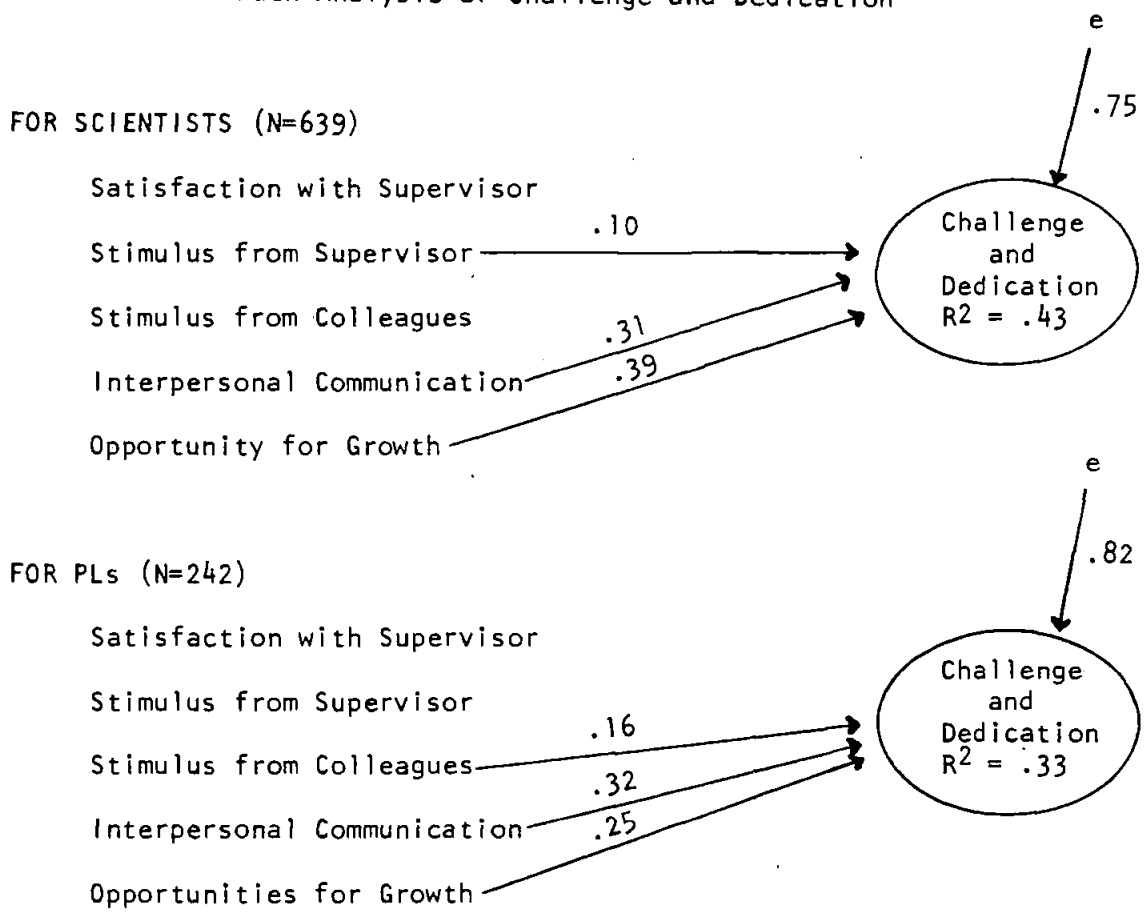
One further note is needed on informal networks: for Scientists this measure appears to account for correlations between challenge and dedication and the supervision items and stimulation received from colleagues and chiefs. In the previous chapter we saw that Scientists are more satisfied with supervisors who give interpersonal support, facilitate the job, and are open to interactions. Since this must happen through the interpersonal/informal communications within the work group, we might speculate that supervisors are more important in increasing challenge and dedication than the analysis here indicates -- i.e., that they are important in keeping informal communication flowing. Turning this around, supervisors <u>may be too</u> committed to using <u>only</u> formal communication channels.

The analyses do not account for all of the measure of challenge and dedication, however, as the moderate variance-accounted-for figures attest (43% for Scientists, 33% for PLs). From analyses not shown, moreover, we find that what is "left" in challenge and dedication after the interaction and opportunity

*We return to path analysis here, although it ignores statistical interactions, since we are beginning to build the overall predictive model which is too complex for the AID approach.

FIGURE 6-9

Path Analysis of Challenge and Dedication



measures are controlled out still predicts satisfaction with station and job in just the way it did earlier (i.e., in all analyses except job satisfaction for PLs), but its predictive power is lowered considerably. So, there are differences in challenge and dedication not accounted for by perceived growth opportunities and potentials for interaction which still relate to differences in satisfactions with station and job. What the challenge and dedication "remainder" might relate to is a mystery, but some of it may be due to individual variation in interest in the work and where it is done, particular motives, and so on.

In summary, feelings of challenge in and dedication to the work are the strongest predictors of satisfactions with station and job (except for job satisfaction of PLs); and some, though not all, of challenge and dedication can be explained by perceived opportunities for personal career growth and the researcher's ability to interact with important groups. The important groups in regard to challenge and dedication for Scientists are close at hand (the interpersonal network and the supervisor), while PLs are more extended (the interpersonal network and "colleague" relationships in or out of the station).

THE PREDICTIVE MODEL FOR SATISFACTION

The analyses we have discussed so far provide some clues for the structure of the overall predictive model we seek to develop. We have seen that there are several factors which predict the measure of challenge and dedication, and that this, plus other indicators, relates to the two kinds of satisfactions. We will use these relationships in the path analyses to come. In testing the model we have included all of the predictors which our previous analyses showed to be important, and have ordered the model in the way which fits best with both theory and our experiences with the Forest Service.

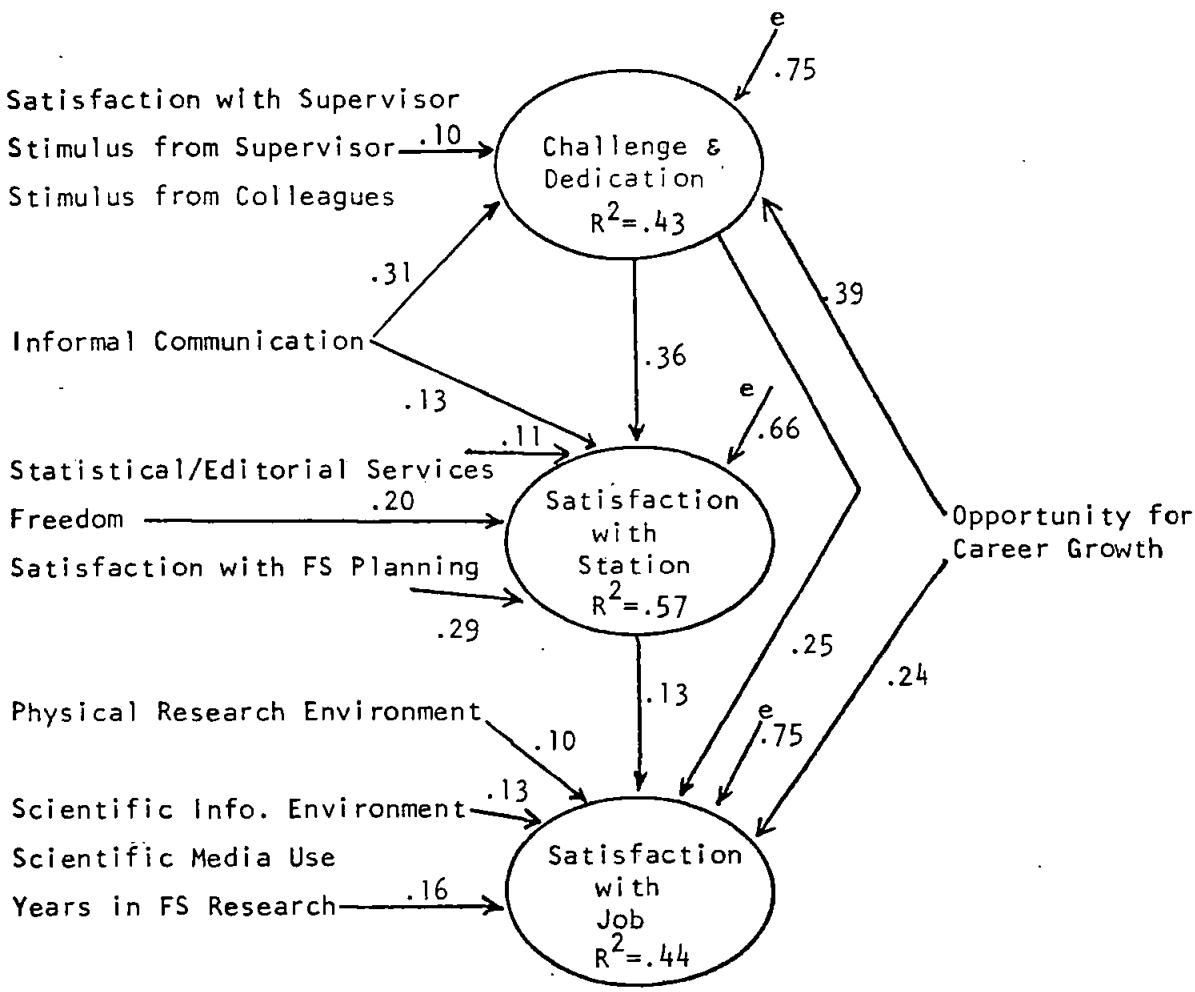
We do find that there are enough differences between Scientists and PLs that we need to produce different analyses for each. Let's begin, then, with the model for Scientists, in which the individual and organizational opinion factors are used to predict satisfactions. The results are given in Figure 6-10. The data for challenge and Dedication we have seen earlier: (challenge and dedication is higher when researchers report greater growth opportunities, and better communication linkages.

For Scientists, challenge and dedication is the strongest predictor of satisfaction with the station, as we've seen earlier. Those who are more satisfied with Forest Service planning are more satisfied with the station, and freedom, informal communication, and services make a difference, too. Note that informal communication affects station satisfaction directly, even though it also is a strong predictor of challenge and dedication, which in turn relates to satisfaction. So, if we summed up the direct and indirect effects of informal communication, the power of this measure would be even greater.

FIGURE 6-10

Path Analysis of Organizational Factors

(FOR SCIENTISTS)



Moving on to look at satisfaction with the Scientist's own job, we find that challenge and dedication and opportunities for career growth are the strongest predictors. The physical and informational environments also help a little. Experience in Forest Service research probably relates to job satisfaction through selective retention of staff -- Scientists who have been employed longer are probably those happy enough to stay. Finally, satisfaction with the station relates to satisfaction with the job, though it is not a particularly important predictor.

Turning to PLs (in Figure 6-11), satisfaction with Forest Service planning replaces challenge and dedication as the most important predictor of satisfaction with the station, and the physical environment becomes significant, though of little importance. Perhaps the PL is reacting to the station more in terms of how it functions as a goal-reaching organization (through planning) than in terms of how it provides a challenging environment; this fits with the data showing PLs to be more self-starting, providng more of their own challenge.

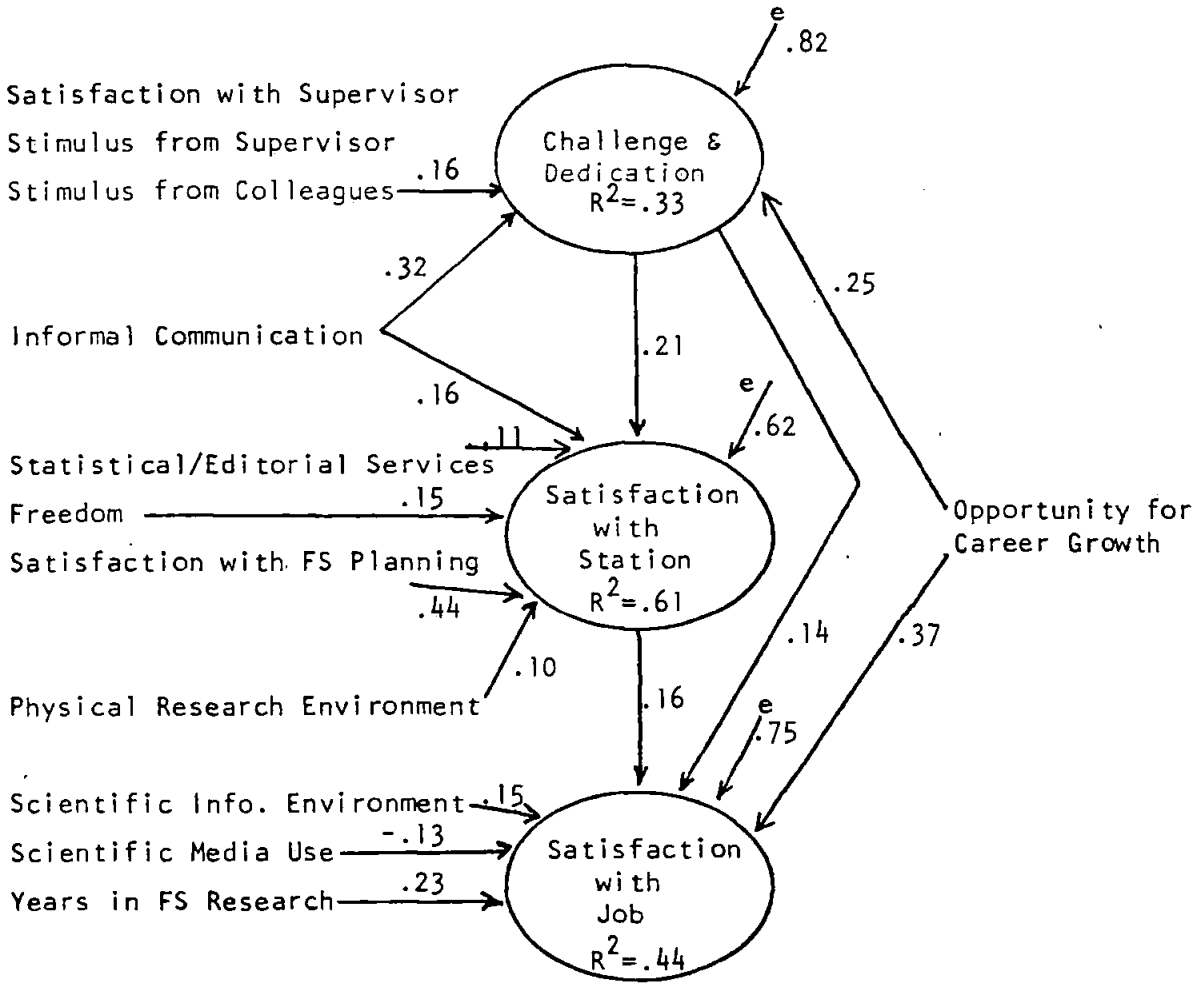
PLs more satisfied with their jobs are those who see more opportunities for career growth, have more experience in Forest Service research, better scientific information exchange environments, and report greater challenge and dedication and more satisfaction with their station. Following the PL trend to be more "internally motivated" growth opportunities are more important, and challenge and dedication less so, for PLs as compared with Scientists. The experience measure probably indicates, again, that more satisfied people stay in the organization longer.

One of the interesting findings for both groups is that satisfactions with the station and the job are relatively independent. Part of this may be due to the fact that challenge and dedication predicts both types of satisfaction, and controls the predictive power of station satisfaction when we analyze satisfaction with the job. Another way of looking at this is, however, that they two kinds of satisfaction are distinct in large part, but that both have at least the one common predictive element: perceptions of a challenging environment in which researchers are dedicated to work.

In summary, then, the watchwords for satisfaction seem to be these: (1) a challenging environment evoking feelings of dedication, (2) open informal information about work and the organization (which helps feelings of challenge and dedication, too), (3) room for personal career growth, and (4) more minor facilitating effects of the physical, support, and informational environments. The satisfying research environment, therefore, is a very human one.

FIGURE 6-11

Path Analysis of Organizational Factors
(FOR PROJECT LEADERS)



CHAPTER 7

SCIENTIFIC AND APPLIED CONTRIBUTION

READER'S GUIDE:

This is one of the key chapters in the report dealing with the important contribution criteria. The analyses are a bit complex, though, as we compare results of several methodologies. The best advice we can give is to work through the chapter concentrating on the discussions and summaries. The diagrams in the analysis section are almost self-explanatory, too.

CHAPTER SUMMARY:

We are attempting to understand the kinds of contributions Forest Service researchers make to science and/or applications. "Contribution" in either area is measured by combining appropriate written outputs, meetings attended, and opinions about past and potential contribution.

The data show that absolute levels of contribution are higher in the scientific area than in the applied. This is particularly true for written outputs. Researchers seem to be more active in reaching applied users through meetings than through print channels. Contribution in both areas is higher for PLs than for Scientists. ADs, however, attend as many scientific meetings as do the PLs -- a situation which may hinder information flow.

There are some differences between Scientists and PLs in terms of factors which account for levels of scientific contribution (PLs may be less dependent on organizational conditions).

- personal styles of work -- a more "complex" problem-solving style (for both groups), and greater experience and education (for Scientists)
- an open, "alive" information flow environment
- a challenging, dedication-creating organizational setting (for Scientists)

The relations between scientific contribution and satisfactions with the job and the station are complex: on the surface, more satisfied researchers (particularly Scientists) contribute more, but if we make "all other things equal" in terms of factors predicting both satisfactions and contribution, then higher contributors among Scientists are a bit less satisfied.

For all researchers, three things are important in reaching high levels of applied contribution:

- some scientific product to disseminate (i.e., higher scientific contribution -- there is a positive relation between the two)
- a stimulus from client problems
- organizational supports for application work (linking with clients)

The chapter ends with some comments about ways managers might try to improve contribution levels. A lot of this, particularly for applied contribution, relates to organizational support expressed through the reward system -- this is covered in the next chapter.

INTRODUCTION

Contribution is the name of the game in science. It is what individual researchers strive to achieve, and what managers evaluate in judging the value of the individual. The difficulty comes, however, when we try to decide just what we mean by "contribution."

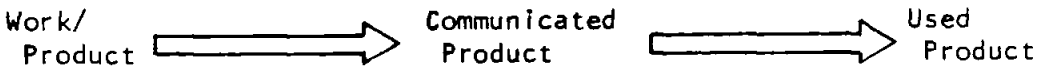
An explication of this term is not mere academic exercise. Debate about what researchers should be doing, and how to evaluate work, is an ongoing and crucial discussion in many areas of science -- and the Forest Service is no exception. In fact, we suspect that debate is stronger here in academic environments, because the mission-orientation of the Forest Service increases external and internal demands for accountability, expansion of knowledge, and utility of research in solving real problems.

The view we will take here is that there is no contribution inherent in new knowledge; there is only contribution to some area of the use of knowledge.* In "traditional" academic-oriented science, the most valued contribution is to the body of theory and findings within the scientific discipline or field. The production and communication systems of discipline-oriented science are geared to maximize this kind of contribution. In mission-oriented science, the basic process of discovery remains the same (the "scientific method"), but the motivation for research shifts from the investigator's own curiosity about the world to that curiosity coupled with the needs of some non-scientific person or group. Also, the contribution is to these same non-scientists and the solution of their real problems. We will maintain that these two approaches to contribution are not antithetical, and that it is possible to contribute to both areas with the same "chunk" of knowledge.

In this approach to contribution, then, the crucial distinction is the group or area which becomes the audience for the knowledge. The communication system of science becomes the handle necessary for analysis of contribution. The scientist is known less for his work than for the communicated products of his work. The difficulty here is that of deciding where in the communication process contribution should be measured; Figure 7-1 shows the possibility.

FIGURE 7-1

Points for Measuring Contributions



*Right away we narrow the scope of contribution to be within the area of knowledge, eliminating administration, group facilitation, etc. These areas of contribution are, of course, vital to the organization, but we prefer to see them as facilitators of the important end product of knowledge.

Each of the three forms of the "product" may be either documented (usually counted) or evaluated. Each form of the product has aspects more or less amenable to documentation or evaluation. The trick is always to find those aspects which give a valid and reliable measure of contribution.

Our approach is that the best point at which to measure contribution is the furthest measurable one along the chain in Figure -1. Ideally, this would be the point of use of the knowledge. Moreover, we contend that evaluations, made by knowledgeable people, are usually more accurate than after-the-fact documentation. However, as the assessment of contribution gets more accurate the further down the chain we measure, the act of measurement also becomes increasingly difficult: the researchers are known, their communicated products are usually known, but their audience and uses made are dispersed and varied.

Let us look briefly at some of the alternative measures of contribution at each of the three product levels (see Figure 7-2).

Each level of the chain presents difficulties: the first because of its dependence on possibly biased self-reports; the communicated step because of possibly fugitive messages and the tenuous (though generally positive) link between quantity and quality; and the use step because of unknown users and external barriers which may inhibit use of the work (particularly in the area of use by non-scientists -- e.g., policy, resource, or change-resisting constraints).

Ideally, we would like to measure contributions at all three levels, looking for convergences in the data from each. Practically, in this study at least, we have been constrained by budgets and lack of access to applied clients from attempting any assessment at the third level. Further, the constraints limited the possibility of doing much in the way of collecting assessments from other individuals. We are forced to rely on self-reported data on questionnaires collected from the researchers themselves. All we can do beyond measuring the number of written products and attendances at meetings, etc., is to ask the researcher to evaluate the impact his work has/will have on his discipline and on applications.

The measures we finally settled on, for what we will call scientific and applied contribution, each give equal weight to three areas:

1. opinion of researcher about his contribution
2. events attended
3. written products

In the case of scientific contribution these are geared toward the scientific discipline and audience; in the case of applied, toward uses by non-scientists. The details of the measures are given in Appendix C.

In Appendix B we also compared our measures with ratings made by ADs in two stations, and with data on supervisors' annual performance reviews and evaluation panel results taken from the station files. The comparisons showed that:

FIGURE 7-2

Alternative Measures of Contributions

	Contribution to Discipline	Contribution to Applications of Science
Work Product	Scientists' evaluations of own past and potential impact Ratings by colleagues and chiefs who know researcher personally	Scientists' evaluations of own past and potential impact Ratings by clients who know the researcher
Communicated Product	Numbers of papers, articles, books, etc. Ratings by scientists of quality of written products Number of verbal presentations of work to scientists	Number of application-oriented papers, manuals, patents, etc. Ratings of useful quality of written product made by clients Number of verbal presentations to clients Size of scientist's and client group (circle of influence
Used Product	Extent work is visible in teaching in field Ratings by peers of impact scientist has made Scientific honors received Citation counts in works of peers*	Extent work/processes are visible in applications Use of materials required to implement scient's work Ratings by clients of impact

*It is questionable whether citation counts truly assess impact (not all citations an author makes are relevant or positively valued -- one cites the author, one is attacking). Moreover, citations only assess impact on other publishing authors.

(1) our measures of scientific and applied contribution correlate about .50 with each other

(2) our measures correlate moderately with ADs' ratings, and a bit less with the supervisors' and panel data

(3) there is not very good covergence among the AD, supervisor, and panel data about the researcher's contributions

The conclusion of the comparison must be that there is only modest agreement among any of the measures of contributions, and our questionnaire data at least look no worse than the information now collected to evaluate Forest Service researchers.

We also created a five-fold classification of researchers based on the high-low combinations of scientific and applied contribution (with a "moderate on both" group added). This grouping proved very useful in feedback, and will be valuable here, as well.

DISCIPLINE DIFFERENCES IN CONTRIBUTION

Appendix C contains an analysis of discipline differences in Forest Service research. One of the most interesting shows contribution differences among five discipline groups (the analysis is shown in Appendix Table C-3). Researchers in the Natural Sciences are highest in scientfic contribution, and Physical Scientists lowest. On applied contribution, the Social Scientists are highest, with Physical Scientists again lowest. We cannot say whether these differences result from differing work, norms, or ties to the organization. Most of the discipline differences in scientific contribution can be explained if we control for the basic-applied nature of work done, feelings of challenge and dedication, stimuli from own work, ideas and curiosity, and information gathering. Applied contribution differences among disciplines are almost explained by differences in scientific contribution, the basic-applied work dimension, challenge and dedication, client stimuli received and organizational support for linking with clients. (Again, see Appendix C for more detail.) Even with these controls the Social Scientists are still higher on the applied contribution measure.

We adjusted the contribution measures to remove effects of discipline: even though the differences are of interest by themselves, we did not want them clouding the analyses to follow.

LEVELS OF CONTRIBUTION

Above and beyond the use of contribution indices, we need to get some feel for how much is actually getting done, and getting transmitted to its scientific or applied users. Table 7-1 shows the distributions on the component items from the two contribution measures, and provides the basic data for all discussions in this section. The typical finding in research on scientific contributions is that written productivity follows a frequency

TABLE 7-1

Levels of Contribution

Number of Authorships/Coauthorships**	SCIENTISTS					PROJECT LEADERS				
A. Scientific	None	1-2	3-5	6-10	>10	None	1-2	3-5	6-10	>10
Books	96%	4	*			91%	9	*		
Book Chapters	84	14	2	*	*	70	23	6		*
Abstracts, Reviews	73	17	8	2	*	65	17	13	4	*
Journal Articles	22	29	27	14	8	11	24	34	19	12
Scientific Station Publications	25	36	30	7	2	20	31	37	8	4
Meeting/Symposia papers	21	38	28	9	3	6	25	37	22	11
B. Applied										
Popularized Articles	63	28	7	1	*	40	36	17	4	2
"How to do it" Station Publications	78	18	3	*		64	27	8	1	
Number of Events Attended* **										
A. Scientific-Technical										
Regional-National Meetings	22	54	21	3	*	8	45	39	8	1
International Meetings	77	21	1	*		58	36	5	*	
Workshops, Seminars	27	45	18	6	4	10	47	30	8	6
B. Researcher-User Events										
Workshops, Seminars	41	40	14	3	*	16	51	25	6	3
Public Meetings, Hearings	75	16	8	*	1	51	29	15	4	2
User Interest Group Meetings	46	31	16	4	3	26	31	29	9	4
Planning Meetings in Public or Private Sector	64	22	11	1	*	33	36	22	5	3
Opinions About Contribution**	Statement Applies				Opposite Applies	Statement Applies				Opposite Applies
A. Scientific										
Unit has made Outstanding Contribution to Field	26	36	29	6	3	36	43	16	3	1
Present Work Likely to Make Very Substantial Contribution	21	36	27	11	5	27	45	21	5	1
B. Applied										
All of Unit's Results Find Follow-up or Practical Applic.	9	43	37	10	*	12	52	30	6	*
Present Work Likely to Make Very Substantial Contribution	29	43	18	7	3	46	37	13	3	*

* Less than one percent.
** In last five years.
*** In last two years.
**** See Appendix A for format of the opinion questions.

distribution in which low output is most frequent, tailing of to fewer and fewer scientists producing increasingly larger numbers of outputs. Many of the distributions here show this same effect. The more difficult scientific outputs, like books and book chapters, are almost never produced. "None" in the past two years is a very frequent response for the applied outputs -- either written or in meetings. There are also differences between PLs and Scientists, with the PLs writing or attending more on every dimension we measured.

Rather than examining these figures closely, we took a flight of fancy to try to estimate yearly outputs of researchers on some of the more interesting and important dimensions. After several assumptions about what the scales mean,* we arrived at the very rough figures in Table 7-2. We would guess that about 3,130 journal authorships have been produced by Forest Service researchers in the past five years (2,110 by the 693 Scientists and 1,020 by the 251 PLs). The yearly production (authorships and co-authorships) of journal articles would then be about 630 in total (425 from Scientists, 205 from PLs). Finally, the average Scientist would then be producing six-tenths of a journal authorship every year (or one every 1.7 years), and the average PL about eight-tenths of an authorship per year (or one every 1.2 years). Of course, since there are many multiple authorships the total number of article would be lower than these figures. The scientific article is the most frequent output of Scientists, and almost as high as the meeting/symposium paper for PLs. (Papers are probably higher for PLs because they attend more meetings, as we will see, and often must write a paper in order to go.)

The applications-oriented publications clearly take the back seat; if the "average" Scientist gets his name on a scientific station publication about once every 2.3 years, his name shows up on an applied "how to do it" station publication only once in about every 14 years, and on a popularized article about every 7 years. The rate for PLs is roughly double that of Scientists for these applied media.

Meeting attendance figures show that the average Scientist gets to a regional/national scientific meeting every 1.2 years, and the PL one every 9 months or so. Workshop attendance is a bit higher for Scientists, though (about one per year). Note, though that (in Table 7-1) about one in five Scientists report no such attendance in the last five years -- perhaps supervisors should check the files and lists of up-coming meetings to identify these people and encourage them to get to some relevant meetings. One thing which does not show up in these data is the meeting attendance rate for ADs, which is almost identical to that of PLs. There seems to be a

*The levels of output were aggregated into categories in the questionnaire, so we started with the following assumption about the meaning of "X" number produced in the last "n" years:

A response of	Probably means
NONE	NONE
1-2	1.25
3-5	3.5
6-10	7
10+	10

Next we recoded the data according to these values, and divided by the number of years involved (five for written products and two for events attended) before computing the yearly average estimates in Table 7-2.

TABLE 7-2

Estimates of Yearly Contribution

	Average Number Per Year	
	Scientists (692)	PLs (251)
No Authorships, Coauthorships		
A. Scientific		
Books	.01	.02
Book Chapters	.05	.11
Abstracts, Reviews	.14	.20
Journal Articles	.61	.81
Scientific Station Publications	.43	.53
Meeting/Symposia Papers	.49	.84
B. Applied		
Popularized Articles	.14	.31
"How to do it" Station Publications	.07	.14
Number of Events Attended		
A. Scientific-Technical		
Regional-National Meetings	.83	1.28
International Meetings	.16	.33
Workshops, Seminars	1.02	1.37
B. Researcher-User Events		
Workshops, Seminars	.64	1.10
Public Meetings, Hearings	.31	.64
User Interest Group Meetings	.77	1.24
Planning Meetings in Public or Private Sector	.42	.94

"show the flag" notion in deciding who goes to meetings. Any tendency to let the AD go to represent the station negates the true information giving and getting functions of scientific meetings. The data for international meetings (over 3/4 of Scientists and 1/2 of PLs reporting no attendance) show the effects of government restrictions on international travel. We have heard many complaints about these restrictions from researchers, particularly from the Northern tier of states regarding Canadian meetings -- ecology does not respect national borders. Perhaps this restriction could be eased categorically at least for annual meetings of relevant professional associations.* Special attention seems to be required, also, for smaller groups interested in problems of vital interest to researchers from both sides of the border.

Researcher-user events occur, happily, more often than applied publications, with workshops and seminars for users being the most frequent involvement for both Scientists (one every 1.6 years) and PLs (one every 11 months). Still, about 40% of Scientists and 16% of PLs have attended none of these most popular meetings in the past two years.

The final section here involves the opinions of researchers about their levels of contribution to science and applications. The distributions and means for these items are given at the bottom of Table 7-1.** PLs rate their present work and their unit's past contributions higher on both scientific and applied dimensions than do the Scientists. It is also interesting that both groups rate their present work more positively in terms of its potential for application than for its potential contribution to scientific knowledge. But, for past work of the unit, scientific contributions are rated more positively than the applied. Perhaps this indicates a perception of researchers that there is a change toward applications underway, and/or a tendency for the actual (past) use of work to be less than the application potential researchers see in it.

We cannot claim that any of these data are particularly accurate assessments of levels of contribution, even though the output and meeting figures seem to be reasonable, if nothing else. Of greater interest is an analysis of who contributes more or less -- we will turn to that analysis next.

WHO CONTRIBUTES THE MOST -- AND THE LEAST?

The place to begin our analysis of contribution is with more "A.I.D." analyses. As we did in analyzing satisfactions, predictors used were those which showed up as important in early regression analysis.

---

*The associations would seem to be in a double bind if they have a Canadian membership: on one hand there is the pressure to meet in Canada periodically; on the other, government-employed researchers won't be there.

**Lower scores represent more positive responses here: 1.0 = "A applies," where statement "A" is the wording listed in the table; 5.0 = "B applies," where statement "B" was a polar opposite statement.

Scientific Contribution

We begin with Figure 7-3. These data show strong differences in predictors of scientific contribution between Scientists and PLs, and the job-role of the individual makes the most difference among any of the predictors (i.e., the first split is on job role): PLs are higher on the scientific contribution measure than are Scientists.

Among PLs, we see the importance for contribution of the individual factors of being a "self-starter" (i.e., getting stimulus to perform well from one's own work, ideas, etc.) and preferring to work on many aspects of problems at a time (the notion of high "cognitive complexity -- see Schreyer, 1974). The largest group of PLs is found in the highest contribution category: that is, PLs high on internal stimulation and cognitive complexity. PLs who are low on either of these factors drop down toward the overall mean (zero) for all researchers.

The results for Scientists show none of the effects of the individual predictors important for PLs; with the exception of educational level, all of the important predictors relate to conditions within the organization, not within the researcher himself. Ph.D. Scientists more active in collaborative research who report good scientific information environments contribute the most, at a level almost as high as the top group of PLs. This group is only five percent of all researchers, however. For the non-Ph.D. Scientist, collaborative research activity does not make a difference in contribution, but feelings of challenge and dedication do. The scientific information environment still is important for the non-Ph.D. group. The 11% of all researchers who are non-doctorate Scientists with poor scientific information environments contribute the least (about two standard deviations below the top group of PLs).

These results highlight the importance to the research organization of maintaining open information environments, and the challenge of work or collaborative assignments, for the Scientists' scientific contribution. It appears that PLs are less dependent on the organizational factors -- they were probably selected for their jobs on the basis of their ability to be self-starting people (for whom the organization may not be too important).

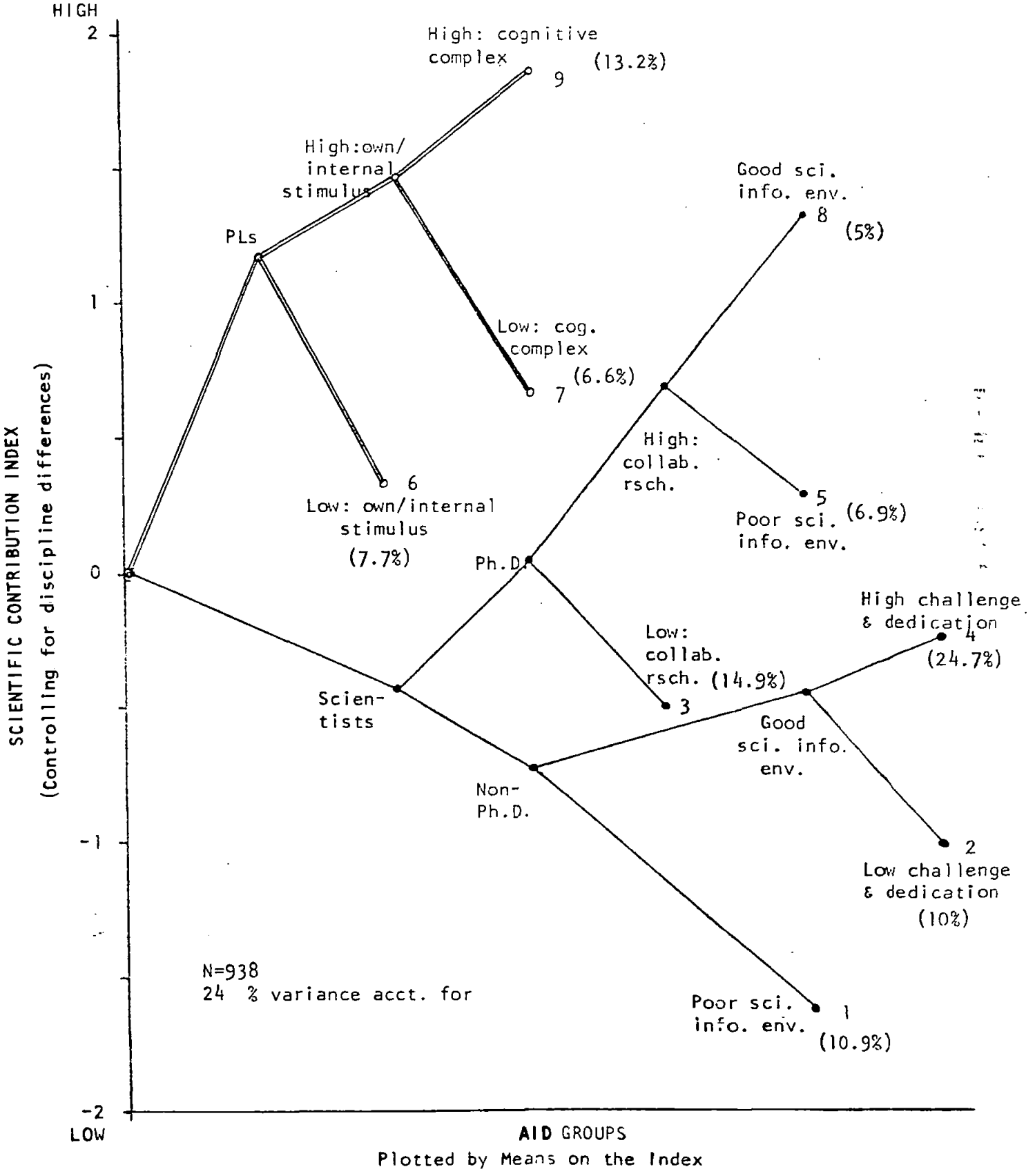
The written comments we have about scientific communication highlight the importance of this part of the environment -- particularly that which deals with getting knowledge disseminated. Let us divide the comments according to the researcher's level of scientific contribution:

Scientific Contribution

LOW	HIGH
I don't care for the emphasis placed on publications in evaluating scientific accomplishment.	Something should be done about the time it takes to publish a Station research paper.

FIGURE 7-3

AID Analysis of the Scientific Contribution Index
(Data from Scientists and PLs)



LOW	HIGH
When it takes 2 years to complete a study, 1 year to write it and get it reviewed, and 7 to 12 months to get it in print, you can't stock up much of a record for promotion purposes.	[eliminate] layers of in-service reviewers.
We need short communications that get results out to users years before they normally get out.	Because of the backlog of material in American journals, it is often discouraging to publish in some fields outside of Forest Service outlets.
...speed up publications...	I manage to read enough journal articles.
Only through correspondence we are able to keep up [with peers] ...shortage of travel funds...	FTS telephone service brings everyone within easy reach.

A scan through the comments these selections represent shows a concern for problems in publishing expressed by both high and low contributors -- either problems from station policies and procedures or lag times outside the station. Low contributors express a distaste for the importance of publishing. Only high contributors mention good information inputs with any frequency.

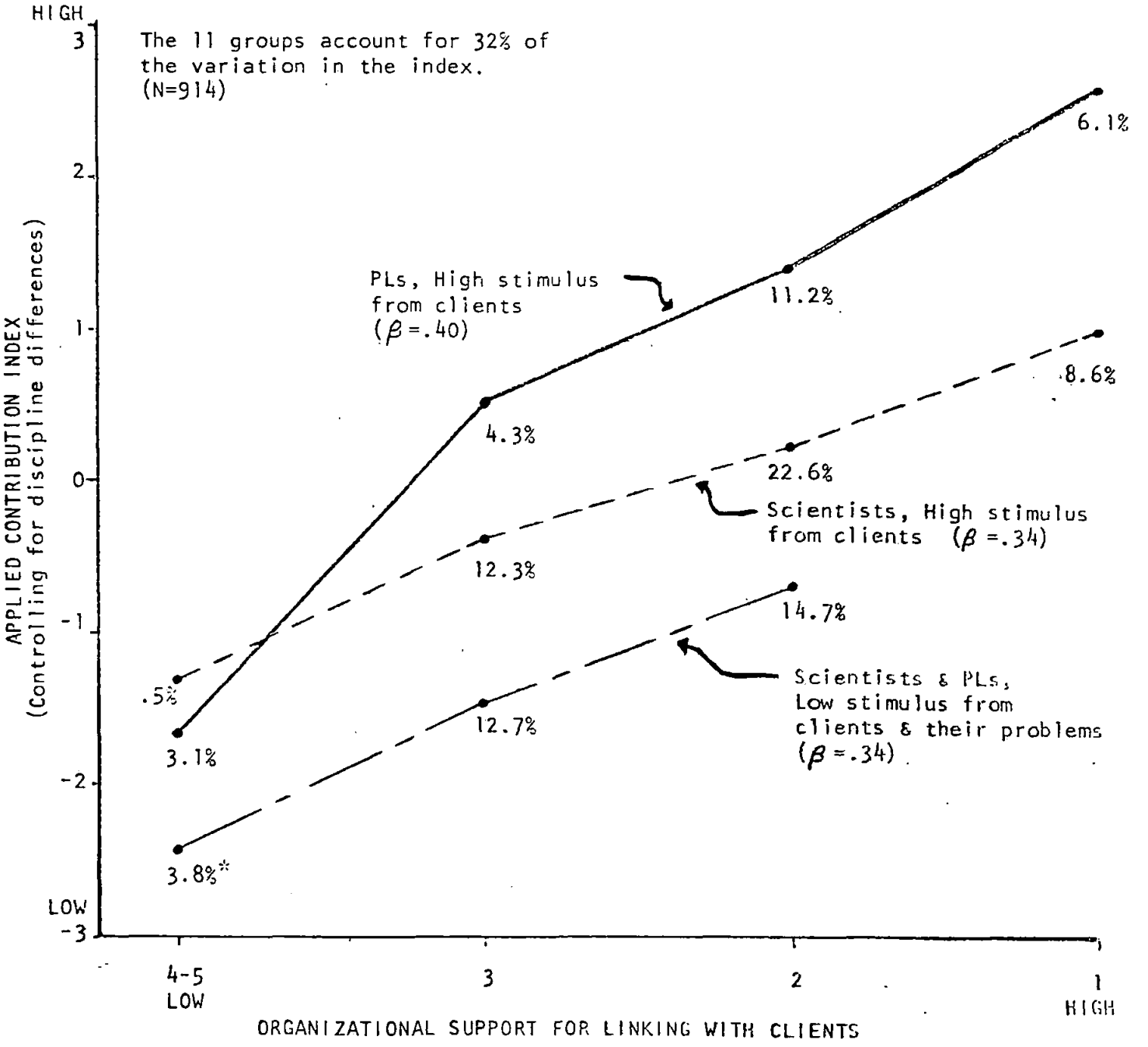
Applied Contribution

The AID analysis of this index shows a much simpler model, one we therefore could re-work in the slightly different format of Figure 7-4. The amount of support the researcher sees from the station for linking with clients makes the most difference in applied contribution -- so much of a difference that each of the levels on this measure kept splitting apart in analysis. We have therefore plotted applied contribution according to perceived linkage support. The three plots represent other groupings the analysis created. The effect of support is positive for all three groups, though a bit stronger for PLs who are highly stimulated by client problems. The organizational supports seem to have effects (pushing?) on researchers who are not stimulated by client problems, but this group is lowest in applied contribution no matter what the level of support. The crucial chemistry, then, seems to be the knowledge of client problems, stimulating and motivating the researcher to perform well, coupled with the permission and assistance the station provides for application work. The question remains as to how to provide both parts of this mixture. Researchers need to be challenged by real world problems and have a desire to contribute to their solution. It is hard to think about how to reorient a researcher who is not -- except through changes in the reward system, which relates back to organizational

FIGURE 7-4

Summary of the AID Analysis of the Applied Contribution Index

(Data from Scientists and PLs)



*Percent of all Scientists and PLs.

supports. Rather than attempting to get researchers to be more client-stimulated, we would suggest that supports be provided in the form of:

(1) Legitimacy given to applied work.
(2) Leadership and support staff skills in the techniques of getting applications.
(3) A climate of active seeking of applications, rather than the passive "OK if you want to."
(4) Rewards rationally and equitably given.

The whole reward question is so important that we will devote a chapter to it later.

CONTRIBUTION IN THE PREDICTIVE MODEL

Here we will continue building the path model we introduced in dealing with challenge and dedication and satisfactions. The model we have developed says that scientific contribution should be predicted by satisfactions, challenge and dedication, and perceived opportunities for career growth, plus the information-processing, stimulus, and collaborative research activity measure we have seen to be important in this chapter. In addition, education and experience should be predictors of contribution as well.

We think applied contribution should be predicted by scientific contribution (the need to produce knowledge before getting it put to use). In addition, the linkage support and client stimulus measures should be strong predictors. As always, we will need to test the model separately for Scientists and PLs.

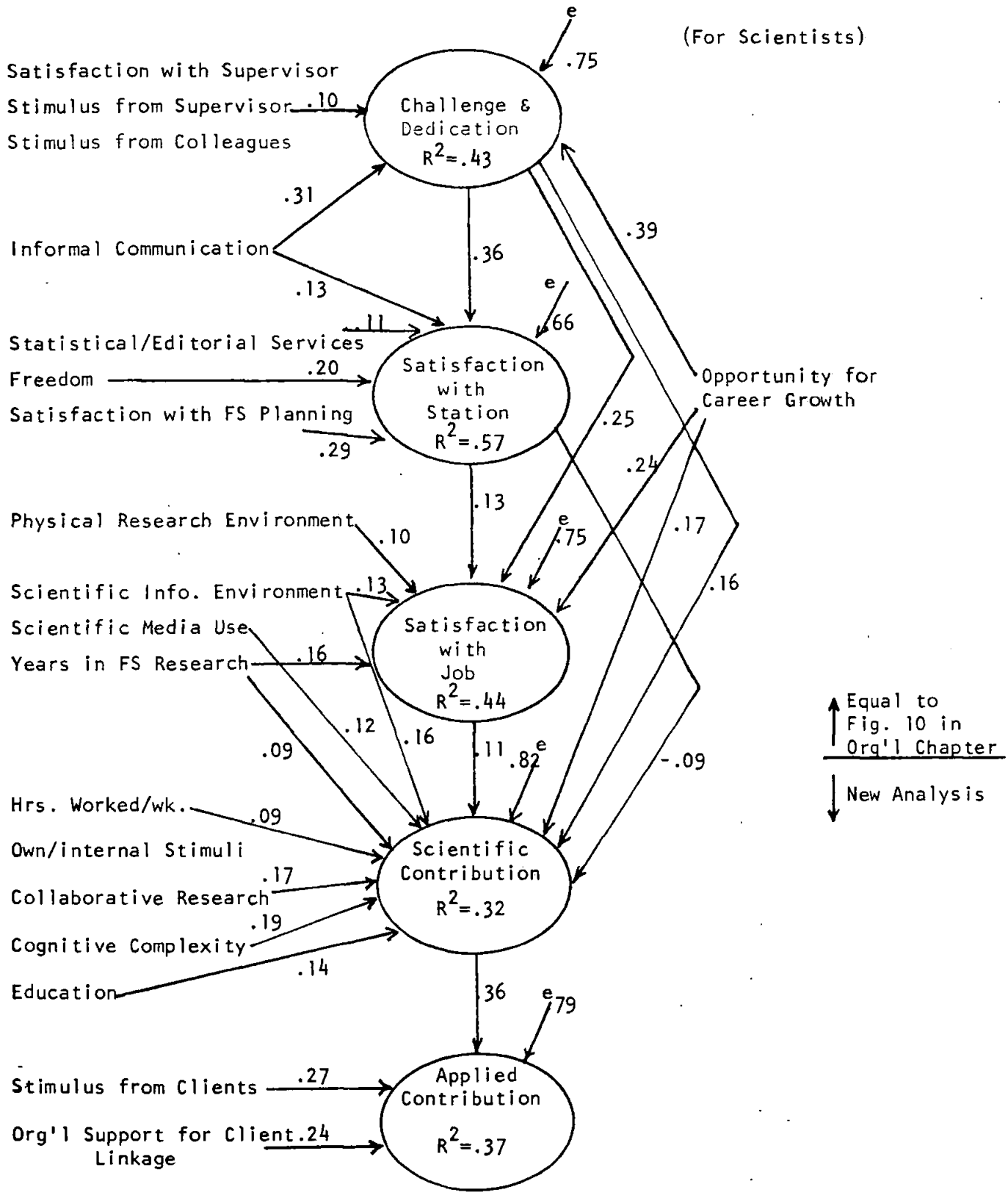
Let us take a look at the analysis of scientific contribution first, then go on th applied contribution.

Scientific Contribution: The results for Scientists are given in Figure 7-5. All of the predictors which made a difference in the A.I.D. analysis continue to be important here: Scientists higher in scientific contribution have better scientific information environments, are more active in collaborative research, see greater challenge and dedication. Beyond this, perceived opportunities for growth and cognitive complexity are important. Education and experience also help the scientific contribution of Scientists. Finally, satisfactions do not have the important, independent effect on contribution we had expected to find. In this type of analysis, then, we begin to see the importance of non-organizational factors -- the cognitive and background ones -- which did not show up in the earlier A.I.D. analysis.*

*A.I.D. shows fewer significant predictors than path analysis chiefly because it uses up cases, producing groups too small to be split further on other measures. The fact that predictors are dichotomized in A.I.D. probably attenuates the power of some measures, too.

FIGURE 7-5

Path Analysis of Organizational Factors and Contributions



For PLs, in Figure 7-6, we begin to see some organizational measures becoming important, i.e., the information environment and collaborative research activity. Higher contributing PLs work more total hours per week, also; and this is more important for this group than for Scientists. The relative independence of PLs from organizational conditions continues, though, since we see that challenge and dedication and job satisfaction do not predict the scientific contribution of the PL.

Finally, we need to take a long look at the effects of satisfaction with the station or scientific contribution for both of the job levels. For both Scientists and PLs, higher contributing researchers are less satisfied with the station. This effect is stronger for PLs than for Scientists.

The negative paths between satisfactions and contribution are accounted for by other factors which relate to both sets of criteria. This is shown well in Table 7-3. First of all, if we look at just the correlation between satisfactions and scientific contribution, we find that in almost all cases, higher contributors are more satisfied with jobs and stations. The one exception is that there is no relationship between scientific contribution and satisfaction with the station for PLs. Many of the differences in scientific contribution and satisfactions are accounted for by feelings of challenge and dedication, however, as we have seen in the analyses above. If we control for challenge and dedication differences, there is no correlation of scientific contribution with station satisfaction, and a reduced one with job satisfaction. If we add controls on perceived opportunities for growth and experience, the correlations gradually become negative between satisfaction with the station and scientific contribution, while for job satisfaction they just go toward zero.

So, it may be the case that a "pure" satisfaction measure, controlled to remove components contributed by challenge and dedication, etc., is lower for researchers who make greater levels of scientific contribution. Greater critical facilities and perceptions of hindrances to productivity might account for this. Still, all researchers are not equal on perceptions of challenge and dedication, and so on, and if we just gathered researchers at random (rather than a group seeing equal challenge and dedication), the more satisfied individuals would be found to contribute a bit more to scientific knowledge.

Still, satisfactions and contribution show only limited relationships -- the "human" and "hard" products of the organization are not as closely connected here as they might be in an industrial job, for example. Job satisfaction does relate more strongly to contribution than does satisfaction with the organization -- simply demonstrating that the station is more remote than the work settings for the individual researcher.

Applied Contribution: As we indicated above, the predictive model for applied contribution is a relatively simple one involving scientific contribution, stimuli received from clients, and the vital dimension of organizational

FIGURE 7-6

Path Analysis of Organizational Factors and Contributions

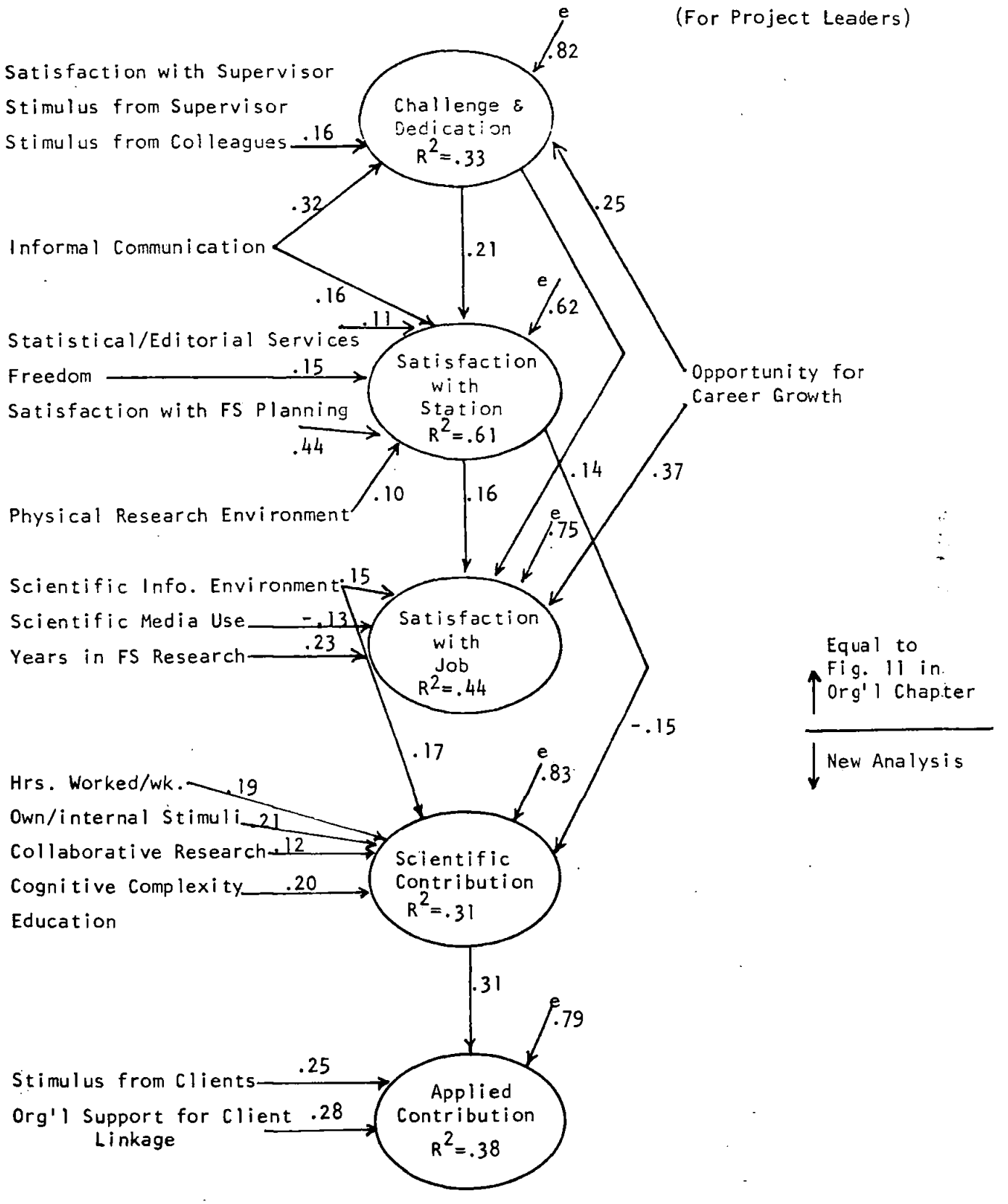


TABLE 7-3

Explaining Correlations between Satisfactions and Contributions

	Station Satisfaction		Job Satisfaction	
	SCIENTISTS	PLs	SCIENTISTS	PLs
Scientific Contribution				
"Raw" correlation	$.12^{b}$	$.03^{NS}$	$.27^{b}$	$.20^{b}$
Partialled on:				
Challenge and Dedication	$-.07^{NS}$	$-.06^{ns}$	$.15^{b}$	$.12^{<.1}$
Challenge plus Opportunity for Career Growth	$-.09^{a}$	$-.12^{<.1}$	$.11^{b}$	$.04^{NS}$
Challenge plus Years in Forest Service Research	$-.10^{b}$	$-.12^{<.1}$	$.09^{a}$	$.04^{NS}$

Key: a = $p < .05$; b = $p < .01$

support for client linkages. All three of these measures show strong paths to applied contribution for both Scientists and PLs. The implications remain as solid as they were earlier: the researcher first needs something (a finding) to get applied, then individual interests in clients represented by their ability to stimulate him to perform, plus the active support of the organization for the work of making the necessary links with clients.

SCIENTIFIC AND APPLIED CONTRIBUTION TOGETHER

We know scientific and applied contributions correlate positively, and that scientific is a good predictor of applied. So far, though, we have looked at them separately. We will remedy that here. Our key to such analysis is a five-group classification of researchers using both contribution measures. This is of interest by itself, and we will then determine what factors distinguish the five groups.

A very useful classification has been developed to identify researchers as to their levels of both scientific and applied contribution. This is the five-group category scheme used in Morris and Lingwood (1973b), which we have described again in Figure 7-7. There is one large middle group, defined as researchers who are moderate on both kinds of contribution, and four other groups defined from the combinations of low-or-high on the two measures. Since the two measures relate positively to each other (with a correlation of around .50) most of the cases pile up along the diagonal from "low-low," through the "moderates," to "high-high."

This correlation tells us that most researchers will fall along the "main diagonal" from "low-low" to "high-high," and this is indeed the case in Figure 7-7. Half of all researchers (Scientists and PLs together) fall in the "moderate" group, while about one-fifth are high in both kinds of contribution. The "pure researchers" and "appliers" each represent just over one in twenty of all researchers. The question is, then, what dimensions discriminate these five groups.

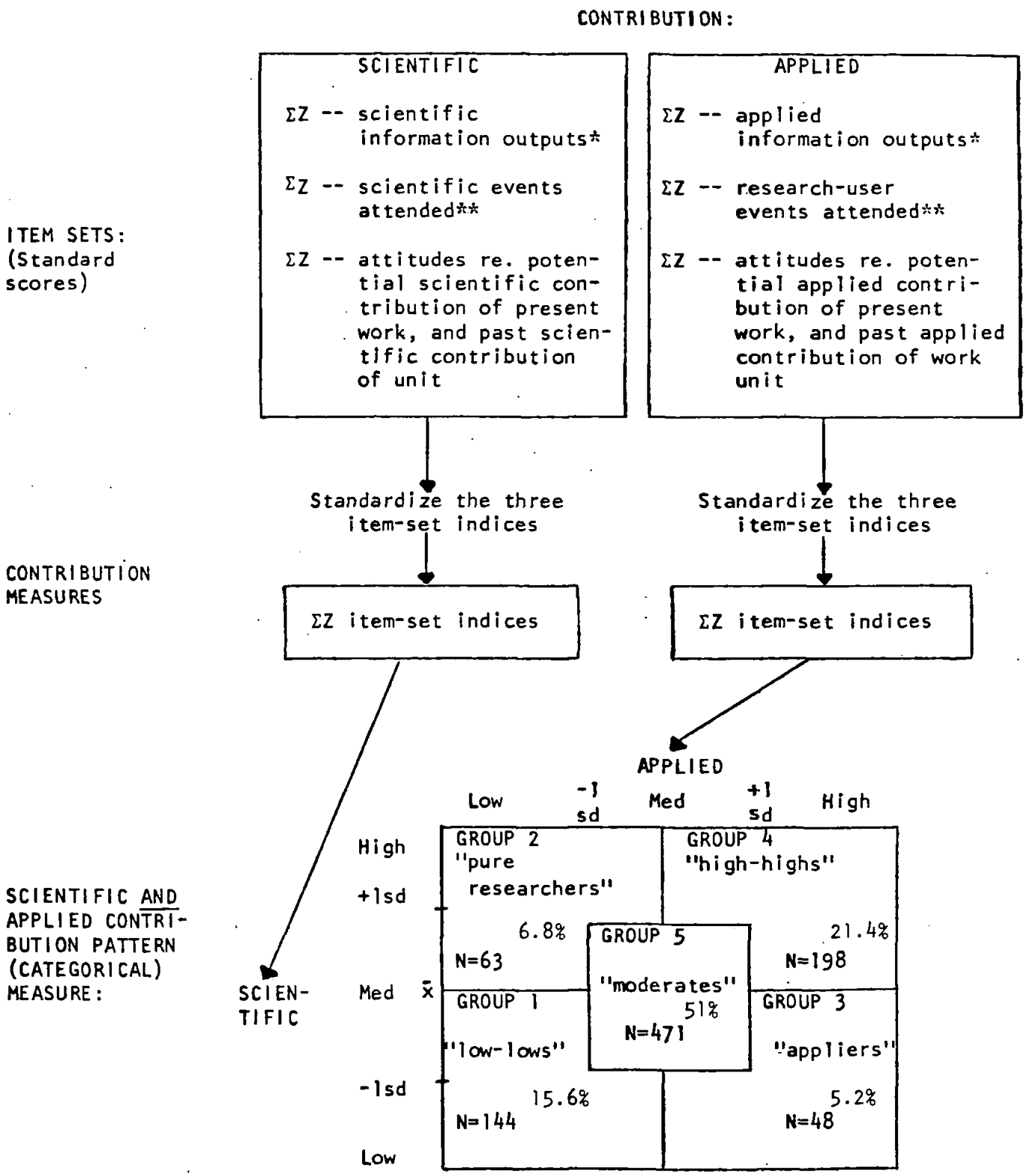
"Multiple discriminant function analysis" is such an intimidating term that, for this reason alone, we would normally not employ it in a report of this nature. However, we have one analysis which captures so much meaning in the data, and which gives such a clear understanding, that we cannot leave it out. The question we are asking through this method can best be summarized like this:

> Are there a small number of understandable dimensions which can be produced to differentiate the five scientific and applied contribution groups, and if so, what is the nature of these dimensions?

Discriminant analysis begins with a number of predictor measures, in our case the same predictors (personal, informational, organizational, etc.) used in the regressions, and attempts to reduce these to a smaller number of functions or independent dimensions. So far this sounds like factor analysis, but there is a qualifier which makes all of the difference: the

FIGURE 7-7

Construction of the Scientific and Applied Contribution Measures



(N's for Scientists and PLs together)

*Number in past five years.
**Number in past two years.

dimensions are formed not just from the correlations among the predictors, rather, the dimensions formed are those which maximally separate cases according to some grouping in which they are placed--in our case, the five contribution-type groups. The number of dimensions needed depends on the data (i.e., number of predictors, the correlations among them, and the way these relate to the criterion groups), and each dimension extracted will account for successively less of the differences among the groups. We can go on to determine how the predictor measures correlate to each dimension, much the way we would look at loadings in a factor analysis to come up with a label for a factor.

All of this technical discussion may not be too helpful to some readers, but the results can be interpreted by anyone. We found that most of the explanatory power we could achieve came from the first two dimensions produced, even though a total of four dimensions were created by the analysis program.* When we correlated the original predictors with each dimension we found we could typify each as follows:

Dimension One: Researchers who got higher "function scores" on this dimension can be characterized as having:

--more years of experience in Forest Service research
--a better scientific information environment
--better informal or project communication
--more activity in collaborative research projects
--more challenge in and dedication to their work
--better chances for promotion and training
--more support from the organization for client linkage activities
--more opportunity to work on problems important to the station or to clients
--more rewards from leadership for applications
--greater overall satisfaction with their job and station

Dimension Two: Researchers who scored higher here were:

--of lower education level
--higher in reading applied media

*The importance of each dimension can be looked at two ways: first, how much of the total accountable-for variation across the groups does this dimension control; second, how much of the variation in the dimension or function scores can be accounted for by the groups. The results for four dimensions looked like this:

	Dimension			
	1	2	3	4
% of accountable variation by dimension	72%	13%	10%	5%
% of variation in dimension score accountable for by the groups	36%	9%	7%	4%

The first dimension combines experience, information, reactions to the organization, and perceived support for applications work. The second looks very applied-oriented, with little surplus meaning. The question is, where do the five contribution groups fall when we plot them on scales representing each of these two dimensions? Figure 7-8 tells the story.

Let's dispose of Dimension Two first, since it requires the least explanation. We said it sounded very applications-oriented, but this is an over-simplification. We can see that only two of the groups are separated according to this dimension: the "appliers" and the "pure researchers." If this were a dimension sensitive only to applied contribution, then we would expect to find group 4, the "high-highs" as high as the "appliers," and group 2, the "low-lows" as low as the "pure researchers." This clearly isn't the case. It looks as if this dimension separates researchers who have chosen, or who have been led by reason of their education level, to make contributions in one of the two areas, but not the other. The "appliers" are less-well educated, but are more attentive to applied media; the "pure researchers" are just the reverse--high education, and low use of application-oriented media.

The most interesting dimension is the first one, that which accounts for the most variation among the groups. It separates the "low-lows" from the "high-highs" in a most interesting way: researchers who are high on both scientific and applied contribution are the more experienced staff, with good information channels, who rate the organization positively, and see many opportunities and rewards. Those who are low in both contribution areas are low in these factors. What is even more interesting is the fact that the three other groups ("appliers," "moderates," and "pure researchers") are almost identical on this most important dimension. That is to say, researchers who are moderate in both kinds of contribution, or who are high in one but not the other, come out in the middle on this dimension. Researchers who have the higher levels of experience, better information, higher evaluation of the organization, etc., tend to be making high levels of both scientific and applied contributions at the same time. Those who are low on the dimension, that is, are low on the predictors we have just mentioned tend not to be making much of a contribution in either area. Frankly, we had expected the plots of the group means to "tip" in favor of scientific contribution on the first dimension, that is, for the "pure researchers" to move higher, and the "appliers" lower; and it is a good sign, we think, that these groups came out about the same. Had it been otherwise, then the experience/information/evaluation dimension could be said to be favoring the researcher who is making a scientific, rather than an applied contribution. It seems a healthy sign that the dimension responds to a well-rounded contribution, rather than one biased toward either applications or peer-oriented science.

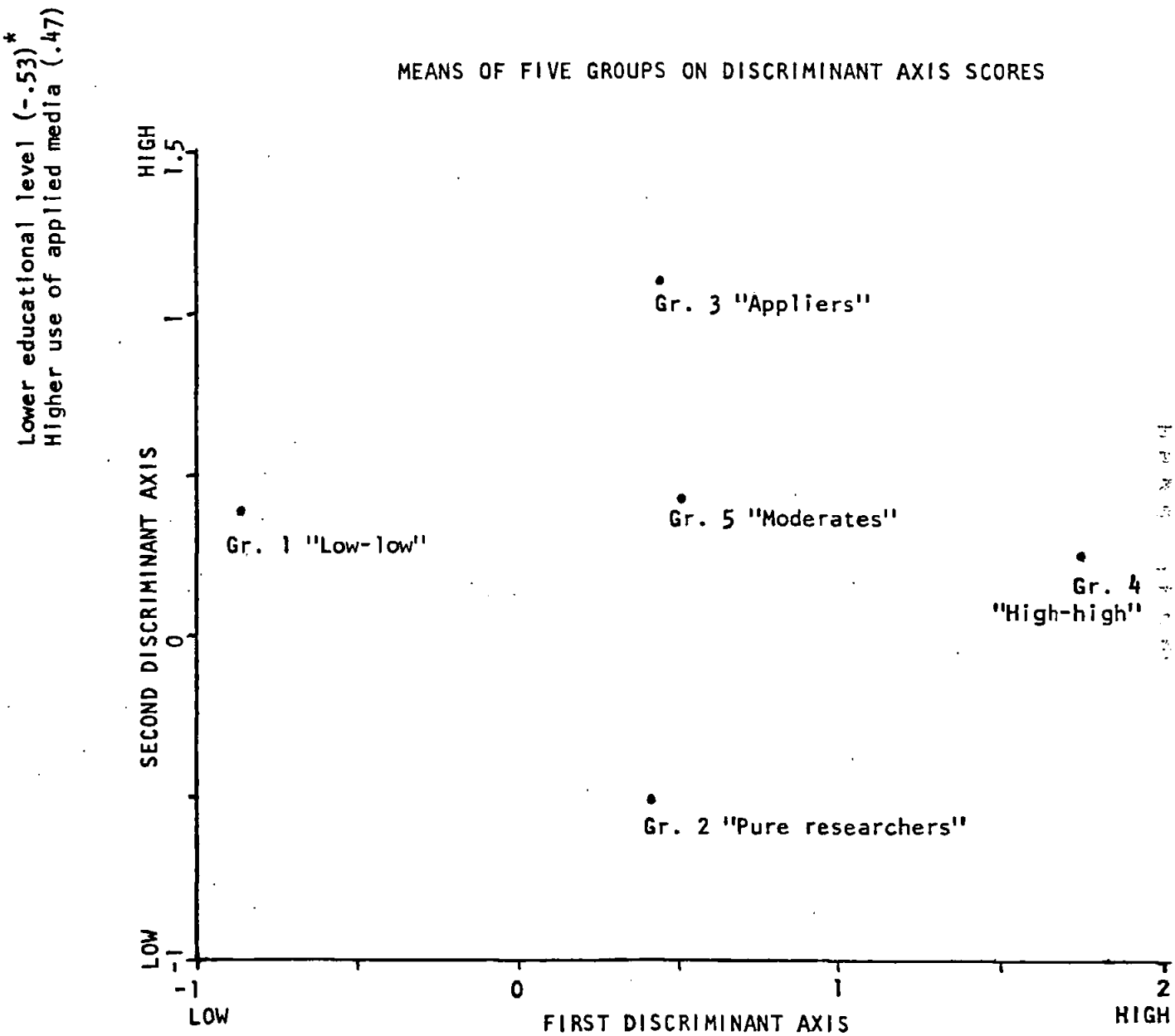
CONCLUSION

This has been a complex and crucial part of our analysis: we have introduced new approaches to measuring the two kinds of contributions researchers in the Forest Service can make; we have explored levels of contribution; and, we have just gone through some fairly complicated analyses of who contributes the most.

FIGURE 7-8

Discriminant Analysis for
Five Scientific and Applied Contribution Groups

(Data from Scientists and PLs)



(lower on these measures)

Org'l. client linkage support (.70)*
Satis. with promotion/training (.53)
Challenge & dedication (.53)
Opp. to work on stn./client problems (.47)
Sci. info environment (.46)
Informal, project communication (.45)
Total satis. with job & station (.45)
Collaborative rsch. activity (.39)
Leadership rewards application work (.35)
Years in F.S. research (.29)

(higher on these measures)

* correlation of measure with discriminant axis score

The most pressing question emerging from all of this analysis involves what can be learned here which can help the research manager improve both the scientific and applied contributions of researchers. Clearly, there are some things which could be done to impact components of contribution directly; also, we assume that further improvements could be made by working on those factors which predict contributions.*

Directly, managers could: (a) continue to encourage publication, but with careful analysis first as to the most effective media available to reach either the researcher or applied client; (b) encourage attendance at scientific events, and at researcher-user events also -- perhaps helping to develop new formats in this latter area; (c) work for liberalized meeting attendance policies; (d) help researchers document the various contributions they do make; and (e) work for more coherence and agreement among the many contribution measures and records kept by the organization with particular attention to how such data are used for evaluation purposes (see the next chapter for more on this).

Indirectly, managers should pay particular attention to organizational factors (of most importance for Scientists' contributions), and to selecting individuals with appropriate personal/internal characteristics. Abstracting somewhat from the kinds of measures we've talked about, we can say that there needs to be a convergence of:

(1) A climate of motivation toward work and toward whoever is the "client" for that work -- either other researchers or appliers, or both.

(2) An alive, informative environment for work; one which fosters both the flow of more "formal" scientific information, and the stimulation brought about by working with different kinds of researchers.

(3) A supportive organization which keeps researchers aware that it will help--and reward--their work in reaching the appropriate client for their knowledge, whether scientific or on the ground.

(4) The recruitment and selection of researchers who prefer complex problems and a mix of job activities.

This list is formidable, especially in demanding times such as these. The best approach seems to be that of making these points goals for both managers and researchers, and then insuring that there is a climate of perpetual concern and open discussion of how to reach them.

*This implies that we are willing to impute causality to the models used here. Even though one feels that the causal inference is logical, we cannot demonstrate it is these data. Nevertheless, we are probably safe in assuming reciprocal or cyclical causation -- and if we work on improving contribution both directly and indirectly, the ultimate impact should be positive.

Such a climate would help to make a good thing even better--and this is the note on which this chapter should end: we have spent a great deal of time with Forest Service research, and with other research systems as well; we see in the Forest Service a highly positive, efficient, open, and "contributing" organization. Even though it may fall short of some of its goals (e.g., making and rewarding applications--see the next chapter), if striving for the goals is as important as we think it is, then Forest Service research must be well on the way toward getting even better. The task for everyone in the organization is to keep up the momentum.

CHAPTER 8

REWARDS

READER'S GUIDE:

This is an important chapter for all readers, since it looks at who in research gets the greatest reward, in terms of G.S. Grade.

CHAPTER SUMMARY:

An analysis of who gets rewarded for what is important in understanding what goes on in organizations. In our case, we looked at G.S. Grade as the "ultimate" reward measure, analyzing it according to educational and experience factors, and by levels of Scientific and Applied Contribution. Educational level and experience relate strongly and positively to G.S. Grades of Scientists, though they relate less strongly for PLs and ADs (other things must relate to advancement in these rather homogeneous groups).

The most important findings here relate to G.S. Grade as a function of Scientific and Applied Contribution. For Scientists, higher contribution in both areas is either positively rewarded, or at least doesn't hurt G.S. Grade. For PLs, however, those with high activity in Applied Contribution actually have lower G.S. Grades than PLs with equivalent levels of Scientific Contribution. The problem seems to come from the G.S. 15 and up level, where there is much lower activity in the area of applications.

THE IMPORTANCE OF REWARDS

At first glance, this section title seems so obvious as to need no discussion. Obviously, rewards are the glue which holds organizations together, and provides the response to individual needs for recognition of accomplishment. Our concern is not so much the nature of rewards *per se*, but with the relation of reward to personal, and contribution factors of individuals: what kinds of researchers, and what kinds of work get rewarded.

We will not explore the problem of the relationship of rewards to ratings of the organization or satisfactions. The reason for this is the problem of determining the proper relationship between the ratings we have collected and some measure of reward. For example, would a more positive evaluation of the organization reflect a situation in which better work, and hence higher rewards, would be possible? Or, are researchers who have done better work and have been rewarded more inclined to rate the organization more favorably as a result? The truth is probably that both of these relationships exist, but this is of no help in trying to analyze organizational ratings together with rewards. Therefore, in this chapter we will skip directly to the relationship of reward with different kinds of contribution and background factors of researchers.

The most important problem, of course, is the possibility that rewards in Forest Service research might be given more often, or even exclusively, for contributions to scientific knowledge, overlooking or even negatively rewarding contributions to applications. Since the Forest Service has said that both kinds of work are important, we need to know if the system, in the Spring of 1973, had put its rewards where its statements were.

The measure of rewards we will use in this section is the individual researcher's G.S. Grade. This measure may miss many less-formal and interpersonal rewards researchers receive from peers, supervisors, professional associations, etc. However, in the final analysis, the most important rewards must be those relating to permanence and advancement in the Forest Service, and G.S. Grade is our best available measure of this.

BACKGROUND RELATED TO REWARDS

Experience and education are factors which explain much of the difference in G.S. Grade among Forest Service researchers, as we should expect. In Table 8-1, however, we can see that education, years since it was completed, and years in Forest Service research show more G.S. Grade differences for Scientists than for PLs or ADs. In the administrative ranks we know that there is less variation in background and in G.S. than among Scientists, and this might account for the lower relationship between experience and education and G.S. It is also probably true that there are other factors which relate to G.S. advancement for PLs and ADs; factors relating to performance, or more subtle evaluations of reward. In any case, the table provides us with the basic parameters of G.S. Grades in the organization: from above ten for the most junior, BS-level Scientists, to above 14 for the highly experienced AD.

When we analyzed G.S. Grades within the various disciplines in which researchers are working, we at first found no differences at all. When we controlled for experience and education differences statistically, however, we see (in the bottom section of Table 8-1) that both Scientists and PLs in engineering and architecture have higher G.S. Grades than their counterparts in other disciplines. The fact that these differences do not show up in the "raw" G.S. means indicate that the engineers and architects have, on the average, somewhat higher G.S. Grades than others with similar educational and experience backgrounds. Perhaps grade here is rewarding the "professional" status more highly.

TABLE 8-1

G.S. Grade by Education, Experience, and Discipline

Job Title	MEAN G.S. GRADE Scientists	PLs	ADs
	11.8	13.4	14.5
Education:			
College graduate	10.9	13.5	14.0
Some graduate study	11.1	13.4	14.2
MS/MA	11.6	13.3	14.6
Ph.D.	12.4	13.4	14.6
Years since education completed:			
<5	11.0	12.8	14.2
5-10	11.7	13.1	14.3
11-15	12.1	13.5	14.5
16+	12.4	13.7	14.6
Years in Forest Service research:			
<5	10.6	12.2	14.0
5-10	11.5	12.8	14.2
11-15	12.2	13.6	14.4
16+	12.4	13.5	14.6
Discipline in which working (adjusted for background differences):			
Natural Resources	11.8	13.3	
Natural Science	11.8	13.4	
Physical Science	11.9	13.7	
Social Science	11.7	13.8	
Engineering & Architecture	12.4	14.3	
	$F_{4;670} = 3.6$ $p < .01$	$F_{4;242} = 4.8$ $p < .001$	

THE RELATION OF REWARD TO CONTRIBUTION

We get credit only for jobs in national refereed journals.

By and large, people in organizations will do those things they get rewarded for. As we've indicated, we are concerned that rewards reflect the trend toward an integration of both "basic" and "applicable" science. The question here is, therefore, how do our measures of Scientific and Applied Contribution relate to rewards in the form of G.S. Grades?

There are two ways of looking at this: first, we will put the two kinds of contribution together into a "pattern variable" which identifies five groups of contributors to both fields (see the last chapter or Appendix B for a complete explanation of this measure). Second, we will look at each type of contribution separately, but will concern ourselves with the components of each measure.

Let's begin with the five contribution groups, remembering that we have identified the following types of researchers:

(1) Low on both Scientific and Applied Contribution
(2) High on Scientific, and low on Applied
(3) Low on Scientific, high on Applied
(4) High on both kinds of Contribution
(5) Moderate on both

Again, each kind of contribution weights equally the three following areas:

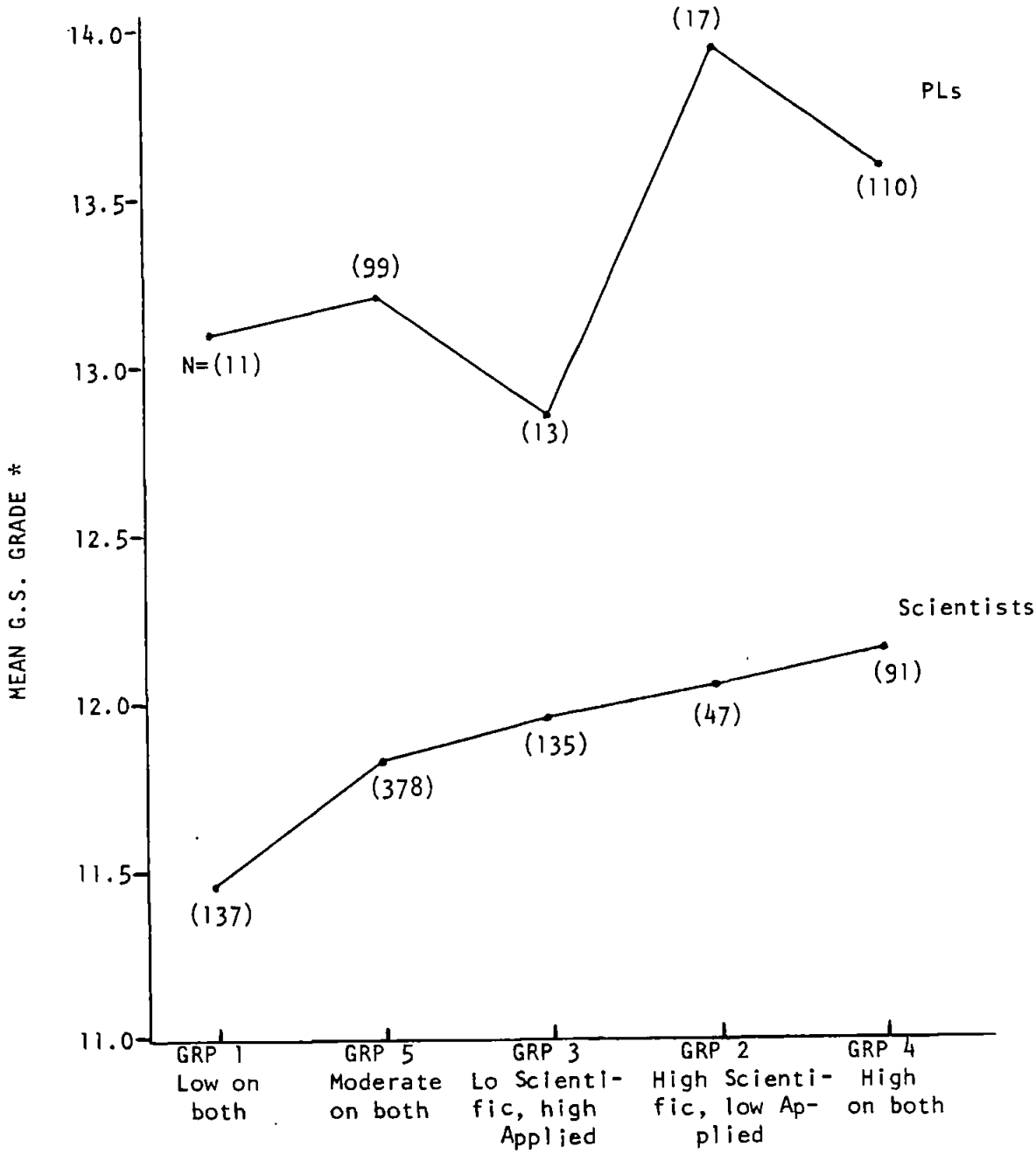
(a) Opinions about past and potential impact (on either science or (applications)
(b) Number of written products authored (either scientific of applications-oriented)
(c) Number of either scientific or researcher-user events attended

Figure 8-1 contains mean G.S. Grades for Scientists and PLs in each of the five contribution groups. The picture looks relatively good for Scientists, and bad for PLs. In both analyses plotted in the Table, we first controlled statistically for education and experience factors, so the G.S. differences across the five groups are not due to differences in education or experience.

For Scientists, we see that G.S. Grade is lowest for those individuals who are rated as low on both kinds of contribution. It is highest for individuals high in both kinds. This is as we would hope, if rewards are linked to the total amount of contribution the individual does. The plot also shows that if the individual is high on either Scientific or Applied Contribution, his G.S. Grade is higher than the Moderate group, and much higher than the "Low-Lows," though less than the individuals most active

FIGURE 8-1

Analysis of Covariance for G.S. Grade
of Five Scientific and Applied Contribution Groups



*Means adjusted to remove effects of background factors listed below.

Table of Covariates:		Scientists		PLs	
		t	p<	t	p<
Level of education		15.1	.0001	3.5	.001
Years since education completed		8.0	.0001	4.2	.0001
Years in Forest Service research		6.5	.0001	2.3	.05
Equality of adjusted means:	d.f.	4;680		4;242	
	F	6.8		7.1	
	p<	.0001		.0001	

in both areas. Again, this seems to make sense, and indicates that the reward system for Scientists appears to give relatively "correct" rewards, regardless of the area (Scientific or Applied) in which contribution occurs. (Note, however, that we are talking about relative rewards among the five groups, not the absolute level of reward for any or all of them.)

For PLs, however, the story is disturbingly different. We don't see the increasing curve of G.S. Grade as a function of high contribution in first one of the areas, and then in both. Rather, we see that the highest G.S. Grades have been given to individuals we classify as "pure researchers," while the lowest-graded PLs are not the low-low producers, but rather those who are high in Applied Contribution and low in Scientific. In fact, the G.S. Grades of PLs high in both areas is lower than those who are in the "pure researcher" group, even though they are contributing equally as much to the scientific community as are the "pure researchers."

The tentative conclusions are: (1) the reward system cannot recognize Applied Contribution of PLs unless it is accompanied by high Scientific Contribution, and (2) even then, the PL has a lower G.S. grade than his colleague who is contributing only to his scientific field. It appears that Applied Contribution can hurt a PL, on the average, to the tune of 1/4 to 1/3 of a G.S. Grade (comparing groups 1 and 3, and 2 and 4).

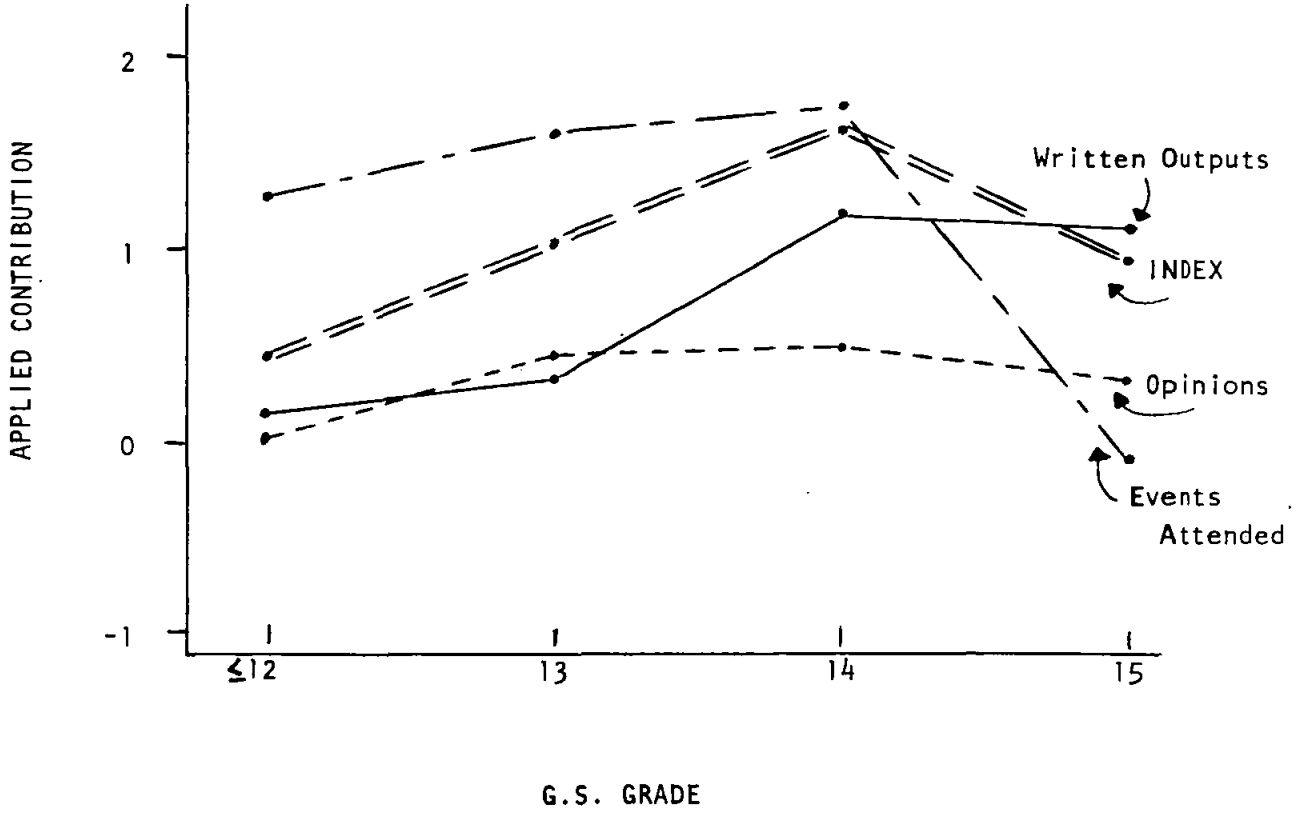
The overall index of Applied Contribution doesn't tell all of the story for PLs, however. We can see that the three components of Applied Contribution relate differently to G.S. Grade if we turn our analysis model around, and plot the means or each component for PLs at each G.S. Grade level, as in Figure 8-2. Again, we have controlled for education and experience differences in this analysis, plus another factor, the number of hours the PL works per week (this measure was not important in dealing with the five contribution groups, but is a significant covariate in analyzing the components by G.S. Grade). The big difference is that high G.S. PLs are much less likely to be involved in attending applied events.

As a comparison we have broken out the components of the Scientific Contribution index for PLs in Figure 8-3. The differences from Applied Contribution are quite striking. Here not only does the overall index continue to climb almost linearly with G.S. Grade, but all three of the components move upward consistently. What seems to be separating the G.S. 15 and above PLs from the others is their very high rate of production of written information for the scientific audience. Note also that scientific events attendance continues to climb with G.S. Grade, so it is not the case that the high G.S. PLs are not going anywhere -- they just drop out of the very important area of direct contact with users.

In summary, we have seen that for Scientists, Applied and Scientific Contribution have positive relations to G.S. Grades, but that PLs are lower in G.S. Grades if they are relatively high in Applied Contribution. The final analyses we showed help explain this. There must be fewer of the G.S. 15 and up PLs in the high Applied Contribution groups: while all of the components of Scientific Contribution climb steadily with G.S. Grade, the components of Applied Contribution peak at the G.S. 14 level, and then decline (particularly in the case of applied events attended by the PL). Thus, the top G.S. Grades for PLs seem to be given only the high contributors to scientific knowledge, not to those active in applications, and not even to those most active in both areas.

FIGURE 8-2

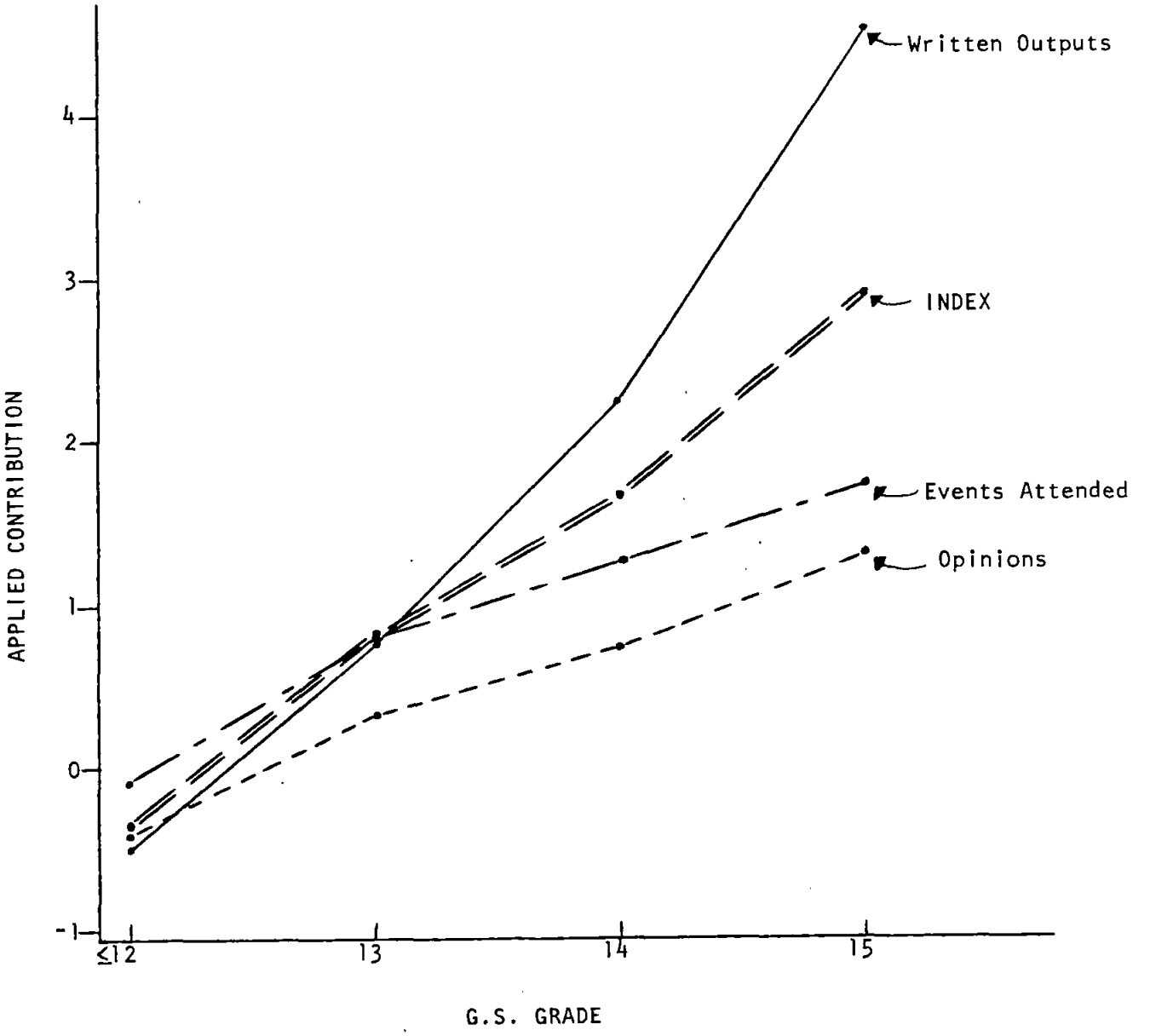
Applied Contribution of PLs
by G.S. Grade



(Means adjusted to control for educational, experience, and work-discipline differences.)

FIGURE 8-3

Scientific Contribution of PLs
by G.S. Grade



(Means adjusted to control for educational, experience, and work-discipline differences.)

Our concentration on rewards parallels the concern which is obvious among researchers as they are asked to become more active in helping secure applications of their work. The basic thrust of all of the data and discussions we have had with researchers is a simple one:

> No researcher is going to get very involved in applications work if he does not see a predefined and operating system of rewards for such work.

The problem is more grave at the Project Leader level than among Scientists, as we have shown -- it is among PLs that application work appears to reduce G.S. grade. Yet, "we look to project leader positions for the principal scientific leadership of a professional team of scientists" (Dickerman, 1975). It seems a safe bet that PLs will not lead their teams toward client-oriented applicable research if the rewards are not there.

It is also significant that the new applications section of the Forest Service Manual (U.S. Forest Service Manual, Series 1000) makes absolutely no mention of researcher rewards for such work, even though the section is very explicit in defining steps necessary to achieve applications (need sensing, translation, transmission, etc.). Until this verbal concern filters down to the work of changing guidelines for evaluation panels, supervisors, and even the Civil Service Commission, the amount of improvement will, we feel, be very small.

CHAPTER 9

DISSEMINATION AND UTILIZATION

READER'S GUIDE:

This chapter zeroes in on the processes involved in application of research, presenting the concepts we have used and data relevant to the problem. It is thus important for readers concerned with research applications.

CHAPTER SUMMARY:

We have employed *throughout* our work a model of the processes involved in the dissemination and utilization of knowledge. We present this here, as a way of highlighting our concerns about the role of clients in the process, plus the needed activities in linking research products back to clients. This whole area has been of increasing concern to the Forest Service, but, as the previous chapter shows, one which needs a great deal of work.

We found in the data that researchers see quite a gap between "actual" and "ideal" performance in their stations in areas such as sensing the needs of clients, and developing ways to get researchers and clients together. Indices measuring dissemination and utilization activities in the station differ by the clients researchers see as important, correlate modestly with the applied contribution of researchers, and stronger to researchers' perceptions of organizational support for applications. The station might be able to give support for application by improving the processes and activities identified in the dissemination and utilization model. It appears, however, that Forest Service research has not yet arrived at a consensus as to which approach to use in getting applications. Alternative approaches are discussed at the end of the chapter.

INTRODUCTION

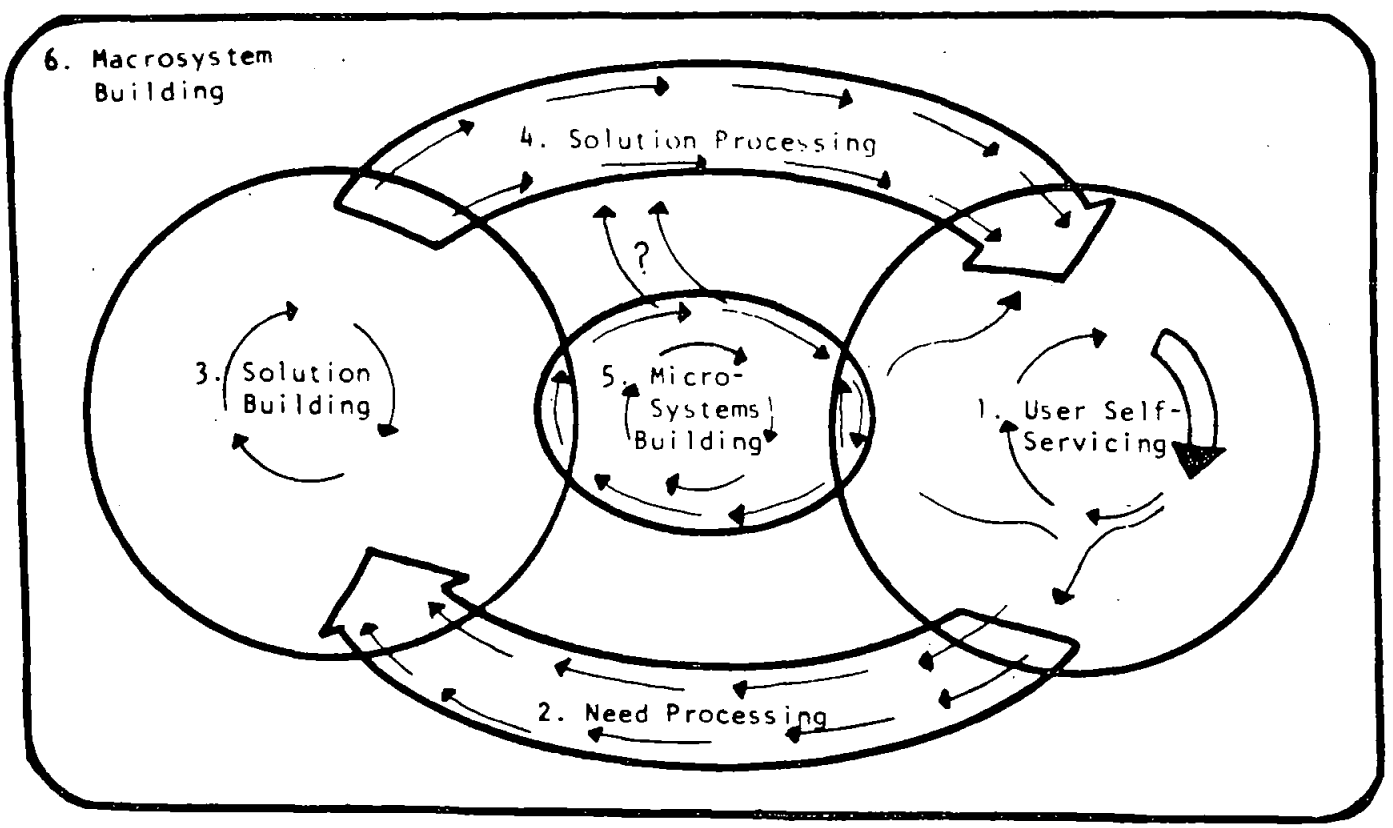
In this chapter we will look deeper into the area of research applications. Earlier we concentrated on a measure of the individual researcher's contribution to applications; here we will identify the important clients of Forest Service research, and report how researchers rate various activities the stations undertake to insure that usable research gets done,

disseminated to clients, and helped into use. Since we were constrained to look at only the research branch we cannot interpret these data as describing the totality of dissemination and utilization work in the Forest Service, nor exactly what the communication system looks like. Individual application activities, and the supports and processes stations provide, are necessary steps toward whatever the "ultimate" use will be, but we are missing a whole set of information from the clients themselves. Our best guess has to be that in most cases there are barriers to use in the client organizations themselves (resistances to change, etc.) which attenuate the impact of research. The best we can do here is to help understand and improve activities within the research branch, and then move into work with clients at a future time.

We will begin, then, with a short analysis of who the clients of Forest Service research are, and then go on to describe how researchers see station activity in several dissemination and utilization processes. The model of dissemination and utilization we will use is taken from the work of Havelock and Lingwood (1973), a study of the research dissemination and utilization activities of four federal agencies. The model, given in Figure 9-1, shows two groups -- a "user" and a "solution builder" (in our case, the research branch), and the three kinds of linkages between them: needs flowing from user to researcher, solutions flowing back, and direct, interpersonal interchange filling the gaps. If we look at each research client separately, we can identify activities in each type of linkage, and facilitators or constraints to knowledge use within each group (the researchers and the client organization).

FIGURE 9-1

Dissemination and Utilization Linkage Process Model



We also asked researchers to rate the extent to which each of several groups was part of their "actual" and "ideal" audience. Indices were formed for "research," "inside Forest Service," "policy," "public," and "business" clients. In this chapter we will also collapse the ratings of clients into "research," and "all other." This provides a hint of how the model steps look to researchers interested in different client groups.

Let us begin, then, with a look at the identification of who the clients are. Then we will move into the ratings of dissemination and utilization activities.

THE CLIENTS OF FOREST SERVICE RESEARCH

Identification of clients needs to be done two ways: first, by the job levels within research -- important since we have seen that the top of the organization was somewhat more concerned with applications when the data were collected than were the researchers; and second, according to the measures of individual scientific and applied contribution.

Figure 9-2 shows several interesting facts when we compare the job levels in research according to their "ideal" and "actual" audiences:

(1) ADs were indeed more concerned with the importance of reaching the applied clients, particularly those within the Forest Service. The researchers indicate that the Forest Service users are important, and the gaps for both the ADs and researchers between "ideal" and "actual" stress this user group as one to which more attention needs to be given.

(2) There is general agreement that researchers are the audience reached best now, and more or less adequately, comparing the "ideal" and "actual" ratings.

(3) The public and policy-maker clients get very little attention now from the researchers, whose "ideal" ratings indicate that they see a need for improvement, even though these clients are of lesser importance than the others rated.

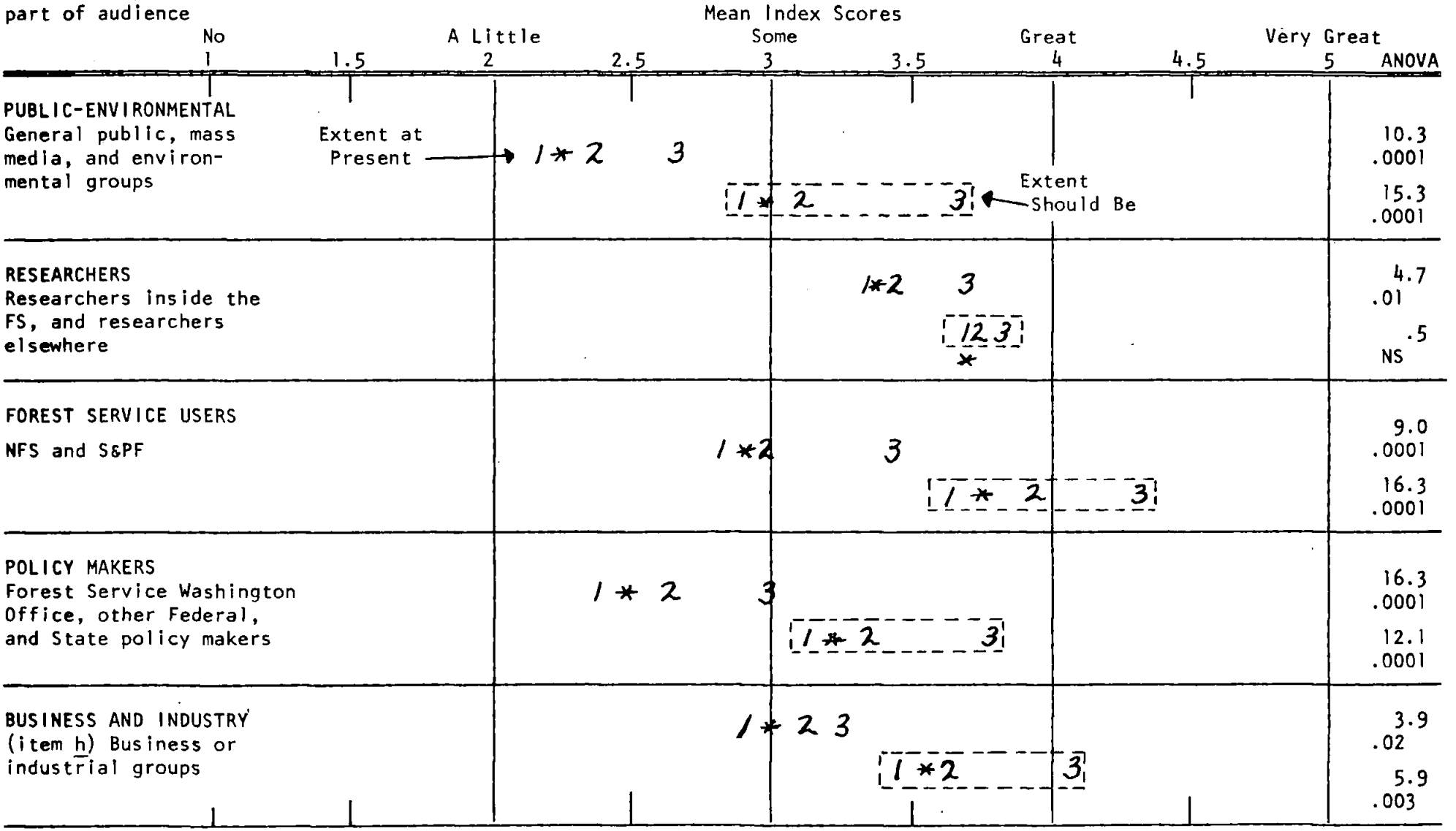
So, this picture is a familiar one: researchers still concerned with reaching other researchers, the audience reached best now, but also interested in improving linkages with other users; ADs are pushing for the applied clients.

At this point we need to look at the differences between those who are reaching the research audience and those reaching applied users. We constructed one index for the extent all of the non-research clients are part of the actual audience of researchers, then divided the researchers into "low" and "high", at the midpoint (meaning "to some extent") of the scale; similarly, we divided researchers into low and high in terms of

FIGURE 9-2

IDEAL AND ACTUAL AUDIENCES

INDEX SCORES FOR THREE JOB GROUPS (1-Scientist, 2=PL & PM, 3=AD)



KEY:

* = Mean of distribution

reaching the research audience. Combining these two dichotomies gives us four groups of researchers, as identified in Figure 9-3, where we compare the groups on the indices of scientific and applied contribution. This gives us some validation across the contribution and audiences measures: there is a very good match between the actual clients researchers report and their levels of contribution.

Most researchers (71%) are below the midpoint ("to some extent") in claiming non-researchers as part of their actual audience. Over a third (35%) are "Research-oriented" exclusively, and only 11% are classed as "Application-oriented." We will use this four level client breakdown later in looking at ratings of dissemination and utilization activities; it is the best we can do along the lines of rating the linkage processes separately for each client.

Users for many aspects of research are other researchers.

We work closely with [users] at all levels of research and application. We also work rather closely with NFS-BLM-State and other [forest survey or inventory] organizations. Other users are reached through publication. I have little knowledge of the relationship of other projects to their users.

STATION ACTIVITIES IN DISSEMINATION AND UTILIZATION

The model in Figure 9-1 shows the various kinds of activities and linkage processes involved in dissemination and utilization. We usually start by considering the client and his particular needs -- since research done without such inputs is usually limited in the extent it can be used by clients. Next, the research done must be "client-centered" and timely (here the organization plays its important supportive role). Third, results must be transformed to be compatible with the interests, language, and media of clients. Fourth, there must be methods for direct interaction between researchers and clients in some instances.

Finally, there must be some method of helping users apply research in some instances. These steps can be illustrated by comments taken from the questionnaire, though we will see that researchers are by no means of one mind on the whole topic of linking to applied clients:

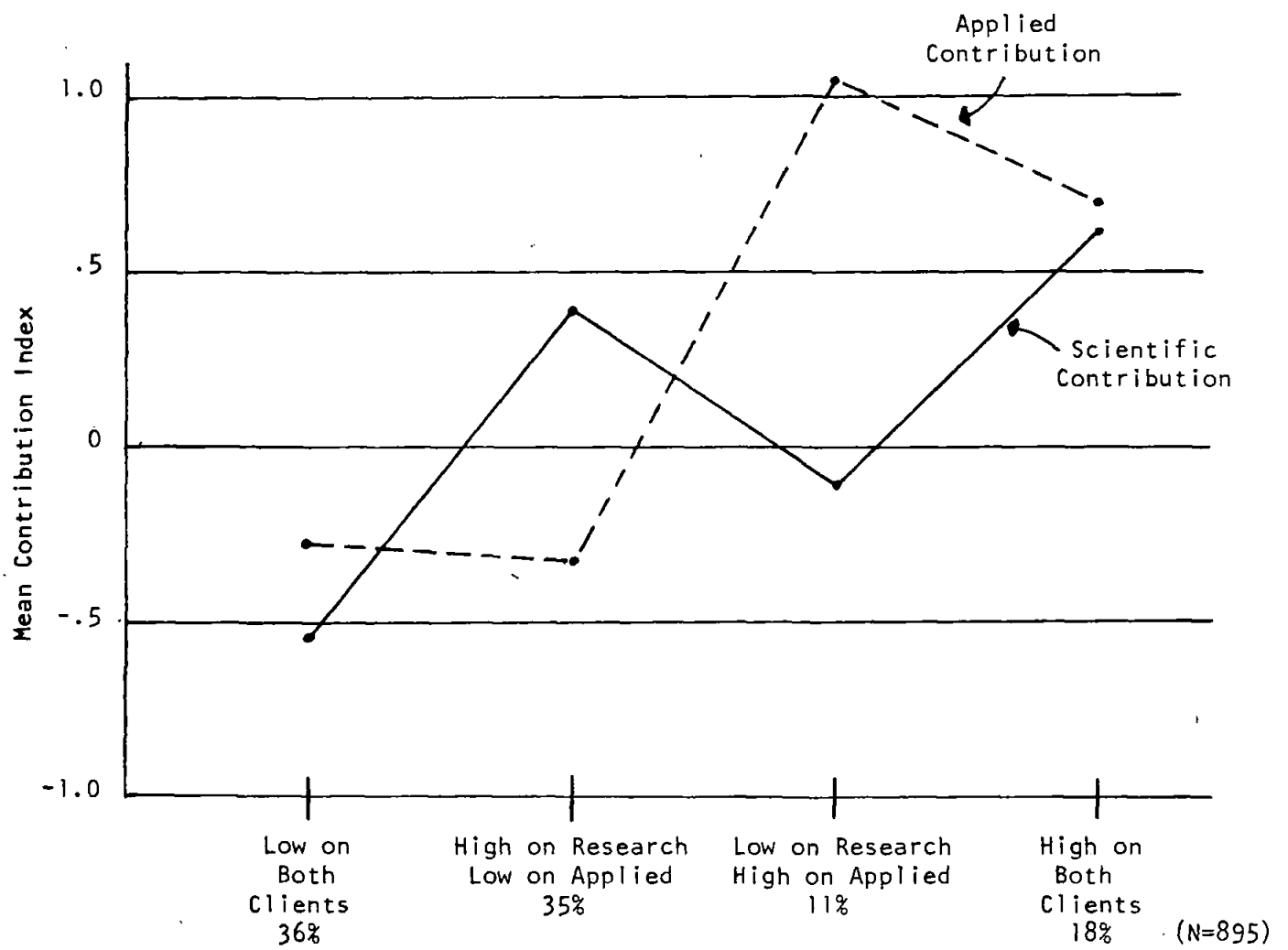
NEEDS

Would like to work more closely in early stages, then follow through.

Researchers need the communication with the user to define the problem and frame the dimensions of the solution.

FIGURE 9-3

Contribution According to Audiences Being Reached Now



(Data from Scientists and PLs)

Fs (3;891):
Scientific Contribution: 17.6, $p < .0001$
Applied Contribution: 19.4, $p < .0001$

CLIENT-CENTERED RESEARCH

In actual practice, the present evaluation system discourages these sorts of things because any time you spend on dissemination of information decreases the research output on which you are being evaluated.

Right now it seems we don't get started until NFS has patched together their own solutions.

I was happy with my research because I felt that I had the opportunity to do research that best fitted my capability and interests. With the reorganization into multi-functional research I no longer have this choice...ongoing research was terminated...

TRANSLATION-DISSEMINATION

My project is not big enough to contain people who can do both very technical research and spend a large amount of time with people who do not speak their language.

We must somehow find a way to break the communication barrier between researcher and user. It has become popular in the last 3 years to pay lip service to this goal, but little has been done.

There is no adequate "extension" unit between FS research and user. Researchers besides publishing need to establish or use devices or techniques for "wholesaling" research to key people [who can] "retail" the research results to the individual "buyer" or user.

USER PROBLEM-SOLVING AND ACCEPTANCE

Too often, administrative people won't take the time to even call a researcher who could give him some advice.

User is usually mired down in his own administrative methods and cannot utilize even the presently available methods. He needs policy changes to incorporate new research findings.

DIRECT INTERACTION

The dialogue between user and researcher needs to be increased, [but] it requires an informality and spontaneity that cannot be forced.

We still haven't figured out best way to rap with each other except on a one to one basis.

Our questionnaire items mapped this same series of steps, as outlined below. Each of the five question areas was formed into two indices: one for the extent researchers see these activities in the station now, and one for how important they think these areas are. The questions were:

Need Sensing:
- "Developing and using regular mechanisms for determining what users' needs are."
- "Transforming users' needs into problem statements and researchable questions."

Client-Centered Solution Building:
- "Doing research which is directly applicable 'on the ground'."
- "Doing work on problems at the time they are most important to users."

Translation and Transmission (Dissemination):
- "Producing summaries, abstracts, and reviews of research findings."
- "Rewriting research products in the language of each important user group."
- "Determining who the important users should be for each finding to be transmitted."
- "Selecting the most appropriate channels to be used to reach each user most efficiently."

User Problem-Solving and Helping:
- "Helping user groups develop a capacity to solve their own problems."
- "Finding someone in each user group to help in dissemination and implementation."

Micro-System Building:
- "Designing ways to get users and researchers working together on joint projects."
- "Organizing ways users and researchers can get together to exchange information."

Dissemination-Utilization Processes and Clients Reached

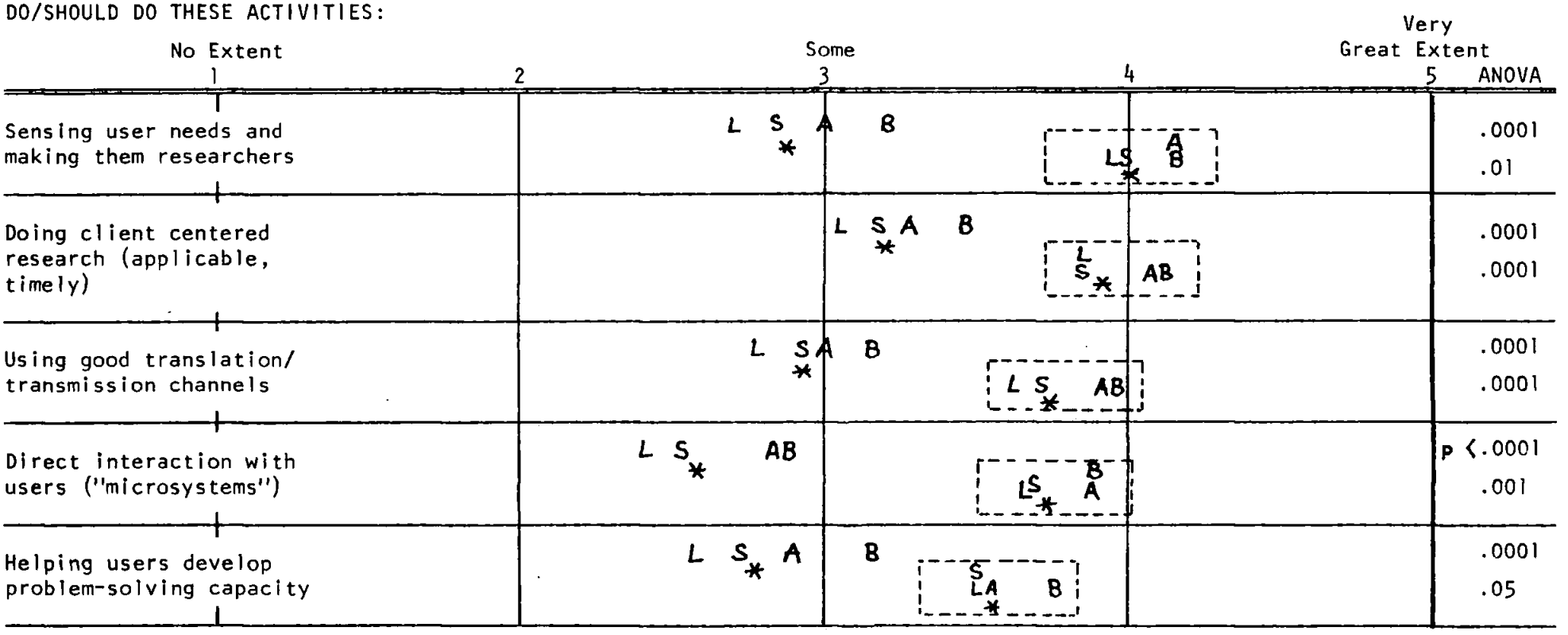
The first step in the analysis is to look at the ratings of these processes according to the clients researchers say they are reaching. Here we will use the four-client-group classification introduced earlier. Figure 9-4 contains the data. Of interest here are the following findings:

(1) The groups almost always align themselves from the lows on both to the highs on both in terms of means for actual or ideal activity in dissemination and utilization. The group classed as "Applied" oriented (high applied, low scientific clients) almost always rates the ideal or actual steps higher than the "Scientific" group.

(2) Direct interaction is the area seen as being done least by the stations now, for all four of the groups.

FIGURE 9-4

Ratings of Dissemination and Utilization Areas According to "Audience Groups"



KEY: L = Low on reaching both scientific and applied clients
S = High on scientific, low on applied
A = Low on scientific, high on applied
B = High on both scientific and applied
* = Overall mean of distribution

(3) The groups agree that the best-done area is that of doing client-centered research (i.e., timely and applicable research).

(4) Conversely, the area of sensing users' needs is seen as most important in terms of the extent stations should be performing the linkage activities. The differences across the four client-orientation groups are relatively small here.

(5) The greatest gaps between actual and ideal station activity comes in the areas of sensing needs and direct interaction between researcher and user -- the former because it is seen as so important in the ideal, the latter because it is seen as being done so little at the present.

(6) It is usually the case that there is a greater gap seen between the ideal and the actual among those who are oriented toward both client groups than among those who are lowest on both.

We might expect to find reversals in the four groups for the "actual" items -- i.e., those more oriented to applied clients seeing the present state of affairs as worse than those not oriented toward these clients. This does not occur, however. It is simply the case that as researchers are more oriented to applied clients, they perceive more going on in the station in all of these steps -- they still, however, continue to think more is needed.

A concluding comment here involves the different ratings for doing client-centered research (which came out highest in the "actual,")and the other process measures. We wonder if doing applicable, timely ("client-centered") research is truly effective if the areas of direct interaction with users, need sensing, dissemination, etc., lag far behind. The model indicates that there is a sequence beginning with need sensing which must take place for the subsequent steps to be effective. The researchers seem to share the model's concern with this, since they rate this area so high in the ideal case. On the other hand, there is less researcher enthusiasm for being in direct interaction with clients, and least perceived activity in this at present. The verbatim comments of respondents have highlighted the quandry these data represent. On one hand, many researchers seem to have found the face-to-face approach to be very effective. On the other hand, it is seen as time-consuming and non- or negatively-rewarding, since the time demands take away from the researcher's ability to write for scientific publications. Hence, many researchers seem to be looking for the "people multipliers" provided by extension or outreach personnel -- capacities the organization has not yet developed.

DISSEMINATION AND UTILIZATION ACTIVITIES COMPARED WITH OTHER MEASURES

We have from other parts of the questionnaire several other measures that are relevant to applications activities. In this section we will

relate these to the ideal and actual ratings on the stages of the dissemination and utilization model. The measures are:

(1) the importance of user problems to scientists,
(2) the opportunity they feel they have to work on those problems,
(3) the extent to which researchers are stimulated by users and their problems,
(4) the degree to which they feel their immediate organizational context supports dissemination and utilization and client helping in general, and their own utilization activities in particular, and
(5) the indices of scientific and applied contribution.

We would like to know how well the model ratings relate to these factors, controlling for personal and job-related differences of Scientists and team leaders. The middle columns of Table 9-1 contains the answer.

The partial correlations here indicate that those who think the dissemination and utilization model steps are more important, as an ideal, also indicate they get more stimulation from their clients, and think user problems are more important. The correlations for the "acutal" steps (as they are now) are much more modest. Perhaps these inidcate the constraints we have discovered in the organization and/or the reward system which limit the ability of researchers to respond to client needs, thus attenuating the power of the "actual" measures to relate to client stimuli and client problem importance. The "ideal" measures may be free of such constraints.

Conversely, those who rate actual dissemination and utilization higher now are those who have greater present opportunity to work on user problems. Again, the ideal-acutal differences show up across all of the model indices. If we look at the two indices of importance of and opportunity to work on user problems, we see the kind of convergence we would hope to find: ratings of actual dissemination and utilization, in model terms, correlate best with opportunity, while ratings of ideal dissemination and utilization correlate best with improtance of user problems.

Finally (in the fourth column of Table 9-1), we see that the researchers' perceptions of the degree to which Forest Service research supports dissemination and utilization, and their efforts in this direction, correlates reasonably well with ratings of actual dissemination and utilization in the five model areas. Again, the actual ratings correlate better with the index of organizational dissemination and utilization than do the ideal model indices.

TABLE 9-1

Ratings of Dissemination and Utilization Factors
Compared with Other Measures

N=710
Scientists and Team Leaders

D&U FACTORS:		Partial Correlations of D&U Ratings with: Stimuli from Clients*	Importance of User Problems*	Opportunity to Work on User Problems*	Organization Support for Client Linkages*	Scientific Contribution**	Applied Contribution**
Sensing User Needs	Actual	.09[a]		.27[b]	.31[b]	.12[b]	.08[a]
	Ideal	.22[b]	.18[b]				.10[b]
Doing Client-Centered R&D	Actual	.11[b]	.08[a]	.21[b]	.29[b]		.10[b]
	Ideal	.31[b]	.30[b]	.10[b]	.08[a]	-.11[b]	.22[b]
Transmission & Translation Channels	Actual			.19[b]	.22[b]	.08[a]	
	Ideal	.17[b]	.20[b]	.10[b]	.11[b]		.13[b]
Direct Interaction Microsystems	Actual	.15[b]	.11[b]	.27[b]	.37[b]	.09[a]	.13[b]
	Ideal	.26[b]	.27[b]	.10[b]	.12[b]		.17[b]
User Problem Solving & Helping	Actual	.08[a]	.09[a]	.16[b]	.20[b]		
	Ideal	.15[b]	.21[b]	.10[b]	.07[a]		

KEY:
a=p<.05
b=p<.01

*Partialled on: education level, years experience in organization, hours worked per week, job title (Scientist vs. PL), and G.S. Grade.

**Partialled on the above, plus: Scientific Contribution index partialled on Applied Contribution, and Applied partialled on Scientific

Thus, we have found that indices representing the model do correlate to a moderate degree with other measures of dissemination and utilization, and that there is a convergence between model "ideal" perceptions and (at least one) separate measure of ideals (the importance of user problems), and between ratings of actual dissemination and utilization and other measures of present conditions in the organization. On this level, at least, the model seems to "work" as we would hope.

We have not discussed differences across the model steps. These are minor differences in the correlations in each of the columns of Table 9-1 which are explainable. For example, actual microsystem building is the best of the actual model measures in terms of correlation with stimulus from clients. Our interviewing has found that informal, direct interchange between research and client is a way effective linkage is sometimes accomplished. If this is so, stimulation from clients should come primarily through this mechanism, and the "actual" model correlations seem to bear this out. Overall, however, the model indices seem to operate very similarly, in their ideal and actual sets, in terms of their correlations to other measures. We know, also, that there are very high correlations among the model-derived indices. It is difficult to say whether the indices are poorly conceptualized and incapable of controlling distinct variation, or whether it is simply the fact that persons who see ideal or actual dissemination and utilization as high or low in one model step also see other steps the same way.

The next question is the extent to which the model steps relate to the contribution of the individual to his field and to applications. We would hope that the dissemination and utilization indices correlate better with applied contribution measure than with scientific contribution.

Before we can have any degree of confidence in the correlations, however, we must control for personal and job-related characteristics which are known to relate to both the dissemination and utilization indices and to contribution. Also, we need to remember, there is a .50 correlation between applied and scientific contribution, so we will need to "purify" each contribution measure by controlling for the other. The correlation are given at the right in Table 9-1.

Let us look at how the dissemination and utilization indices relate to scientific contribution first, even though we had no specific predictions for these correlations. We find that those Scientists and PLs who are higher in scientific contribution say actual need sensing is done better in their stations, but they are lower in terms of the extent to which they think doing client-centered solution building is an important ideal. These findings may be clarified somewhat: there was no exact definition of who "clients" are, at least within the dissemination and utilization model items themselves. High scientific contributors may well be thinking of other researchers as their primary client groups for the need sensing items. The client-centered solution building items were, however, more closely specified as referring to "on the ground" land manager clients.

Different results occur for the relations of the dissemination and utilization indices with the man's applied contribution. Independent of personal and job factors, and of scientific contribution, those respondents who are making greater levels of contribution to applications rate their stations higher, and consider the ideal activity as higher in the areas of need sensing, doing client-centered research, and microsystem building. In addition, applied contribution is greater among those who think translation and transmission are more important in the ideal, although there is no relation for current stations activities in this area.

Thus, all of the dissemination and utilization index areas except user problem-solving and helping appear to have some modest independent relationships to the researcher's applied contribution. The lack of relation for problem-solving might be based in the fact that the Forest Service research has not really stressed direct help for clients beyond microsystem activities such as workshops, consulting, etc., and much reliance is placed on "how to do it" publications: there is a continuing debate as to just how much direct "user-helping" a researcher should do.

None of these correlations are large, especially compared to organizational and individual predictors of contribution. We should expect to find somewhat greater correlations for "ideal" ratings if there is a strong relationship between attitudes and action, since individual behaviors in each of the five index areas would be defined as exactly what we mean by applied contribution. The rather abstract question wording (couched in terms of what the station's researchers actually do and should do) might account for some of this slippage.

SUMMARY

If we were to pick one area from this analysis to highlight in summary, it would be the positive correlation between organizational support for client linkages and researchers' ratings of station actual performance in all of the five dissemination and utilization factors. From the data, and from our experiences in visiting stations, this support dimension keeps coming up as a crucial one. We feel that both support and reward must be active, not merely a passive permission for the researcher to make applied contributions as he wishes, before real progress will be made. In addition, researchers have been carefully trained to do research, but not necessarily to link with clients: there are a whole range of relational skills, translation skills, etc., which researchers will have to be able to use just as skillfully as they run a correlation if they are to be truly effective in applications.

In finishing this discussion, however, we need to interject the point that we are no more clear than is the Forest Service about which model of applied contribution is to be stressed in the organization. It is not necessary, first, that every researcher be active in this area; but work will have to be done, as we have seen, to make the reward system work equally for those who do devote time in applications. Beyond this, however, there are several models which need discussion, not so much to decide on the correct one, but rather, to develop guidelines as to when each is deemed most useful and appropriate. These models may be outlined like this:

(1) Application as the last step in the research process--here the organization would support one more phase, for appropriate projects, beyond the report-writing stage. Researchers would take an additional amount of time working on applications before moving on to some other topic.

(2) Researchers, or ex-researchers who work on application as their major activity--these research staff members would serve on several projects as one member of a team.

(3) Dissemination and utilization projects which would take over when research and development was finished, probably with completely different staff.

(4) Support of non-researcher application staff to work with projects--there are some examples of this in Forest Service research now, but they are so few that we have heard about several of these persons time and time again when the topic comes up in discussion.

(5) Adding an application capability in research support services--if we have editors, statisticians, and information officers, why not a utilization specialist? These people could only be expected to provide support skills, not to do the whole job; examples would be applications media and translation work. In some respects, the new AD for Planning and Applications fits this definition, or could supervise such a person. We need to caution, however, that this AD cannot be expected to do the applications work himself--he should be a "facilitator."

(6) Developing an applications organization--here the scope would be wider than the mandate of State and Private Forestry, and might follow a model similar to agricultural extension agents. This obviously could not be done by the research branch unilaterally; careful need explorations and policy planning would be required at the top of the Forest Service organization.

The first five of these models have direct implications for different roles researchers would play in the dissemination and utilization process, and all of them are, to some extent, being used now. The point is that we need to explore them in much more detail to develop guidelines for individual researchers when they are planning projects--if the decision as to how application will be sought is made any later in the research process than this, we feel that the decision will be too late to be effective, no matter what it is. Recent statements such as the application section of the Forest Service Manual (U.S. Forest Service Manual, Series 1000) provide the permission to undertake such model development (and establishment of rewards), but this is only the first step, and we have not seen the kinds of staff work needed to produce the operating guidelines and procedures.

CHAPTER 10

TECHNICIANS

READER'S GUIDE:

This is the only place in this report where Technicians' data are discussed. There are enough important issues involving this important group to make this chapter important and part of the continuing discussion of the Technician career.

CHAPTER SUMMARY:

Research Technicians are relatively well-educated individuals, most of whom have less than ten year's experience. They show up as more satisfied with their jobs and stations than Scientists. Many of the same things predict satisfactions as were important for the researchers: freedom and challenge and dedication relate to satisfaction with the station; station satisfaction, together with better opportunity for job stability and salary, and skilled supervision relate to satisfaction with the job. Also, Technicians with more experience and less education are more satisfied with the job. Two-thirds of the high school educated Technicians think they would never have the organization, but only one-third of the college graduates think this.

Job stability, fair evaluation, growth opportunities, chances to use skills and having congenial co-workers are most important for Technicians, but growth chances, fair evaluation, and making use of skills could use some improvement -- opportunities for these are rated lower.

Particularly important problems regarding Technicians appear to involve the topping out of the career path, the possibility of trapping Technicians in the organization, and the award/reward/recognition problem.

INTRODUCTION

Most of our effort, and all of our analyses so far, have been focused on the researchers within the Forest Service. Here we will concentrate on the Technicians, a group which may not get the attention it deserves, because Technicians are not as powerful or vocal. However:

--Technicians are crucial to getting the work done, and in many cases we have seen, the work would or could not be done without the Technician -- who often performs at a level beyond what it says in the job description.

--Technicians are individuals, employees, people -- just like any others in the organization (some of whom we have not studied at all). They therefore have a right to a fulfilling job in an organization responsive to their needs.

In many ways our analyses for Technicians parallel those for researchers. The overall analytical model in the organizational and supervision section can apply directly, for example. In some cases we have found Technicians who contribute to research products (papers, articles, etc.), and who form an important bridge to clients (Technicians may spend more time on the ground, near or with users, for example). So, we also need to identify the kinds of Technicians who are making these contributions.

Technicians also have special problems, most of which we have learned about during our interviewing and feedback work. A partical list would include:

--unclear or "dead ended" career paths, and/or lack of procedures to let topped out Technicians move into a different career track.

--unclear job expectations and division of labor with researchers.

--the friction between the 8 to 5, often unionized approach to "labor" under which Technicians are protected and (sometime) handcuffed, vs. the requirements of a research job (e.g., changing needs and tasks, flexibility, and unplanned-for conditions).

One of the key questions involves what is important to Technicians, and what gaps exist in achieving important goals. This is also one theme of the precedent study of Forest Service Technicians (Koch, 1970), which did not cover research Technicians, unfortunately. As we go along we will make comparisons with the Koch study whenever possible (given different questions, wording, etc.).

WHO ARE THE TECHNICIANS?

The descriptive data in Table 10-1 show that Technicians tend to be in their thirties, recently and rather well educated, and with less than ten year's experience. The difference between research Technicians and those in the Forest Service studied by Koch is that research Technicians are better educated (65% have more than high school education vs. 25% in the Koch data).

SATISFACTION

Four out of ten Technicians reported that "I like my job extremely well, and another 37% tended to agree with that statement. Only 22% were in the middle or negative (and most of these checked intermediate rather than negative responses). This may be a bit lower than in the Koch study,

TABLE 10-1

Characteristics of Technicians

Percentages (N=154)

Age	8%	8	28	16	10	11	8	9	2
	<25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	<60
Years in FS Research	14%	43	19	11	6	3	3		
	1-5	6-10	11-15	16-20	21-25	26-30	31+		
Years at station	18%	43	19	7	6	3	3		
	1-5	6-10	11-15	16-20	21-25	26-30	31+		
Years since education completed	28%	15	18	13	10	8	8		
	1-5	6-10	11-15	16-20	21-25	26-30	31+		
Education level	35%	38	17	6	3				
	High Sch. or less	Some College	College Graduate	Some Graduate Work	Master's Degree				
G.S. Grade	3%	24	11	31	5	22	4		
	4	5	6	7	8	9	10		

but the questions were not identical. Comparing Technicians with the researchers on overall satisfaction with jobs (see Table 10-2), we find that Technicians are more satisfied with both their station than are the researchers, and equally high (with PLs) in terms of job satisfaction. Either Technicians' needs are better met, their expectations are not as high, or they are not as critical as are the Scientists. Perhaps they are not close enough to some issues to be able to form any judgment other than "it seems OK."

To analyze factors relating to satisfactions, we adopted the general predictive model used for researchers (with a few modifications), and got the results in Figure 10-1. Freedom is an exceptionally strong predictor with station satisfaction, and challenge and dedication does a good job,

TABLE 10-2

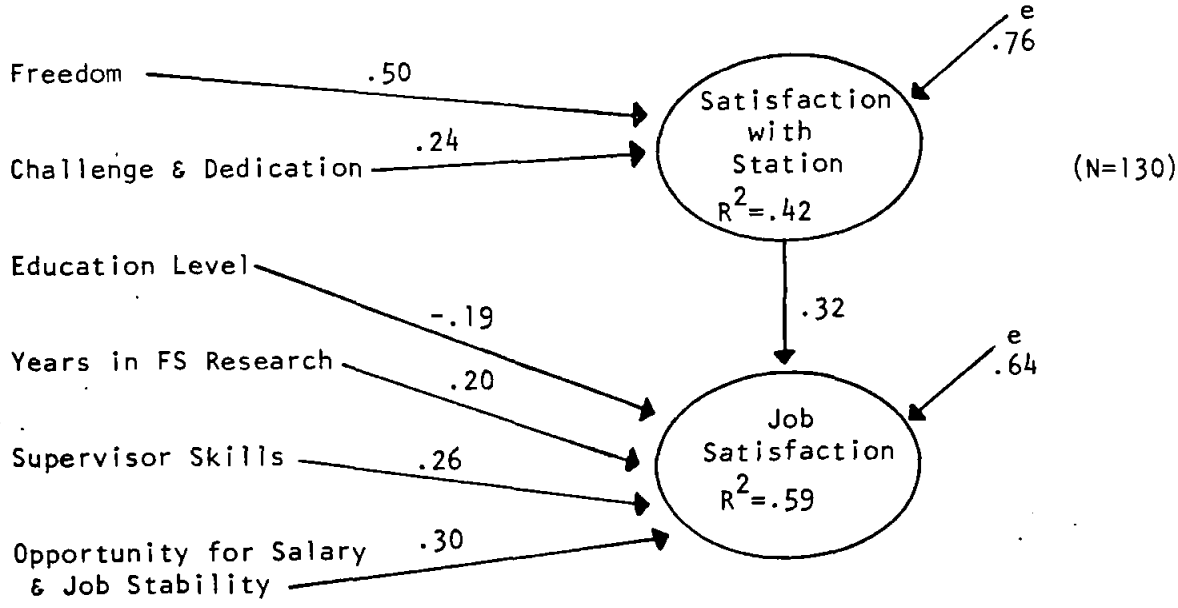
Comparing Satisfactions for Technicians and Researchers

	Mean Satisfaction with*:	
	Station	Job
Technicians	2.36	2.01
Scientists	2.94	2.39
PLs	2.82	2.06
$F_{2;1095}$	28.5	28.6
$p <$	.0001	.0001

*Satisfaction scales run from 5="low" to 1="high," i.e., lower scores indicate greater satisfaction.

FIGURE 10-1

Path Analysis of Satisfactions for Technicians



too.* Job satisfaction is higher for those more satisfied with their stations, with more skilled supervisors, with better opportunities for good salaries and job stability, who have less education, and who have been employed longer in research. The power of the experience measure may, again, be due to less-satisfied Technicians leaving the organization.

So, the model looks much as it did for researchers, with some reasonable changes -- career growth is not as important while job stability and salary is, and information flow does not enter the picture.** It is interesting to note the strength of the freedom factor in accounting for satisfaction with the station. The Koch study found that national Forest Service Technicians put a high value on freedom, so perhaps this should not be too surprising. The question is, how can we give sufficient autonomy/freedom to Technicians within the constraints of their job roles and the requirements of the work. Koch found, as did we, that more educated Technicians are less satisfied with their jobs. The question then becomes one of career paths, training, and education.

One way to look at this is to zero in on one component of job satisfaction, whether the Technicians would ever consider leaving Forest Service research. Technicians who are more satisfied with their stations say they would be less likely to leave (r=.42), as do those who like their jobs (r=.55), and those with more year's experience (.24). More educated Technicians tend to be less favorable to the "never leave" viewpoint (-.26). Table 10-3 looks at this relationship in detail.

The splits are almost neat two to one both ways: two-thirds of the high-school educated group fall in the "never leave" group, while among the college graduate Technicians, two-thirds are neutral or inclined to disagree about never leaving. There are two ways to look at this: first, how to keep the highly educated Technicians who are very skilled and valuable, but may have good job opportunity outside. The second is the possibility of trapping Technicians (by over specialization or physical location roots) so that they could not leave if they wanted to. Unfortunately, we do not have any data which can tell us how many Technicians feel trapped, but we know the problem has been discussed in some stations, particularly as it relates to career growth limits on the Technician job.

*Though not shown in this analysis, it appears that the component of station satisfaction most related to job satisfaction is that part which is predicted by challenge and dedication -- if this latter measure is added to predicting job satisfaction the predictive power of station satisfaction disappears.

**Chances for growth are important for Technicians, as we will see later; this factor is overshadowed by others in the prediction of satisfaction, however.

TABLE 10-3

"Would Never Leave" by Education Level
for Technicians

"I would never consider leaving FS Research."*	Education: High School	Some College	College Graduate	
Agree or tend to Agree	67%	52%	37%	53% (80)
Neutral, tend to, or disagree	32%	48%	64%	47% (71)
$\chi^2 = 8.74$ $p < .02$	100% (52)	100% (58)	100% (41)	100% (151)

*Actual meaning is in terms of checking whether the statement applies or tends to apply, or whether the polar opposite statement does.

IMPORTANCE AND OPPORTUNITY RATINGS

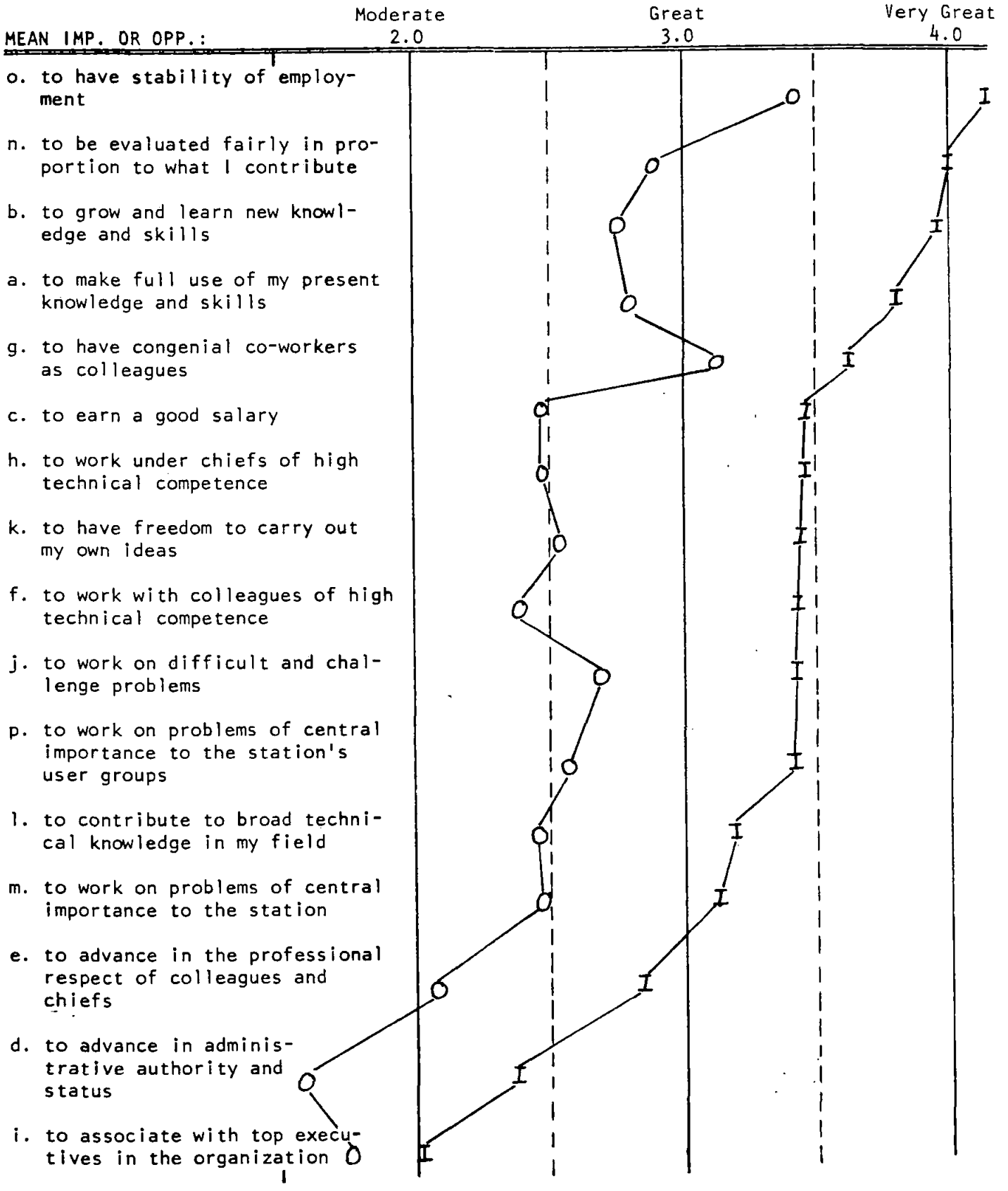
The "importance -- opportunity" measures give us a good, quick summary of what things Technicians think a good job should have and the opportunities which exist for those things (see Figure 10-2). The five most important "job factors" make an interesting story. Technicians are looking for stable jobs in which they can grow and be useful (and be evaluated fairly for their contributions) in a congenial personal setting. "Status advancement" items are of least importance. Among the important factors, it looks as if Technicians are well along in meeting their needs for stability and congeniality: the gaps between means for importance and opportunity are relatively small. Growth and skill learning in particular, and evaluation and chances to use skills also, seem to be areas where Technicians would like to see greater opportunities. Perhaps the key questions here are how to provide for growth and utilization of Technicians -- and how to reward it.

WHAT THE TECHNICIANS SAY

Most of the written comments made by Technicians are indistinguishable from those of researchers -- they are, for the most part, very insightful observations of the state of the organization and of individual roles in it.

FIGURE 10-2

Importance of and Opportunity for Job Factors for Technicians*



*All importance-opportunity paired mean differences are significant at the .0001 level.

Of course, there are also some comments about things which affect Technicians specifically. Below we have organized the comments according to the major sections of the questionnaire.

About the Station

...personnel are highly cooperative, friendly, and interested in their work

...ideal facilities close to our working area

Given reorganizations and freezes imposed I feel station is doing OK

There is freedom at our lab

The goals of the station are vague or unknown to me

...need more help at the Technician level and less administrative harassment

Generally I consider administration of station very poor

About the Locations

...outstanding. We have a University School of Forestry and a national forest in our town

...excellent for getting into the field and living conditions →

...located in a remote area, has no library facilities for this type of research...no classes available

...terrible as far as access to administration, equipment, and supplies

...poor climate and a high cost of living. Many people have serious family problems because of this [Alaska]

...could hardly be worse...we are primarily a field operation... stuck in a multi-story federal office building never intended for this use

About Units

A good group of people to work with

...has done outstanding work in the past →

...however, it has stagnated because PL was [away]

About Units, continued

PL is tops. The work gets accomplished as it should. All segments cooperate to a remarkable degree

My unit is small and split... most of my unit dissatisfaction probably stems from this split

About Jobs

...challenging and interesting → ...but I'd like more administrative responsibility

...it's fine, for lack of a college degree → ...other than its apparent policy limitation for advancement... financially it doesn't keep up with inflation

No career to develop for technicians...

Limited as long as I am a Technician. However, I accepted that fact when accepting the position

About Supervisors

I still look to my former supervisor (scientist) for immediate direction. I regard him most highly

Don't blame him, it seems that no one can keep up-to-date with confusing, changing, and conflicting rules

Well organized and certainly an outstanding individual--I am supervised enough to give me help when I need it and to "keep me on my toes" but not so much as to make me feel that "someone is standing over my shoulder"

A good man but overworked and sometimes discouraged by lack of upper echelon direction

Knowledgeable, dedicated, considerable and congenial. A go-getter

CONCLUSIONS

The data show that Technicians react to the organization and the job much the same as researchers, though the scientific values of discovering knowledge are less important than dimensions of job stability. Technicians can thus be seen as the bridge between the values of the committed researcher and those of the 8 to 5 employee. There are probably both approaches to the job at work in differing proportions in each Technician, and the job environment also pulls him both ways at once. The difficult task for management is to provide the challenges, contribution opportunities and rewards needed in the scientific motivation while satisfying the more routinized 8 to 5 protections, motivations and regulations. Unionization is, in part, a reaction of Technicians to job-related demands that they function more or less like Scientists (the long hours, personal inconveniences for the sake of the project, etc.). The conflict in the approaches will remain, and can be partially resolved only (in our view) by careful attention to the group settings and personal recognitions provided for Technicians.

For example, much of the discussion in the feedback/problem-solving meetings at one station involved how to recognize and reward the work of Technicians, and indeed, just what the Technician's job should be. Recommendations included more attention to the awards program for good work, better writing of job descriptions, and a frank but helping approach to career guidance.

Open discussion and problem-solving work such as this is needed in each station, using settings in which Technicians feel free to contribute fully. We also remember the problem-solving meeting at which Technicians met as a group -- and stated that this was the first time they <u>had ever</u> met together. Management needs to do a better job than this.

CHAPTER 11

PROBLEM-SOLVING AND FEEDBACK PROCESSES

READER'S GUIDE:

This chapter covers in detail the feedback and problem-solving work of the project. It is of value to anyone concerned with how scientific data need to be "plowed into" organizations.

CHAPTER SUMMARY:

The use of data in problem-solving must, we feel, be in the role of a stimulus for group discussion, given the limitations, the results the context contain. Groups can, with good process help, be led to milk the data well, extracting problems and implications for change.

Varying degrees of feedback and problem-solving took place in the eight stations and the Forest Products Laboratory. Some got through to making changes based on recommendations from the groups which worked with us. Others got only a small distance down the road.

There is some (very) slight evidence that stations who got more involved in feedback and problem-solving may be more innovative and provide more coherent, satisfying research programs.

It is extremely unlikely that this questionnaire (survey instrument) is going to bring about any change.

INTRODUCTION

Our task here is a broad one of describing the "what" and the "how" of the process by which we have tried to help Forest Service research learn from and make use of the information we have collected in our study. We will focus on the activities through which we have linked research findings with real people, groups, and problems for the purpose of designing ways to improve the system.

What we will see is a series of "wheels within wheels" problem-solving activities, ranging from the overall "R&D Lab Renewal" model we have developed for the project on one hand, down to the specific discussions held within stations to come up with workable action plans on the other hand. That is, the overall lab model we have used is basically a problem-solving sequence. Nested within this there are many specific complete problem-solving sequences.

In this chapter we will concentrate on four things:

(1) an elaboration of the stages in a complete problem-solving sequence, and examples of how the processes were used in this project;

(2) the relation of the problem-solving stages to the Lab Renewal model and to data feedback activities, where we will see that the model steps are really only different labels for more general problem-solving steps, and that feedback is the way we relate what we have found to the groups who must use this knowledge;

(3) a detailed look at the process of data feedback, and the specific role of data in the problem-solving sequence;

(4) we will end by describing what we actually did in stations as part of feedback and problem-solving.

ORGANIZATIONAL PROBLEM-SOLVING

Let's begin by looking at the basic processes of problem-solving which underlie both the lab model and data feedback, and which guided our work in stations. As we present each stage in the sequence we will discuss both what we did in terms of the content of problem-solving work, and how we worked to insure good problem-solving processes were used.

It is not difficult to explain organizational problem-solving. It is a rational-logical process of working through the major issues that concern a goal oriented and organized group of people. The process starts with carefully structured procedures which identify and effectively define the problems of the system. It ends one cycle and begins another when that system has conducted a careful evaluation of its new actions and has decided that the solutions have either worked or not worked.

Helping a group understand and then <u>use</u> this process is not so easy; but that was our goal in the Forest Service project. The aim of this section is to describe the steps we use in organizational problem-solving.

As we begin, the reader needs to understand our assumption that problem-solving takes place at two "levels." The first of these is the visible task-related level of working tasks and steps that need to be achieved if problems are to be solved. The second, less noticed level concerns itself with the processes, skills, and interactions of people as they work on problems. We call the first the content area of problem-solving, or WHAT we do, and the second the process area, or HOW we do these things. Without the complete support of the HOW, the WHAT goals will be retarded, or in many cases forgotten or discarded.

Let's go on to a brief description of the major steps of organizational problem-solving which we use, and a short discussion of the behavioral acts which we feel are necessary to accomplish each step in the process.* Below we will list the five major steps, but we need to note that the boundaries between steps are often somewhat unclear in the work of a group, and that there is often a certain amount of re-cycling to an earlier step as knowledge and situations change in the group. The attempt is, however, to try to keep the process as linear and clearly defined as possible as we work with a group, both to help them learn the sequence and to work on real problems.

(1) Problem Identification and Definition

Problems in any organization, of course, cannot be solved if they cannot be identified. We believe that the better the problem identification procedures are, the better will be the chances for implementable solutions to these problems. Partially or incorrectly defined problems can prove frustratingly immune to later solution. Therefore, the first step emphasizes work done to identify major issues in Forest Service research.

Problem identification may be done several ways. In this project we have chosen to use two methods in the hope that they would converge on the types of problems they brought to light, thus giving some needed validation of problems before extensive effort was placed on developing and trying solutions. The data we collected to describe and relate organizational and individual factors, knowledge flow, etc., was one method. The second was the collection of problem statements from Forest Service staff. There was a cyclical nature to this merging of methods: we listened to the system for a full year, in station visits and group interviews, before creating the survey instrument. In the first stages of feedback the data are used as stimuli to evoke further and redefined problem statements from the groups to whom we report.

*For a thorough description and discussion of organizational problem-solving, see Morris and Sashkin (1976).

How do these two methods combine to insure good problem identification and definition. It occurs by emphasizing and supporting the establishment of specific behaviors within ourselves and in those who are a part of the problem-identification step during the first phases of feedback.

At the content or WHAT level we:

--seek out as many information resources as possible, insuring that all points of view are represented;
--look at a problem area from as many aspects as possible;
--take all of the information relating to one problem and look at how these pieces "hang" or fit together;
--and finally, we attempt to state the problems so that everyone understands them and agrees that they are defined adequately.

At the process-HOW level we:

--make sure that those directly involved in a problem area will have an opportunity to give information freely;
--attempt to create an atmosphere that encourages openness and sharing by everyone concerned;
--encourage suggestions from as many people as possible on how the various inputs on a problem area fit together to form a conceptual whole;
--and keep everyone problem oriented, rather than solution oriented during the process;
--keep the discussion focused on validated problems (derived in a convergent manner from data and group experiences), and more to another time and place any "researchy" discussion of methods, statistics, etc.

(2) Problem Solution Generation

Up to now the research has been done. The facts are in. The "truth" is known.* What happens now? We could send a report, publish the results, and go on to something else, hoping that our clients--in this case Forest Service Research--would "see the light" and implement our recommendations for action, our solutions to organizational problems. Unfortunately, most lasting changes come from people interacting personally with each other to hammer out solutions to problems and in the process commit themselves to carry out those solutions, not from a list of outside recommendations, however well written. Thus, we have stated our major concern: how do we help people develop ways to use the knowledge they have collected about their systems to benefit both themselves and the groups and organizations in which they work? A simple answer but a difficult task: they and we become personally involved in finding answers and designing actions. This was the intent of the work which followed feedback in meetings in the research stations. We were no longer looking in on the system as observers,

*At least to the extent social scientists removed from the actual situation. We have found that, in the problem solving interaction with clients, we got leads for qualifiers, conditions, and other predictors which led us on to more powerful and refined analyses later.

we were joining into the problem-solving activities. Necessarily, at this stage we were joining stations and even smaller groups--where the data are relevant to specific, rather than general problems. We also needed to begin teaching and supporting different problem-solving behaviors.

When data are being fed back into smaller groups in the organization, we are attempting not only to teach problem-solving skills but also to help focus on specific problems and derive potential solutions to these problems.

At the content-WHAT level we:

--try to make sure that everyone understands the "rules" of the activity, to propose many solutions to a problem without criticisms from others;
--attempt to generate as many solutions as possible from all the resources of the group;
--make sure that alternatives are clarified, and others added when necessary;
--and help the group combine various ideas into tentative "sets" of alternatives.

At the process-HOW level we:

--encourage ideas from everyone, particularly those who might be slower than others at proposing ideas;
--help the group recognize that all solutions to a problem are sought, even those which at first glance might seem foolish;
--discourage and postpone evaluative comments, asking for another alternative instead;
--attempt to discourage dominance of the activity by one person or only one frame of reference by several people;
--and finally, make sure that all alternatives are written and posted so everyone can see them.

(3) Solution Evaluation and Selection

If small groups have done their brainstorming well, there are many alternative solutions to a particular problem to evaluate. At this stage in the problem-solving process it is essential to critically evaluate each of the proposed solutions. During this period everyone is more able to help and participate if there is no attack or threat involved. So, rather than weeding out the poor alternatives (and making those who proposed them feel defensive), we believe it is better to select or combine alternatives to produce the best ones and work them over, until everyone can agree on one or two (or the set) of solutions to be tried out.

At the content-WHAT level we try to help the group:

--discuss thoroughly each idea in terms of the information needed to support or contradict that idea;
--modify and combine alternatives into an improved set of potential solutions;
--examine alternatives in terms of human and material costs associated with each, and in terms of new problems which might result;

--and finally, select a set of alternatives for trial and discuss these as to potential outcomes.

At the process-HOW level we try to help the group:
--critically evaluate ideas without attacking the individuals who proposed or supported them earlier;
--give support to persons whose ideas are being evaluated, reducing feelings of rejection;
--focus on identifying and selecting the best alternatives rather than identifying and rejecting poor solutions;
--and take into account differences of opinion and personal preferences and work these through to a final consensus on a trial solution.

(4) Solution Action Planning

Many believe that problem-solving stops with completion of the steps outlined above. For most this is a natural stop-point in the work. It feels good to come up with a solution to a difficult organizational problem, make recommendations to the boss, and go on to something else. Unfortunately, this is just the reason why many solutions to organizational problems do not get implemented--somebody else has to make plans to carry them out, often those who themselves won't even be involved in the process of carrying them out. Thus, our goal becomes one of helping the problem-solving group itself plan and design the solution implementation procedures. In Forest Service we found that this approach conflicts somewhat with the traditional model of "staff work recommends, line officer implements," (see the next chapter).

At the content-WHAT level we try to help the group:
--prepare a list of sequenced action steps needed to implement the solution, including a realistic time schedule;
--identify and list the forces which might help or hinder the action process being planned;
--identify all of the needed resources, material and human, necessary to make the solution work;
--and clearly assign responsibilities for carrying out specific action steps and for coordinating that process.

At the process-HOW level we try to help the group:
--involve everyone in the discussion, particularly in sharing information needed to define action steps adequately;
--use an effective brainstorming process to generate and then evaluate influential forces that might affect action steps;
--openly identify persons whose support would be needed but might be withheld, or those who might have to take part in certain actions but might not choose to do so;
--and finally, make sure that each person asked to accept a task responsibility is willing to make a commitment to the group to carry out that responsibility.

(5) Solution Evaluation Planning

Organization and small group problem-solving is not yet complete. Even with well defined and clearly understood problems; excellent work done to generate all solutions possible; choice of the right set of solutions through careful evaluation; and a well thought out plan of action with clearly assigned responsibilities for implementing the processes not completed, careful thinking remains to be done to create a plan to evaluate whether or not the chosen solution worked. Thus, our goal in this last stage of the overall process is to reinforce the actions necessary for describing such a plan and monitoring the process of its implementation. Basically then, we help the group develop an evaluation plan, assign responsibilities for it, and describe procedures for carrying it out. All organizations are interested in success--in effective solutions solving real problems. We believe that if they can learn to keep track of exactly what happens as a result of specific actions, then it will be possible to make, during this process, fairly minor improvements or adjustments which will significantly help in solving the problem they started with. This is best done not by guess work or trial-and-error, but on the basis of hard, accurate information about the effects of actions. It is through this phase, we believe, that the greatest potential exists for learning to solve organizational problems AND for learning the skills ncessary to continue that process inside the system, rather than continuing to seek outside help. Frankly, we never got this far in this project, for reasons we will discuss later.

THE RELATION OF PROBLEM-SOLVING TO THE LAB MODEL AND TO FEEDBACK

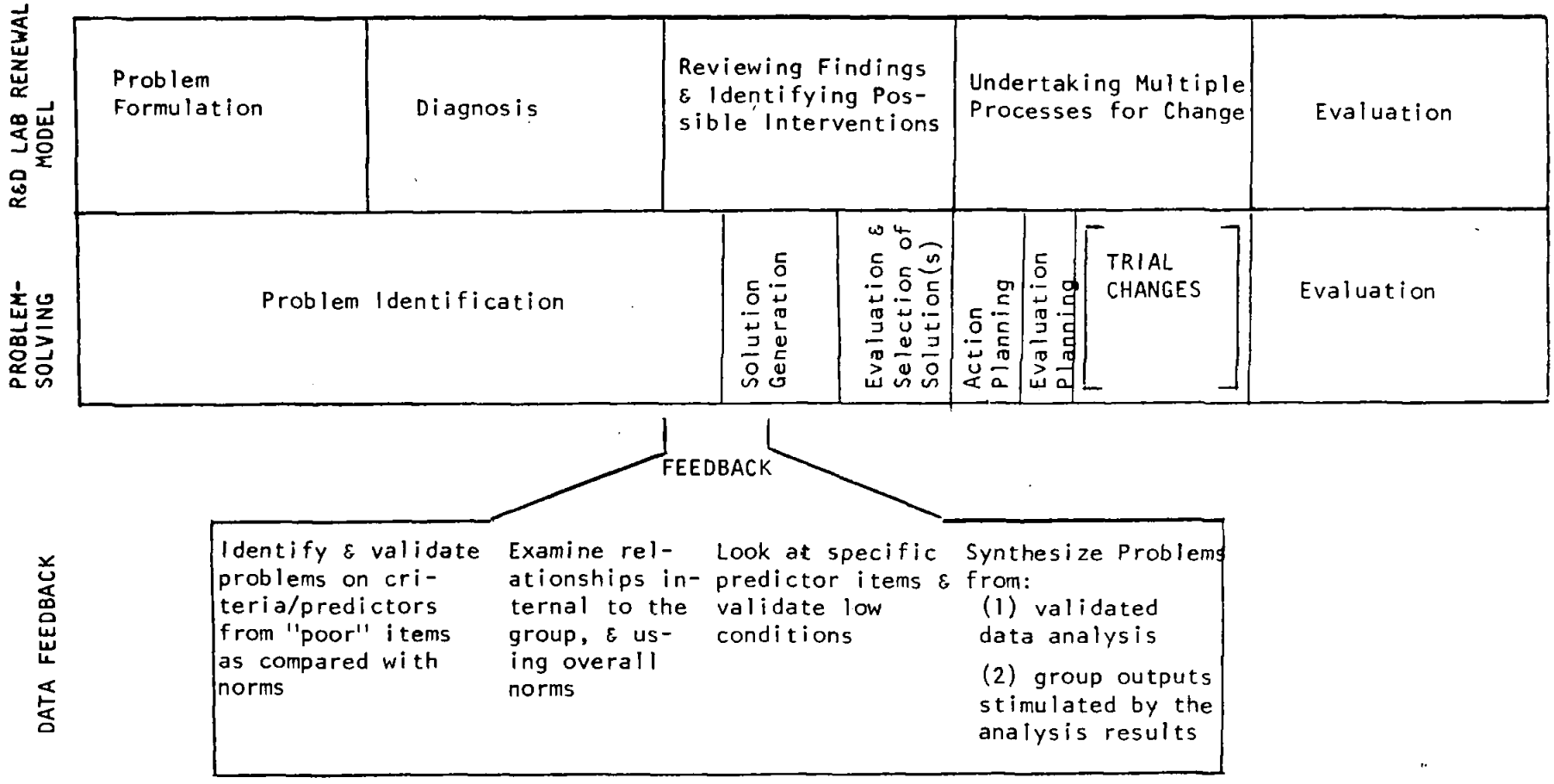
As we've said earlier, the lab model can be seen as a problem-solving sequence with a slight change in the labelling of activities. In other words, it is an attempt to change the "pure process" terminology of problem-solving to terms which have more specific meaning in the R&D lab context.

The data feedback process is, on the other hand, one specific way of doing problem identification and implication-building in the situation in which research knowledge is used as a stimulus for group generation of problem statements, and for its ability to consider many empirical factors at once in defining problems. Since, in the next section below, we will go on to look in detail at the role of research data in feedback, we need to be very clear as to how feedback, problem-solving, and the lab model relate to one another.

Figure 11-1 shows the relationship between these three formulations. We can see that the major differences between the lab model and the more general problem-solving process come at the "Problem Formulation" and "Diagnosis" stages of the lab model, as these relate to problem identification and solution-building in problem-solving and to data feedback activities.

FIGURE II-1

The Relationship of the Lab Model, Problem-Solving, and Feedback



What the lab model calls diagnosis is one way of doing problem identification; that is, the researcher's way in which empirical data are collected and analyzed to highlight the conditions (and major problems) in an organization. Thus, diagnosis is part of the first step of problem-solving. As data analysis is completed during diagnosis, the results shape our plans for activities to be done during data feedback. Specific feedback activities are designed to highlight the descriptions and relationships in the data. Descriptions of conditions can be interpreted as "good" or "poor" performance in many instances, and in this way the analysis serves to identify potential problem areas. Feedback must, then, carry these insights back to the group for validation, and for combination with problems seen from the viewpoint of system members.

Thus, feedback activities serve to link the problem identification work of the researcher to the implication-building and action planning of groups, in a way which allows for corrections of poorly or partially identified problems. The details of how we have used data to do this are given in the section below.

THE USES OF DATA IN THE STATION FEEDBACK PROCESS

At first glance the title of this section may appear gratuitous, since the "feedback" process is one in which the findings of research are presented, and implications for action produced. Yet, the process is never this straightforward, at least in the Forest Service project. Our basic contention here is that the research findings must, for maximum impact and action, serve primarily as stimuli for the work of groups in the organization, and that it is the products of these groups which then have the real effects. In other words, it is often impossible to see clear implications and action recommendations in the data themselves. Several reasons may be suggested as to why this seems to be the case:

A. IN THE RESEARCH PRODUCT:

(1) The data are abstracted from reality. Survey questions are designed to encompass all of what we learn in problem formulation, and hence have to be more abstract, or cover more ground, than a specific problem in any given station. Some questions were drawn from concepts, models, or theories in the social sciences, and thus have been abstracted even further.

(2) Analysis involves indices created from questions. This is really a further level of abstraction brought about by the fact that we had to ask many questions to cover a real research organization in the depth demanded by our model. It was necessary to reduce this confusion of questions into

some smaller number of dimensions for the complex analyses required. Index construction combines questions together to accomplish this reduction and to increase the reliability of measures, but it also abstracts further from the original reality.

(3) Measurement and analysis involve error. Error enters into research at many levels, and all error adds unclarity as to the real state of affairs in the organization. Questions may tap their core area poorly, as a result of poor wording, etc. Respondents may make errors in reading questions, and in recording their answers. Computational errors are possible in scoring and in analysis. The result is that the findings are probabilistic, and there are always unexplained differences across groups, or unrelated variations in correlations which obscure "truth."

(4) The data get old. Time does not stand still, and the research organization changes. Conditions and staff present when the data were collected may no longer be in place.

(5) Not all of the relevant analyses can be done. Analysis of survey data, particularly with the complexities imposed in our model, can, almost literally, go on forever. This is true for analysis across all of the stations, let alone within a particular station or other group, where a predictive model may differ slightly from the national model.

(6) It isn't possible to do some analyses. Particularly at the station or other small group level, but even at the national level at times, there simply aren't enough data to allow for the many predictors, subgroupings of cases, and criteria which we feel it is necessary to use to get a picture of how all relevant factors relate at the same time. There is always some important factor not controlled for.

(7) We are never certain of predictive models. Even though we have been trained not to, there is a real need to try to turn predictive analytical models into causal models, but we can never be sure, in most cases, whether A leads to B, B leads to A, or they lead to each other in a reciprocal fashion. We make our best guess based on temporal sequences of events, logic, previous theory and research, and perceptions from our clients of how things relate, but there is still a great deal of slippage.

B. IN THE FEEDBACK SETTING

(8) Groups sometimes miss findings. There is a lot of information to be covered in a feedback meeting. We may fail to highlight what looks to be an important finding, or the group may miss what we say, or miss the finding themselves in data charts. There may not be enough time for elaboration.

(9) Methodology may confuse some people. Even though we try to keep it simple, some people may not understand the methods we are using, and thus, miss the import of what the data say.

(10) Arguments about methodology take place. This is a problem particular to data feedback with scientists, who are often better methodologists than we are. We have to appear methodologically credible. On the other hand, researchers like to talk about methods, and some individuals even take pride in being able to stop another researcher cold with a methods question -- particularly if they don't happen to agree with his premises or intent.

(11) There is danger of information overload. Complete analysis of many factors in complex organizations creates a great deal of information, often more than one person can deal with. Listeners are forced to be selective in order to retain anything. Thus, no one ever has a really complete picture of all of the findings, let alone how they all inter-relate.

This list could go on and on. The point here is not to be exclusive in listing the limitations on the data and the feedback setting which keep the process from leading immediately and automatically to implications and action. Rather, all of these factors combine to create real questions about the validity and the comprehensiveness of the findings, and thus lead to limits on tbeir immediate utility. A further process must intervene, and this is why we have tried to stress to groups in feedback the value of the findings as stimuli and as idea-generators, while cautioning that they themselves must turn these into validated statments about strengths and weaknesses, levels and relationships.

Typically, we divide feedback settings into stages of familiarization and findings, group derivation of implications, and generation of prioritized problems for further work (together with a process for getting on with the task). The second step is most important: small groups look through the results, relate them to their own experiences, and come up with a "validated" set of statements. Many findings disappear in these discussions because they fail on one or more of the limitations listed above. Other results get combined together as indicators of some more general condition, or conversely, some more specific factor which we did not measure. Finally, completely different factors may be brought into play, again things we did not measure or report, as a result of the concerns and perceptions of one or more of the group members. The variety of the questions asked helps insure that the group members get a chance to look at their work and organization from many different perspectives, some of which they may not have thought of before.

Description and Relationships: This is a separate specific issue related to the usefulness of various kinds of analysis in the Forest Service feedback. Basically, we have found that many different kinds of analysis can be valuable, but each must be used in its proper role. The basic distinction is between analyses which report the position, level, or description of some group on an item, index, or sets of items or indices, and analyses which report only relationships between or among items or indices. It is our impression that both are necessary to achieve understanding of the results, but that neither type is truly sufficient alone.

A typical descriptive analysis displays the averages or mean scores of a group or groups. This may be as simple as just an average on a scale (e.g., the mean for Scientists in the station is 2.5 on a scale ranging from 1=low to 5=high on question X), or a comparison of the means of groups (through t tests or analysis of variance). Descriptive measures may also include percentages of groups who have some characteristic; the data here aren't limited to mean scores. Descriptive analyses need not be simplistic--many sub-groups may be produced.

Description often includes a comparison to a reference group or norm, and these comparisons can be broken into four types:

(1) comparisons internal to the data -- looking at differences in means across items (e.g., question X is rated lower than question Y).

(2) comparisons internal to the groups -- looking at differences among relevant groups within the feedback organization (e.g., Scientists rate this higher than do PLs).

(3) comparisons against an external norm (e.g., Scientists in our station score higher on this than do Scientists nationwide).

(4) comparisons against an ideal -- ideals may be either measured, as in the contrasting of ratings of "how it is now" and "how it should be"; or they may be unmeasured, in which case the group supplies a standard for how high the rating ought to be (e.g., "I think we can improve on this area -- the group ought to be rating this "very good," rather than just "moderate").

One comment on the scales of measurement is important here. We have found, particularly in index construction, that it is essential to preserve the original metric used when the question was asked. Most methods for constructing indices "standardize" the data, for good methodological reasons, but in so doing eliminate the underlying scales, and this completely removes the ability to make comparisons of the first and fourth types above. For example, standardized scores will all have equal means and variances, so we can't tell how one such score compares with another.

On the other hand, the analysis of relationships tells us how much one measure varies with another. A correlation of .80 tells us that 64 percent of the variation (.80 squared) in one measure is controlled by the other measure. Other measures of the predictive power among measures work in a similar fashion -- they all tell us how things relate. Obviously, though,, a correlation can't tell us where groups are on the measures: it is possible to get the same correlation for measures which are rated as "poor," on the average, and for measures rated generally "good."

We have found that analysis of relationships serves best if used as a filter to highlight which measures are important, and which relate well to criterion measures. This is necessary when there are as many questions and indices floating through the data as we have in this study -- something must be used to direct our attention on only a few of the measures.

Once this filtering has taken place, however, we have found that we have to return to the descriptive data before there is enough useful information for the group to use the results as a basis for action planning. A hypothetical example of the kinds of questions that would be asked in the group, and answered from the data, is helpful in clarifying the way the various analyses are used:

(1) First, where are we as a station on the criterion of "Scientific Contribution?" Are we high or low, compared with other stations, how do Scientists and PLs in our station compare? Are these levels as high as we think they should be? Are there any particular areas or components of contribution that might be low, even if the overall index measuring this area isn't?

(2) Assuming it is important to try to work to improve this: What do we know nationwide about how various characteristics, behaviors, and opinions of researchers relate to, or predict contributions?

(3) Where do we as a station, and the various groups in the station stand on the important predictors of contribution? Where are we high or low, or are we as good on these as we think we should be?

(4) These predictors are broad <u>index</u> areas: Where are we on the original questions which make up those index areas we have said are low, or otherwise need some improvement?

(5) Now, what do these low <u>question</u> areas really <u>mean</u>: What is producing that low rating here, what does the question stand for, is the question valid here, do these results look right in terms of the station as you know it now?

At this point the group has, by working itself down the ladder of abstraction and inter-weaving relationships and descriptions, arrived at the point at which it can begin talking about how to develop action implications and programs. None of the various analyses would have been sufficient in and of themselves, and by implication, the CRUSK staff could <u>never</u> arrive at the same level of potentially useful action recommendations by itself -- the group must participate in the process in order to understand, validate, and make input to the action planning process in order to come up with <u>needed</u>, <u>workable</u>, and <u>acceptable</u> solutions.

Even with all of the limitations mentioned above, the data <u>do</u> provide a large number of valid stimuli useful as a starting point for problem formulation. A good example of this is contained in a comparison of our data and comments from staff in the Southern Station.

The first part of Figure 11-2 indicates the topic areas or responsible "action points." The second part compares the comments with areas our data had identified as potential problems.

FIGURE 11-2

The SE Station Poll

Tabulation of Comments made by Station Staff in Poll*

Directed to	Approximate Number of Comments
Director or ADs	18
Project Leaders	25
Scientists	5
Promotion Panels	24
RSS Staff and Operations	20
Meetings and Visits Needed	10
Station Policies or Activities	151
(Technician Problems = 32)	
(Poor Communications = 46)	

Although this list does not include all comments, 90% of the comments fall within these subjects.

Comparison of CRUSK Findings with Comments made in Poll

Problem Highlighted	CRUSK	POLL
Scientist's Role in Planning	Yes	Yes
Location of Work	Yes	No
Cooperation Among Projects	Yes	Yes
Supervisors are Work Oriented	Yes	Yes
Lack of Stimulation in Job	Yes	No
Scientist and Tech Training Insufficient	Yes	Yes
Personnel Evaluations	Yes	Yes
Knowledge Communication	Yes	Yes

*This figure was prepared by a member of the "Jackson II" team.

The vast majority of the comments dealt with policies or activities of the station as a whole, many of these in the area of poor communication and non-specific as to who or what group should try to solve the problem. This is typical of such problem statements, indicating the amount of work a team must do to design practical solutions. The overlap between our data and the poll was quite good here except in two areas. We accept the judgment of the staff here rather than the data--this is the validation process.

A SUMMARY OF FEEDBACK AND PROBLEM-SOLVING WORK IN STATIONS

Armed with the results and our knowledge on one hand (the content side), and problem-solving and feedback techniques on the other (the process side), we began to plan work with each of the stations in Forest Service research.* In this section we will review these activities, noting the differences in the progress of the work at various stations.

By the time the 1974-75 budget year began, we had just begun Phase III of the overall Forest Service Research project model. The lab model indicates that during this phase we would be reviewing the findings from the previous data collection effort and identifying possible intervention strategies to use in each of the stations. The method to be used during this year of work was a combination of data feedback and action planning processes. Thus, while continuing to organize the data in ways appropriate to individual station groups we began scheduling data feedback dates with each of the stations. As we began this scheduling task it became increasingly apparent that there would be considerable variation across stations in the models and processes of data feedback we would be using. Every station leadership group chose slightly different variations of the overall model we proposed.** In a very general way that model called first of all, for us to present specific station data to selected station groups; and secondly, as a result of those sessions help the station group derive from the data a set of specific implications for next steps of action in the station.

Within this problem-solving framework then, we will go on to describe the process used in each of our visits. All months mentioned below were in Fiscal Year 1975, unless otherwise noted.

The Southern Station

Our first visit of the year was to New Orleans. Here we met with the Director and his staff. We had prepared data charts ahead of time for the Southern station, as we also did later for all other stations. The charts were presented to the staff and we spent considerable time discussing the data and attempting to derive implications from them. The other major purpose

*Least this sentence give the impression that all of the details were worked out from the beginning, we need to note that both the content of data and analysis in feedback, and the processes used, changed and matured as we gained experience in the various stations.

**See Morris and Lingwood (1973b) for six suggested data feedback models which were proposed for use in work with the stations.

of the meeting was to make decisions regarding further feedback efforts in the station. It was decided that a first step in this process would be to attend the Project Leader's meeting the following month, in October 1974. At this meeting we presented newly organized data charts (resulting from suggestions made in the Director's staff meeting) to the Project Leaders and spent a short period of time helping small groups derive some problem statements from the data--the problem identification step in the overall problem-solving process. At this meeting no decisions were made to continue this small group problem-solving process. Within the following two months we were asked by the Southern station to provide a written report of findings and recommendations for further actions. We responded to this request by writing a brief report. We also re-emphasized the importance of continuing the problem-solving process by involving many station members in the process--both of problem identification and creation of alternative solutions to problems. In April, 1975, the station circulated this report to all researchers and 40 selected technicians, asking for a review and for written statements of current problems as the staff saw them. A vertical team of 11 members met with the CRUSK staff in May, 1975, to discuss all of this information and to derive solutions and action plans for the most critical problems. By early July the product had been edited into action recommendations for the station in 6 problem areas and this document was submitted to the director for review and action. Southern has made substantial progress through the problem-solving steps, and at a level roughly equal to that of Rocky Mountain, the "Jackson 11" team may provide a core of skill and knowledge for future work unsurpassed by any other station. The Station Director received and responded to the recommendations.

The Northeast Station

Our second station visit of the year was to Milford, Pennsylvania. Here we met with the Director's staff to present data charts on the Northeast station. Purposes were the same as at the Southern station, to familiarize the leadership staff with the data and to decide on further feedback efforts. Although the first was accomplished, the second was not. It was decided that there would be further efforts using a "vertical" station team of 10 to 14 people. During the late fall, the Director appointed a cross-sectional staff group of Scientists, Project Leaders, Assistant Directors and Technicians to meet with us, look at the data, and make some recommendations to the Director's staff for next steps. We met with this group of thirteen staff people in February in Media, Pennsylvania. During this two day meeting we examined the Northeast station data thoroughly and began to identify important issues for the station. We spent considerable time also helping the group work on several particularly important issues. In this way we were attempting to help them learn to use their own group problem-solving skills. As a result of this meeting several recommendations for action were made and reported to the Director who evaluated the recommendations in a report to all PL's in late June and initiated some of the recommended changes. PL's were requested to share the team's report and Director's evaluation with scientists and technicians.

The North Central Station

Prior to the one meeting we have attended at North Central, data charts for the station were sent. Attending the meeting were the Director and his complete staff, two Scientists and the station Personnel Officer. The day was spent going over the station data and attempting to identify potential problem and strength areas which might receive further attention. No decision was made at that session regarding further feedback or problem-solving efforts at the station. We declined an invitation to present data in a short feedback session at the Project Leader's meeting in October, feeling that a more lengthy session was needed devoted primarily to the results and to problem identification at the station. Subsequently a letter was written to the station making some suggestions for further work we might do and enclosing a new set of data charts which made the data more specific to the North Central station. Somewhere in this process we and the station each thought the other had the next move, and the work came to a halt.*

The Forest Products Laboratory

In October we made our first trip to FPL in Madison. Prior to the meeting laboratory members had organized some of their data and distributed it to most laboratory members. Our meeting was held with the Director's staff and the Scientist who had done the preparatory organizational work with the data. We presented the complete set of data charts to the group and discussed the several areas in which the laboratory might do further work to identify problems. The latter part of the session was devoted to a discussion of the various alternatives of proceeding to involve additional laboratory members in the feedback process. Many alternatives were considered. The group decided that a full day's meeting of all members of the laboratory staff was the method which they preferred. We were, therefore, invited to conduct such a session in early January. Approximately 150 staff members were present at this meeting. We began by a brief explanation of the total Forest Service study and presented some sample data from FPL as a model to be used in the day's work. We explained that the day's sessions would be a Derivation Conference; that is, a session in which small groups would first go through their data and make a list of generalizations that they saw coming from the data. Next, they would take the more important generalizations and derive from them what they saw to be implications for action for the station. Thirteen smaller groups were then formed to meet in various locations in the laboratory to look at data charts and derive implications. They were asked to post these implications on newsprint and report back later to the reconvened total group. After this was done we helped the staff summarize what had resulted and conducted a closing discussion on potential next steps for the laboratory. Subsequent to this session we wrote a letter to the Laboratory Director proposing a series of alternatives

*The implication here is that of the need to make periodic reviews of correspondence files, and to keep up constant phone linkages. Such failures also indicate that the researcher may be trying to do too many things at once.

for continuing the feedback and derivation process. Thus, at FPL a large number of people have been part of the feedback process; considerable work has been done to identify and define problems and laboratory strengths; and both some recommendations for proceeding and some recommendations for solving problems have been generated--a good start on the overall organizational problem-solving process.

The Southeastern Station

Only one meeting has been held with this staff group. We met with the Director and his staff in early November and presented all of the data from the Southeastern station. Several general problem areas were discussed and several alternatives were generated for doing further work at the station. Because the agenda was already set for the Project Leader's meeting it was decided that we would not participate in that event. Thus far, the station leadership group has not requested additional feedback or problem-solving meetings. In summary then, Southeastern just began the overall problem-solving process--a first look at problem identification

The Pacific Northwest Station

The Pacific Northwest station was visited twice, once in November and once in January. As for most other stations, the first was a planning meeting in Portland for the Director and his staff. Data charts were distributed and a thorough discussion took place regarding potential strengths and weaknesses in the station. After this problem-surfacing discussion the group extended an invitation to us to visit the coming Project Leader's meeting and make a short presentation of the project data for PNW. They emphasized the need for distilling some conclusions and findings from the data for presentation. We attended this Project Leader's meeting in January. After a brief presentation on the overall Forest Service study, a summary of our perceptions of problem areas was discussed. Finally, several alternatives were proposed for continuing the problem-solving work. The group did not have time to derive their own implications for action from the data presented. Thus, the PNW group has seen their data, been introduced to general problem areas, and has considered different ways of continuing the feedback process. They have not gone into the third problem-solving step--that of generating possible solutions to problems. We have supplied PNW with a written summary of the results accompanied by a restatement of some recommendations made in verbal form during the presentation at the Project Leader's meeting.

The Pacific Southwest Station

A somewhat different data feedback model was used at the PSW station. Prior to these visits several alternative feedback methods of feedback had been considered by the PSW leadership group. As a result of these discussions two meetings were arranged, one in Berkeley and one in Riverside. Each was to last for 1-1/2 to 2 days. All Project Leaders, all Assistant Directors, and a cross section of Scientists from these locations were invited to attend. The agenda for both meetings was the same. We looked at PSW data together and then broke into small groups to list generalizations

from the data. Each small group then chose major problem areas and derived some possible recommendations for action that they thought needed to be taken. After reporting this material back to the total group we helped them brainstorm possible next steps in the overall process, including feeding back the results of their meetings with the rest of the station's staff. Thus, the PSW groups began a strong effort at organizational problem-solving. They identified and defined problem areas; they generated several potential action steps to solve these issues and they made recommendations concerning these actions.

The Intermountain Station

We made one visit to this station where a short one-hour presentation was made to the Project Leader's meeting. Data charts were distributed and a station problem-solving process was proposed and recommended. However, considerable work had been done before we arrived. The P and A AD had distributed data charts and made several visits to project locations. **We do not know if problem-solving efforts have continued beyond the initial feedback process.**

The Rocky Mountain Station

Two visits were made to Rocky Mountain. The first of these was a planning meeting with the Director and his staff. Prior to this meeting we had been contacted by a planning group of Project Leaders who were organizing the Project Leader's meeting in March. They had asked us if we would lead a complete problem-solving session at their meeting. At the Director's office planning meeting this request was approved and plans made for our involvement. In addition, we presented the Rocky Mountain data and conducted a discussion on possible strengths and weaknesses of the station. During the period between the planning meeting and the Project Leader's meeting, the data charts were sent to most members of the station staff. They were requested to read the charts and then send to the Project Leader's planning committee a list of problems which they had identified (either from the data or from other sources) along with their recommendations for solving these problems. Before the March Project Leader's meeting we were sent these lists of problems and recommendations for action. On the first day of the Project Leader's meeting we made a short presentation of additional station data. Most of the following two days was spent on problem-solving activities. The first day was a problem identification day where problems were presented and organized . On the second day, we organized into small groups, each of which considered a particular domain of problems. They were charged with choosing the most important issues, defining them more completely, and writing down all their ideas on how to solve these problems. We asked them to return to the total group with specific action plans for implementing their solutions. After the reports were made and before the close of the session we made several recommendations for continuing this process in the station. Thus, Rocky Mountain, like the Southern station, **made considerable progress** in developing and beginning to use a station problem-solving process. Their problem identification was one of the most involving and most complete.

The generated alternative solutions to many of these issues and they made plans to implement some of them. In addition, several individuals learned and practiced group problem-solving skills and some groups may continue to help the station leadership team with overall station problems.

Other Visits

Two other Forest Service related visits were made during the year, one directly and the other indirectly related. The first was to the Denver session of Planning and Application Assistant Directors. Several informal sessions were held regarding the process and skills needed in the knowledge dissemination and application process, and a list of recommendations for planning and applications was given. The other meeting was in Estes Park with the National Recreation Researchers' Workshop. Dr. Duane Lloyd asked if we would lead a knowledge derivation session at this event. Several Forest Service researchers were in attendance.

A meeting was also held with Washington office staff in May. Here we presented data feedback on divisions and indicated overall findings and recommendations from the study to date to the "inside team" and to the chief in staff.

We also made a presentation in June to members of a DOD technology transfer research group regarding the Forest Service project. We invited Hal Marx to give the agency's view of Forest Service D&U activities. This will help build links to other agencies involved with similar problems.

A SUMMARY OF THE PROCESS

A quick summary of the activities in each of the stations is given in Figure 11-3. We have listed the stations in decreasing order of their level of feedback activity. The three most active stations show some differences in, primarily, whether the total staff had a chance to produce new problem statements based on the stimulus of our feedback data. NE didn't do this, DO and RM did. RM is listed third because the station did not choose to identify a vertical problem-solving team, though the coordinating committee of PLs in charge of the meeting and its agenda might make up some of the basis for such a team.

The middle stations in this listing chose some form of presentation by us to their staffs, through PL meetings, special feedback sessions, etc. The stations at the bottom of the list have, as yet, gotten no further than the basic presentation to the director's office staffs.

We contend that the steps listed across this chart are all necessary preconditions for maximum use of our results, and for changes or actions based on this work:

-- Feedback to the director's office staff serves to define the boundaries and contents of our work, and to motivate leadership while showing that our results are not a threat to their authority.

FIGURE 11-3

Summary of Station Feedback Work

	Data feedback to top levels	Summary reports, added materials	Data feedback to staff	Feedback--problem-solving team	Recommendations	Recommendations to staff	Actions	Level of activity code (see text)
NE	Feb. mtg. at Milford		May '74 PL mtg. (limited)	February meeting	Sent to Dir. in Mar.-Dir. responded in June	Recs.& Dir's. response sent in June	Some directions issued	5
SO	September meeting	Summary report sent, staff created probl. lists	October PL meeting	"Jackson II" May	Written by team; presented to Director	Director responded in June	Some recommended actions taken	
RM	November meeting	Staff created problem lists	P/S meeting, March	Done by PLs only				4
FPL	Do staff meeting - October		All lab P/S meeting - January					3
PSW			Berkeley & Riverside staff P/S mtg. - Nov.					
PNW	Do staff meeting - November	Summary report sent June	Brief presentation at PL mtg. - Jan.					2
INT		P&A AD review and comments on data	Some done by P&A AD; brief PL mtg. presentation					
NC	Do staff meeting	Revised charts sent						1
SE	Do staff meeting - November							

-- Resummarization or special analyses are usually needed as the director's office staff meeting generates new ideas or local issues which need clarification. A written report, however, may be dangerous to further work since it may be seen as a traditional, safe (but ineffective) "stopping point" for a project.

-- Feedback to the staff has taken three forms: the often time-pressured and incomplete presentations at PL meetings, the more complete and participative problem-solving meetings, and written feedback and data charts sent to the staff. We have found very little positive results of PL meeting sessions, unless the staff has received written material in advance, had the time to think of problem statements, and spends considerable time at the meeting in problem-solving activities. The short presentations with no staff opportunity to become involved afterward produce few results.

-- The collection of problem statements, using feedback as a stimulus, seems crucial in overcoming the age and shortcomings of the data, and in getting the necessary local perspective. This allows us to begin problem-solving with new, relevant, and involving materials, and thus moves the effort along faster.

-- It may not be necessary to create a feedback and problem-solving team, but such groups have the chance to dig deeper into the material than do meetings of location or lab staffs as a whole. More importantly, the smaller groups have the chance to develop their problem-solving skills to a higher degree. They could also form the basis for further work on a more permanent basis in their station. Also, the smaller groups, because of their size and the knowledge and skills they develop, seem to have more of a chance to influence station leadership over the long run, and to serve as problem sensors and intermediaries.

-- A formal list of recommendations seems valuable in recording the work of station staff, however they do the task, and gives a <u>focus</u> to the outcomes which is missing in more vague non-written formats. But again, there is the danger of thinking that the list is the final product, and that the job is done. In most of the stations, groups who produced recommendations did a fairly good job on a few issues they worked through almost to the final details, but left many other problem areas at the stage of only problem statements or un-analized possible solutions. Obviously, there is a great deal of staff work remaining in these instances.

-- A response from the Director or his designate to the recommendations seems a natural and necessary step in responding to the work of the problem-solving group. We would suggest that Directors go over their tentative responses with some of the people involved, before making them public, in order to clarify two kinds of issues: perceived problems and needs the director may not feel, and constraints the director might have which the group was not aware of. Directors should be particularly careful in areas where they think programs or policies are sufficient now to take care of a problem area -- if they truly <u>were</u>, then we doubt a problem-solving group would put

much emphasis on such areas. Where directors have responded, they have been particularly careful to explain why specific recommendations were accepted or rejected, and have then informed all staff. Both explanation and sharing with staff are vital, we think.

-- Following from the above, feedback of recommendations and the outcomes to all staff is required to show responsiveness and movement on the part of station leadership on one hand, or practical limitations or policies (of which staff are frequently surprisingly unaware) on the other.

-- Finally, the "action" step is not a unitary thing. What is required is rapid movement on a few "easy" changes, together with concrete plans for work on the more difficult problems. We've always stressed the need for the leadership to show responsiveness by making some one change right away, as a desmonstrable success for the staff's effort. We are now at the stage where a few of these things may be beginning, but we have no tests of our impact even at the level of the "easy" change. Part of this may be the fact that stations did not always keep us informed of what they were doing.

Analysis of Station Feedback Activity

After producing this table we began to wonder if there might be some factors in the various stations which might predict their extent of involvement in the feedback and problem-solving process. Therefore, we produced the ordinal scale of involvement (shown at the right of the figure), and rank-order correlated this with the items from the section of our questionnaire which elicited ratings of the station itself, and with indices on supervisory practices. A few significant differences were found, though the magnitude of the correlations was not too impressive. We even removed INT and SE from the analysis, since there was some negative reaction in these stations two years ago at the "news" that these stations would be eliminated. The correlations remained significant in the other stations with one exception. Below we have listed the significant differences which survived this station control. Note, these were ratings of the station made two years before the station's level of activity in feedback and problem-solving.

Stations who were more active in feedback and problem-solving work were rated higher by their staffs on --

-- Station does well keeping up and adapting to change
-- Station does excellent job fulfilling objectives
-- Staff satisfaction with way research is carried out
-- Staff ratings of degree of coherence of research program.

Thus, it may be that the stations who have become more fully involved in our feedback and problem-solving were somewhat more innovative and positive research environments to begin with. There is an old saw among organizational researchers and change agents that the people who need help most are least willing to seek it. This may be the case here, but to some limited extent, given the fact that the correlations in ranks is not all that good (the highest was about .13).

In final summary, eight stations and the FPL were involved to some extent in the problem-identification phase of data feedback. Seven stations did varying amounts of work with us to derive implications and potential solutions to station issues and problems. Five stations have in different ways moved from these potential solutions to making suggestions and recommendations for further action and change. At the crucial point of developing specific plans for implementing solutions to problems however, only three stations (SO, NE and RM) have, with us as a part of the process, planned specific actions and assigned specific responsibilities for problem solutions. Two stations, SO and NE, have developed teams who have had a chance to become deeply involved in station problems and building recommendations, and who have received some problem-solving skill training. These teams can be a valuable resource for the future but in both cases their future role is still unclear. Finally, however, we cannot say that only three stations have moved most of the way through a station problem-solving process. The others that proposed solutions to problems may, in fact, be moving inttheir own ways to implement these recommendations. We have no information to assume that they are not.

NOW WHAT?

After the feedback and problem-solving work the model shows a period of time for changes to work, followed by an evaluation of the process and a consolidation of new skills. In actuality, however, our work on the project came to a halt, for all intents and purposes, at the end of the work discussed above. In the next chapter we will look at some of the possible reasons for this.

The project itself has not necessarily stopped, however; work continues within the Forest Service. The Washington Office "inside team" met in December, 1975 to evaluate the recommendations presented in the next chapter, and to construct responses to them (sent to station directors in February, 1976). In some cases our recommendations were felt to be established as policy already or were too general to deal with. Many others were favorably received. This response to our recommendations also will be discussed in the next chapter.

CHAPTER 12

PROBLEMS AND RECOMMENDATIONS

READER'S GUIDE:

Here all of our work comes together in a series of recommendations for the whole organization. This chapter is, therefore, a crucial one for readers connected with Forest Service research. It is of less interest for other readers, though still a useful summary of what we found.

CHAPTER SUMMARY:

We feel that the recommendations we provide here are sufficiently abstracted and terse that little is to be gained by summarizing them. These are recommendations which apply to most or all stations, or have implications for needed system-wide change through action at the Washington level. Some discussion is included of the reactions to these recommendations by the Washington Office.

INTRODUCTION

The recommendations coming from our work have been returned to the organization in many ways. First, the task of feedback and problem-solving in stations was, as we see it, the most important and valuable step. Not only did the station staffs take the lead, but the work went beyond the often abstract and sterile recommendation to produce action plans for the local context. Our second step met a need for a formal list of recommendations expressed by Washington staff members. Recommendations were given to the organization in two forms.*

The recommendations below cover areas important above the station level, or across all stations. We incorporated all of our learnings about Forest Service research in developing these, together with the compiled products of the station feedback and problem-solving groups. Thus, these recommendations come not only from us, but have survived a great deal of discussion at the station level.

*Initial recommendations were given in a mimeographed form. The most complete version (closely parallel to those below) was presented in Lingwood and Morris (1975).

As always, we have some comments on the recommendation process as well as the content. First, most organizations (and this one in particularly) express a strong need for a formal list of recommendations. Such a format fits well in the notion of "staff work" and ad hoc task forces, whose outputs often take this form. The listings are also easy to process in an hierarchical decision-making structure: leadership can react to each recommendation as it wishes, using small groups to form the appropriate response. In this case, the Washington "inside team" went over the recommendations, formed responses, and sent the response to Station Directors.

The point is that formal recommendation lists handled this way are somewhat at odds with the kinds of participative problem-solving we try to use and teach in our model. However: (a) we cannot have a great impact on the decision-making procedures of an established organization, and (b) at some point "normal" processes must take over from the work of the project. The recommendations are, imperfect as they may be, the unavoidable interface with the "regular" way the organization does its work.

One of the consequences of this problem is seen in responses to those recommendations which attempt to promote open, interpersonal, and participative activities. The typical response is "a revision of the manual will do (or has done) this." There is an obvious gap between a written policy and the work of individuals -- and it is just this gap which often led to the recommendation for change in the first place. This is why organizational change requires monitoring and evaluation: establishing a policy may be a facilitator of the change, but one has to look at later activity and behavior to see if the changes themselves are there.

In the sections below we will first outline a problem area, giving support information from our data or from problem statements generated during feedback and problem-solving. Then we will go on to give some general recommendations (though not in the detail we have seen in the work in stations). At the end of this chapter we will comment on the reactions to these recommendations.

1. PLANNING

Our questionnaire contained a brief section on processes used in planning, and satisfactions with individual access to planning, and with the way planning is done at various levels in the Forest Service. We have concentrated on the satisfactions in our analysis, but still we do not have the degree of depth we need in this area -- largely because the field of planning is complex with its concepts still under refinement. Nevertheless, what data we do have, and the problem statements generated in stations during feedback and problem-solving highlight some areas in which there appear to be strongly-felt problems

As a general statement, many of the difficulties here are tied closely to the individual's level in the organization, and merge the areas of clarity about goals and objectives, and access to the planning process: at high administrative levels, staff can see the picture, and they have the power to in-

fluence it, but both the knowledge and insight and power over planning decline markedly as we reach the level of the Scientist. Thus, we will begin below with the clarity issue, then move on to staff access to planning, and conclude with some more specific problems.

1.1 Clarity of goals and objectives: In many places the researchers themselves seem unclear about the basic goals, objectives, policies, and constraints of Forest Service research. This leads to a lack of understanding of why plans are made as they are. This is more true of Scientists than of PLs, but there are sufficient mentions of this problem even at the PL level to warrant attention to its solution. Unclear goals and objectives themselves seem to run the gamut from such broad issues as "with what and with whose problems should our station "be involved and concerned" to specific issues such as the amount of funding available within the station. Thus, there seems to be both a need for more accessible and used statements about the purpose and constraints on Forest Service and the station, and for more open channels from leadership to researchers for information about on-going planning. Therefore:

REC. 1.11 *Leadership should review the availability, currency, and accuracy of basic goal, objective, policy, and planning procedures information for the research staff. Simply saying "it is in the manual" isn't enough.*

REC. 1.12 *Leadership in stations and above should take every opportunity to let researchers "hear it from the top" about policies, goals, objectives, and practical constraints on the planning process. Presentations about new developments at PL meetings are good; periodic schedules sessions at research locations (for the Director and visitors from Washington) would be even better.*

1.2 Staff access to the planning process: There are several problems here, keenly felt by staff in the stations. Most involve Scientists, but Technicians, PLs, and even ADs have access problems, though at different levels of the planning process. Of course, not all staff need direct access to all levels of planning; the trick is to design ways for staff to have access where appropriate, plus information about what is going on at the planning levels above and below so they may make an input if something is particularly crucial.

REC. 1.21 *Reorganization does not seem to have cured all problems of AD access to planning at the project level, so mechanisms need to be developed for ADs to be kept informed (at least), and make inputs (where appropriate) in the planning of individual projects. Do not forget the P&A AD here, either (more on this role later).*

REC. 1.22 *New procedures are needed for PLs, Scientists, and Technicians to make inputs in research problem selection, in both the short and long range. Possibilities include: station-wide functional*

planning advisory committees, problem-focused planning meetings held on a yearly basis by the P&A AD, early planning meetings for RWUDs (attended by all prospective project staff plus station and WO representatives, if possible).

1.3 P&A job role: The new P&A AD job is very broad and demanding, and current concepts in long range planning suggest that planning should not be localized in one place in an organization. Therefore, we feel the P&A AD should not try to do the planning job himself.

REC. 1.31 P&A ADs should learn to work as coordinators and facilitators of planning efforts, concentrating on the process of how planning is done, but not on the content of specific plans. They should try to work with representative station groups which would be responsible for the content of plans. An example would be the kind of meetings recommended in one station where the P&A AD would hold "at least two planning meetings per year--each meeting dedicated to one research problem area selected by Director and staff as being of significant importance to the Station's program."

1.4 Client inputs: This isn't a new idea, but we feel more work is needed in bringing research clients into the initial program and project planning process. This also helps the ultimate utility of the research product.

REC. 1.41 Client groups should be represented in program and project planning at more than a once-a-year level in a formal setting. The kind of problem-focused meeting suggested above would include attendees from prime client groups, but we feel there is also need for more informal, project-based linkages with clients.

2. ORGANIZATIONAL FACTORS

The support, climate, role definitions, and interactions provided by the research organization are important facilitators of the work of researchers, and relate to their satisfactions, as well. In station feedback many of the problems and solutions have dealt with these topics, and we feel that many of these problems are best handled at the station level. Nevertheless, many of the organizational problems have implications for changes, or at least support of station changes needed at the Washington level.

As a final introductory point, we need to remember that our data show satisfactions with the organization and with individual jobs to be very high, and most of the organizational factors such as "freedom," "physical environment," "challenge," "scientific information," etc., also are evaluated very positively by most researchers in Forest Service. Basically, most researchers are quite happy with the organization and their jobs. However, there are still some areas where changes could make a good thing even better.

2.1 Staff recruitment: Ceilings and limits on hiring have resulted in "locking in" the organization, and reducing the number of younger/newer researchers. The average age of all job groups is not encouraging for the future, expecially in terms of providing a pool for development of future leadership and in terms of stimulus from new scientific developments.

REC. 2.11 Thought must be given to ways to keep the organization up-to-date with the best new research skills and knowledge, and to keep staff challenged by these developments. More attention should be given to retraining staff, and to creating changes in assignments to add diversity when staff begin to show signs of intellectual stagnation.

REC. 2.12 More thorough evaluation might be given to prospective applicants for scientific jobs, especially in those stations which are below norms in terms of educational levels.

REC. 2.13 Leadership should project from current age breakdowns in the Scientist, PL, and AD roles, what the average ages and sizes of these groups will be in coming years, given present and foreseeable hiring patterns. Any gaps in the talent pool for leadership could then be recognized and planned for.

2.2 Clarification of job roles: There are, in various stations, several kinds of unclarities about what the various jobs should be. At the top, the best ways to split responsibilities between Director and Associate Director are unclear, or at least differ among the stations. Placement and coverage for field ADs is still evolving as is the relation between field and P&A ADs. PLs continue to have problems with the administrative portion of their jobs--how much they must do, how to get help from RSS, how to get rewarded for it (since it seems to take more time than officially recognized). Technician career ladders and opportunities continue to perplex staff in some places. Overall, position descriptions may not cover all the tasks required, or may be worded vaguely, and staff may not know (in some stations) in how to define positions adequately and accurately.

REC. 2.21 The study of reorganization, planned for several years, should be gotten off the drawing board, paying special attention to: work and demands on ADs, how field ADs relate to the many projects they cover, how the P&A AD fits in, how to recognize the increased administrative tasks of PLs under the reorganization, etc.

REC. 2.22 Specific interpretive materials should be prepared describing the advancement opportunities and realistic limitations on careers for technicians; these materials should be distributed to all technicians, and forums developed for guiding and counselling technicians developed.

REC. 2.23 RSS might provide a specialist in the area of helping research staff analyze new positions, and then helping them write good position descriptions (remember the importance role job descriptions can have in panel evaluation.

REC. 2.24 Leadership should take every opportunity to discuss with PLs the policies on PL activity in administrative work. WO and the stations need to recognize that PLs are simply doing more administrative tasks than they are (or think they are) getting rewarded for. The PL job description may, in many cases, have to be rewritten to include more administration; and formal rewards for good administration need to be improved.

REC. 2.25 Managerial and administrative training needs to be more available to PLs (see the section 3 on training for more on this).

2.3 Researcher input to decision-making: Researchers need to feel they are a part of the process of making decisions in the organization. In many cases this is simply the chance to make an input, not necessarily complete involvement in all stages of making decisions. Part of the problem may be that decisions get made without researchers being informed about who is making them, what the constraints really are, and what the probable outcome will be. On the other hand, once leadership asks researchers for input, it has the firm obligation to use the input, or give definite reasons why recommendations cannot be implemented -- in some places researchers have developed the view that "I won't even bother to respond with my ideas, since I know they won't use them."

REC. 2.31 More efforts should be made to develop ways to inform researchers of areas in which decisions are currently being made, who has responsibility, and how inputs can be made. Solicited input should be responded to, with reasons for non-use of ideas given.

2.4 Leadership problems: Most of the leadership problems we have seen in the data, and in the station problem statements in particular, come from other areas such as rewards, training, lack of evaluation systems, and job role definitions. Therefore, these sections should be read for their bearing on leadership. We have allowed some duplication below, with one exception: problems of training for leadership are located in the training section below.

The most difficult leadership problem involves communication between PLs and ADs -- the physical and content differences fostered by the organization structure. These will be covered under 2.5, below.

A second leadership problem involves PLs, whose roles do not seem to be defined to account for the leadership they must provide, who are not necessarily selected for leadership potential, who are then not given specific leadership training, and finally, who are not tied into a reward system

which is capable of evaluating the leadership they provide, and then rewarding good leadership. At all levels we feel the organization needs to develop ways to evaluate and reward leadership, however, PLs are not the only ones with this problem. A part of this is monitoring, developing, using good problem-solving skills and skills of organizational diagnosis.

REC. 2.41 Stations should begin a policy of evaluating both jobs and potential holders of those jobs (particularly but not exclusively at the PL level) in terms of the amount of leadership required, and the leadership potential of the individual.

REC. 2.42 Better methods need to be developed for periodic evaluation of the leadership activities of individuals: methodology for assessment of leadership provided, ways to feed back such evaluations to the individual (e.g., by his supervisor at annual review time, etc.); and leadership evaluations should be separate from evaluations of technical/research competence and performance.

REC. 2.43 An R&D organization needs skills in solving human problems just as much as it needs research skills, yet we have seen some instances in which groups lack problem-solving skills in working on organizational problems. Therefore, a nationwide group should be set up, teaching opportunities and materials developed, and "natural" skills in stations tapped to provide training for groups in organizational problem-solving skills.

REC. 2.44 We feel the leadership of stations could benefit from increased concern with management to improve human objectives. A system of periodic monitoring of organizational conditions should be tried, and if useful, implemented. A quick checklist form on which staff could record their opinions could be used, one based on the concepts of the present study. Leadership would have the responsibility for working on areas which get the lowest ratings.

REC. 2.45 Stations should identify and make use of organizational and problem-solving skills already available among their staff.

2.5 Interpersonal, hierarchical communication problems: This title is complex to narrow our attention here to the many difficulties we have heard about in the person-to-person communications across levels of the hierarchy with Forest Service research. Other communication or linkage problems will be discussed below. Much of the problem here seems to involve the communications between PLs and ADs. Reorganization doesn't seem to have solved this recurring problem since, whole there are now more ADs in the field, there are fewer program ADs in a station. In some places, stations may be forced to specify "research programs" not so much for the real need, but simply to get a PM on line to handle administrative chores which are spreading the program ADs too thin. Also, there is a tendency for stations to shove some of this burden off on the all-too-handy P&A AD, downgrading his ability to perform in the job he was hired to do. Also, ADs themselves may need training in the management, above and beyond

what they now get. All of these problems result in the inability of ADs to provide all of the leadership, and important chances to communicate with their PLs.

Beyond the AD-PL problem, there is a general one of lack of written communication from the station leadership to the projects in such areas as what goes on at meetings, in planning, policy, directives, constraints, etc. There needs to be improvement in some stations here, but at the same time no one wants a proliferation of paper.

REC. 2.51 Careful monitoring is needed, perhaps as part of the study of reorganization, to see if the field AD notion is working. ADs should log their contacts with projects, and PLs should be asked their impressions of changes.

REC. 2.52 More mechanisms are needed for direct, interpersonal contact between station leadership and staff at the various research locations and projects. Director and Deputy or Associate Director should make annual visits to locations, holding meetings with the staff to discuss where the station is and is going. Program ADs should make contact with projects as often as possible (e.g., some minimum such as four visits per year). P&A ADs and the RSS AD should also circulate among the locations.

REC. 2.53 Meeting notes circulated to PLs should be available (posted or circulated) to researchers and technicians in the projects as well. The issue of how much of such information researchers want, and how they'd like to receive it, should be handled early (a topic for PL or location meetings, etc.).

REC. 2.54 Research Support Services can be a big help to PLs and Scientists in the administrative work load about which researchers love to complain. However, there appears to be a communication gap in some places. RSS needs to inform PLs of help the support staff can provide. RSS should also be more attentive to the practical solutions researchers come up with to support problems: the direct approach is often better.

2.6 Communication problems within research locations and across projects: Even a single location can have its communication problems: some are more formal and job-related in areas like equipment sharing, logistics, etc., but others are informal, affecting the necessary interchange of research information, procedural notes, etc. Factors as trivial as where the coffee room is can have an important bearing on who gets a chance to talk informally with whom. Chances for researchers and technicians to talk to each other, and with other levels in the location, seem limited in some locations.

REC. 2.61 Leadership should push different project staffs to exchange information and look for commonalities wherever possible. The AD is in the best position to do this, but ADs should compare notes, too, since projects with some potential benefit for each other may be under different ADs.

REC. 2.62 Research units should hold periodic staff meetings for all of their personnel.

REC. 2.63 Locations and research units should make sure they have places where notes, notices, meeting minutes, etc. can be posted for all staff to see.

2.7 Scientific communication: By and large, Forest Service research has done a good job of ensuring that scientific information channels from outside are open to researchers. However, within stations, there seems to be some lack of information about research underway. Researchers do not necessarily know who in their station is planning or doing what.

REC. 2.71 Stations should make sure all researchers have, or have access to lists of station research planned, underway, and recently completed.

REC. 2.72 Station newsletters, etc. should list recently published reports of the station, together with locations and phone numbers of authors.

REC. 2.73 Locations which are large enough might encourage periodic scientific seminars among their staff, with attendance open to anyone who might be interested.

REC. 2.74 One station group has suggested that established authors with good records of getting papers into referred journals be allowed to bypass technical review and editing; a policy check from the Director's office would still be required, however. Other stations might consider this idea.

2.8 Collaborative research: There are mixed feelings about collaboration: many feel that not enough collaborative research is being done among projects and programs with Forest Service research; collaboration with people from outside of Forest Service is still somewhat of a grey area, since the proper roles, expectations, etc. are not firmly established in all stations.

REC. 2.81 Program ADs are the logical ones to spot potentials for collaborative projects, and to encourage such work. The field ADs should also compare notes and be aware of the research going on outside of their projects, too.

REC. 2.82 Attention must continue to be given to establishing guidelines and working relationships for collaboration outside of Forest Service research. Questions exist in the areas of funds distribution, authorship policies, role of outside students in collaborative research, monitoring of the quality of outside work, etc.

2.9 Changes in structure vs. performance: Formal organizations tend to look for structural fixes for problems; but structure often works best if it follows changes in procedures and operating styles worked out at the personal level.

REC. 2.91 In the areas we have mentioned, and in others, the first attempt at change should be simply to get people to perform in new or different ways within existing structures. Structural changes should be put in place only if this fails.

3. INDIVIDUAL FACTORS

The "individual focus" in our model deals with sources of stimulation to perform well, individual motivations and work styles, information processing, and so on. Again, many of these topics seem best handled at the station level, where we have devoted considerable attention in feedback and problem-solving. The issue of training also fits in here, and this is a source of comments wherever we go.

3.1 Training: There is a consistent problem which relates to the areas of training such as: training through attending meetings, feedback of learnings to others, etc. The second problem in training is that of specialized training in leadership, management, and human relations. Much of the difficulty in this area concerns PLs. Training for management ties in with the role and reward problems we talked about earlier for PLs: they say they have to manage and administer, but are not necessarily taught how, then their job descriptions read "research," not "administration," and they then can't get recognized and rewarded for such work. Here we will look at just the training side of the problem.

REC. 3.11 *Researcher training plans should be compared within stations, to insure that all possible researchers have some yearly exposure to either training or scientific meetings. Decisions to send administrators to such events should be reviewed carefully to see if a researcher could do the job as well in terms of representing research (and increasing his own visibility).*

REC. 3.12 *Official attendees at events should be given a clear responsibility to report back to their peers who didn't get to go about what they have learned, what new contacts and information resources they have built, etc.*

REC. 3.13 *Attention must be continued on the problem of easing the limits on travel to Canada. Perhaps events involving recognized professional associations could be exempted.*

REC. 3.14 *Training for leadership and administration needs to be extended at least to the PL level (and in special cases lower). Formal, government-sponsored training plans might include requirements for courses in this area, special consultants and trainers could be brought in, etc.*

REC. 3.15 *ADs should specify leadership, human relations, and administrative training in the yearly training plans for all new PLs, unless they have had such training earlier. Reviews of needs in these areas for older PLs should also be done, and deficiencies corrected.*

REC. 3.16 *Projects should make definite plans for training for technicians, and should report technician training to ADs. A better program for announcing technician training opportunities might be developed, also. These opportunities should be closely tied to technician counselling about career paths and limits.*

3.2 Organizational fit of researchers not trained in natural resources or sciences: Forest Service research is deeply based in the field of forestry, and in the resource and natural sciences. There seems to be less of a "fit" for researchers coming out of the physical and social sciences, and from engineering; these people are less satisfied with the organization, and may (under some circumstances) contribute less.

REC. 3.21 Work should be done to open up the organization more to the concepts, inputs, and advancement potentials of researchers trained in areas other than the resource or natural sciences.

REC. 3.22 Special attention must be given to legitimizing the role of social scientists in the organization. The very size of the Forest Service and its client groups make "people problems" very important. Skills in this group in the area of organizational functioning and improvement, problem-solving, and client linkage should be used more.

3.3 Stimulation from outside Forest Service research: Forest Service researchers are highly stimulated from their own work, but there is lower stimulation from colleagues outside (in some stations), and from clients and applied problems (though the situation has improved from what it was when we collected data, we think). In some instances we might find problems in the isolation of researchers either from their scientific peers and disciplines, or from their clients on the other hand.

REC. 3.31 Special attention should be given to researchers who are located away from university environments to make sure they have a chance to keep up contacts with their disciplines through more frequent travel, extra-good library and seminar facilities, etc.

REC. 3.32 Stimulation from clients depends on the pre-condition of interest in applications-oriented topics. We doubt that much can be done on this directly, other than trying to provide linkages between discipline and application problems during discussions, etc. Beyond this, what is needed is the basic opportunity to interact with clients and potential clients (covered in the section on Applications below).

4. DISSEMINATION AND USE OF RESEARCH PRODUCTS

This area has been of prime concern to Forese Service research, and to us in this project. We are including here both contribution to the individual's scientific discipline, and to practical application. Both of these areas are affected greatly by organizational and individual factors, and many of the recommendations we've made above should affect the contribution levels of researchers, as well.

We are including both scientific and applied contributions in the section on "dissemination and use," since we take the view that both kinds of contributions get transmitted, and both should be used to some extent -- it is just that the audiences and uses differ. In either type of contribution the researcher should target his communications: choosing the right combination of content and media to reach the audience. Researchers are so well

trained in doing this for the scientific audience, however, that they fail to see the process is conceptually the same for applied audiences and uses.

Of course, because of the training and interests of researchers, and the traditional emphasis of Forest Service research on reaching the scientific audience, there are fewer problems in the areas of dissemination and use for these products. Many of the most serious problems we have seen in the organization come, however, in the area of applied contributions. In attempting to change or increase emphasis for applications, the system has not yet brought in line all of the necessary skills, motivations, facilities, client-linkages, and (most important of all) rewards.

(SCIENTIFIC CONTRIBUTION)

4.1 Scientific contribution per se: Most researchers see other researchers as their primary clients, and seem to be reaching these peers relatively well, however, there are three problem areas which have come to our attention: First, there seems to be an over-dependence on the scientific journal as the best way to make a scientific contribution; we think journal articles thus get over-emphasized to the detriment of other effective scientific communication media (though we did not find this in all stations). Second, there is divergence across stations, and frequent lack of a coherent, publicized policy within stations, about criteria for authorships and acknowledgments (this affects scientists primarily, though it extends to technicians). Third, we mentioned earlier that Forest Service research "fits" best researchers trained in natural resources and sciences; our data and our own observations indicate there may be some (though not a major) problem in isolation of social scientists from their disciplines -- both physically, and in terms of the work they do.

REC. 4.11 Stations should review the emphasis they put on scientific journal publication, and panels should also learn to balance contributions, in order to develop the notion of targetting for scientific knowledge: what is the best way to get this particular piece of knowledge to the appropriate scientific audience for their particular use. Journals are good at transmitting findings; but Forest Service research is a storehouse of logistical, methodological, and practical knowledge as well, and journals don't transmit these to other researchers very well.

REC. 4.12 Taken from the standpoint that authorship mentions and acknowledgments of individuals serves an important linkage function in the flow of scientific knowledge, we suggest that Forest Service research review those policies which might serve to "push" the PLs name over those of contributing scientists in paper authorships. We also question Forest Service policies which limit direct credit for photographs, illustrations, computer programs, etc. A name credit can serve as a contact point for the reader who wants information about where the photo was taken, how the illustration was made, or how to get or develop a program, etc. Aside from the linkage notion, credits are themselves stimulating rewards. Consistent policies are also needed for footnoting contributions of technicians, or even giving joint authorships, etc.

REC. 4.13 *Attention should be given to helping social scientists, and perhaps physical scientists, engineers, and architects, in maintaining linkages to their disciplines. The further the individual is, both physically and conceptually in his work, from the mainstream of work in his discipline, the more problems he or she is likely to have; leaders of researchers in these fields should make special efforts to keep these people linked to their disciplines.*

4.2 Factors which can help (or hinder) scientific contributions: A great deal of our analysis has been directed at determining the factors which predict high or low levels of contribution. The two recommendations deal specifically with some of the most important predictors.

REC. 4.21 *Special attention should be given to the following individual and organizational factors, which are strong predictors of a researcher's scientific contribution, to make sure as many as possible are in good shape:*

--the researcher's ability to be stimulated from his own ideas, curiosity, and past work

--adequacy of scientific information gathering facilities

--activity in inter-project and inter-discpline collaborative research efforts

--feelings of challenge the work provides, and dedication to work in the organization

--individual capabilities to consider many aspects of problems at once, to work deductively, and to be involved in many stages of the research, particularly with other people.

REC. 4.22 *When predictors are combined, we find that the researchers who are lowest in terms of scientific contribution are those who are: (lowest) non-Ph.D. Scientists who say their scientific information environment is poor; (next lowest) non-Ph.D. Scientists who say the information environment is good, but who see low challenge provided by work and low dedication to work; (third lowest) Ph.D. Scientists who are low in collaborative research activities. By comparison, the lowest group is two standard deviations lower on our scientific contribution index than the highest group: PLs who are highly stimulated from their own work and ideas, and who like to handle many aspects of problems at the same time (high "cognitive complexity"). The implication here is that stations should be particularly sensitive to problems non-Ph.D. Scientists may be having in making a scientific contribution, particularly if they exist in situations which make for poor scientific information environments, or feelings of low challenge in or dedication to work. Some time by leadership thinking about these dimensions in their station could probably identify places and people who*

need special help. The "help" could be in the form of improving the information environment, providing more challenging assignments, or encouraging these people to go on for more advanced degrees.

(APPLICATIONS)

4.3 Organizational climate and support for applications: The single strongest predictor we have of the criterion of applied contribution is the extent to which the researcher thinks the organization gives him support for such work. By support here we mean the climate of concern for applications, and encouragement and facilitation given by leadership. This in turn leads to a climate of support among researchers themselves, if reward systems for such work are in place (see below). When we began the study, top leadership was very concerned with applications, and over time this has trickled down to the researchers' level to some extent. Still, the gains need to be solidified.

REC. 4.31 The tone set by leadership about the importance and legitimacy of applications needs to be bolstered by firm, shared policy statements from Washington and from Directors.

REC. 4.32 Concern for applications (specific content, media, and audiences) must be specified during project planning, not when the work is finished only. Planning for applications is just as important as planning for data collection, etc.

REC. 4.33 Projects must be given adequate time and funding to carry out applications -- this must be planned for from the beginning of the project.

4.4 Definition of roles in the application process: There are unclarities running throughout this area: P&A ADs still have not decided if their job is to do the station's application work, or to facilitate it, or if they should concentrate on planning or applications or both. Researchers do not have the guidance they need on the extent they should be personally involved in applications efforts, or how they should link with clients or intermediaries.

REC. 4.41 A process is required by which the system can produce guidelines for (a) what kind of application effort is justified and needed in which kinds of research, and (b) how active researchers are expected to be in the process.

REC. 4.42 We feel P&A ADs would be making a fatal error if they tried to do the application job themselves. We feel his job should be one of coordination, linking people together, and providing skills and conceptual overviews about the applications process.

REC. 4.43 To be successful, the P&A AD will need time to develop linkages, skills, etc. Therefore, P&A AD slots should not be filled by people who will retire out of the job in a year or two, nor by people who would be moved upward to bigger things quickly. The candidate should be one who is interested in devoting considerable time to what he sees as the crucial objective of increasing applications of knowledge. The P&A AD should also spend a fair amount

of his early months in learning the concepts and skills in the field of dissemination and utilization: it is as unlikely that he could do a good job without this knowledge as it is that a field AD could perform without knowledge of concepts in research methods and management.

REC. 4.44 Station Directors should resist the temptation to use the P&A AD as another helping hand with general administrative work and assignments. These men have to much to do already with the still unclear duties in planning and applications.

4.5 Applications skill: Research utilization, just as research design, involves specific skills. Skills include the ability to translate scientific language into the language of the potential user, the ability to select the correct transmission channel (based in knowing what media clients trust and use), and the ability to help clients (or clients and researchers together) adapt and implement new ideas. We have found that Forest Service research just has not built this skill bank the way it has provided the scientific-helping skills in statisticians, editors, etc.

REC. 4.51 We feel that skilled people should be provided, under the management of RSS, or preferably the P&A AD, in the following areas:

--re-writing research for practitioners

--packaging and running disseminations to practitioners

--use of "new" media -- other than the written word

--process skills for getting client and researchers together and communicating

--extension skills in the area of helping users adapt and adopt new knowledge (not necessarily an extension arm, but someone with knowledge of such work).

4.6 Client linkages in applications: There are two main problems here, one in research and one outside. Within research, we don't see all of the capacity which we think is needed in terms of getting researchers and clients linked together. This is not so much a problem of media (like reports, etc.), but one of facilities for direct, person-to-person communication of clients' needs to research, and research findings to clients. The second problem is, frankly, that there are not enough clear mandates within the main Forest Service client groups that staff there should pay attention to what research has to say (part of this is a reward problem, and will be covered later).

REC. 4.61 Client inputs should be gotten during project planning, both in terms of what research will be done, and how it will be linked to and used by clients. This should be more than a once-a-year large meeting with all clients. We would encourage client representatives or advisors to appropriate research projects who would fill this need.

REC. 4.62 *The temporary exchange of personnel between research, NFS, and S&PF could do a great deal to sensitize each arm to the needs and concerns of the others. Station and Washington leadership should explore how to find possible assignments and people to fill them.*

REC. 4.63 *More "structured informal" models are needed to link clients to researchers, even though some good initial progress has been made here. Persons with specific "linking" responsibilities, and the power to get knowledge and user together, should be placed at the overlap of research and practice. Such job roles should also have the responsibility for carrying users' needs for research back to the researchers.*

REC. 4.64 *Forest Service research needs a capability to respond to users' questions on an immediate basis. Some stations are now moving to funds and staff assigned (on a rotating basis) to answering specific questions. This should be expanded. At the end of a researcher's assignment to such work, however, he should be asked to write up his impressions about the kinds of questions he has been asked, the success of his efforts, and remaining questions on which new research is needed.*

4.7 Rewards for application work: This, frankly, is the biggest problem we have seen in the study. The data show its effects; the comments we have gathered, and the recommendations coming out of the problem-solving groups are strong. Even though leadership has been vocal about the need for applications, researchers are, quite sensibly, taking the view that they do not want to take the risks of committing themselves to work which is not rewarded. Areas where change is needed extend from the non-quantified rewards which come with a supervisor's praise, through station policies and directives, to the great problem of evaluation panels and the Civil Service guidelines which define what a researcher should be and do.

REC. 4.71 *A group should be set up at the Washington level, with station participation, to look at the relationship between scientific and applied contributions as evaluated by panels. This would include whether job descriptions adequately reflect application needs, whether sufficient data is gathered to assess contribution to applications, and whether the application work done is then given adequate reward in terms of pay and G.S. grade. The recent addition to the Forest Service Manual will help in this process, but it cannot be expected to correct the situation by itself.*

REC. 4.72 *The Awards program could be extended to cover outstanding work in getting knowledge put to use. It might even be expanded so that research could give awards to practitioners in Forest Service.*

REC. 4.73 *A monitoring effort should be set up to look at the G.S. grades of researchers over time, as a function of their involvement in applications, and to examine cases where inequities might exist.*

REC. 4.74 Station leadership should take every opportunity to equalize the rewards for scientific and applied contributions -- this is more in the nature of putting money and grade where our mouths are (and have been for several years). This is put rather bluntly here to make the point that this area will need continued attention for the foreseeable future. Washington should also make sure that continued support is given to the stations in this area.

4.8 Monitoring of applications: We have not seen any really good examples of documenting and researching the actual formal and informal linkages between research and clients, nor of the impact in terms of actual use. We suggest that the methodology used by the G.A.O. audit of a few years ago was not sufficient for this task, which is really one of the most difficult in the whole area of dissemination and utilization. Effects can be direct or secondary, people can relay what they learn to someone else for use, credit for researchers is dropped quickly, ideas change and are combined with other ideas as they move into use, people communicate informally (and indeed, we think this is often the most effective method) and formal assessment methods usually miss this.

REC. 4.81 A project is needed to measure, on a continuing basis, the linkages between researchers and their clients: who is saying what to whom over which channels and with what effect. Both formal and informal linkages should be included. The results of this effort should be tied to on-going efforts to improve linkages and effects.

4.9 An overview of recommendations on applications: We have scattered our recommendations throughout this and other sections. In looking at the application process as a whole, however, we feel it is useful to recap our suggestions as follows:

REC. 4.91 Forest Service research should improve the extent to which job roles are defined to include applications, and the development of guidelines as to what kind of application work is appropriate in what situations.

REC. 4.92 Considerable work is needed to determine how to measure the applied contribution of individuals, for input to their evaluations; and work is needed on measurement of applications on the broad scale, as an input for policy making.

REC. 4.93 The reward system for applications, from immediate supervisor through panels and Civil Service guidelines, must be brought into line with the appropriate, measurable applications efforts of researchers.

REC. 4.94 Much work is needed in developing procedures, skills, opportunities, and media for communicating with clients. The P&A AD has a big role here, but will need help. Interpersonal contacts seem the most productive way, but are demanding of researchers' time; thus, Forest Service will have to seek constantly for methods which have the effects of direct contacts, but which allow for some "multiplier effect."

REACTIONS TO THE RECOMMENDATIONS

In December, 1975, the "inside team" met to evaluate these recommendations and develop a response to them. The responses have been sent to Station Directors, with a letter requesting comments. At this time we cannot tell what the ultimate outcome will be.

We cannot devote the space here to a complete analysis of the reactions to each recommendation. However, there are some general themes and patterns in the reactions which are instructive for us as we study the process of having an impact on Forest Service research, and which the organization needs to be aware of as a check to make sure it has really understood the things we have been saying.

In some cases the team did not comment on a recommendation, either because they felt it was already a policy, or was too general to be valuable. In one or two cases they disagreed with our recommendation. When there was agreement, however, the responses still varied in the priority of the problem and the specificity of action to be taken.

In general we feel the group did a good job in processing our recommendations, but some specific "reactions to the reactions" do come to mind.

In many cases the reactions pointed to new policies or documents, and we would hope these will be given high visibility in the various stations. The most important case here is that of research applications, where the group thought that the Forest Service Manual (FSM4031) section on dissemination, statements by the Chief, and a new "Guide to Help Package Research for Application" would help the organization overcome difficulties highlighted in the recommendations. This may be so; still, we are reminded that other areas came up as problems <u>even though there had been policy or in the Manual in the past</u>. We need to mention again that such statements don't solve problems unless people <u>act</u> on them.

In response to many recommendations about training, development, and communications, the reaction centered on the need for station leadership to pay attention to the area. There were many "we should do" statements. We hope that station leadership will have the time and energy available to turn these broad <u>prescriptions</u> into new activities -- and to make researchers aware that they are doing so in response to the problem statements and staff work the researchers produced earlier in their work with us.

Finally, the organization should, we feel, monitor the extent to which the reactions/recommendations actually get put to use, and keep up the pressure to insure that needed changes take place. Perhaps this is the point at which researcher advisory groups in the stations could become active again (or be started if they did not exist earlier). Not only could such groups help produce action programs, now that their work is supported by the weight of the positive reactions from Washington, but having a <u>group</u> work on making a change helps create discussion within the organization that something is being done. This discussion is crucial in helping the researchers to know that the organization can and does respond to problems they feel -- and achieving a mood of "perceived responsiveness" is half of the battle in making the organization a better place.

CHAPTER 13

LEARNINGS ABOUT THE PROCESS

READER'S GUIDE:

The focus here is a broad one on factors which affect the use of research. It also brings home some of the realities which limit the impact of research -- both ours and the Forest Service. Thus, it is a fitting and general close to the report which should be of moderate interest to most readers -- and a caution and reminder to the rest of us.

CHAPTER SUMMARY:

When we look back at the project from the point of view suggested by the R&D Lab Model, we see that difficulties increased over time as the work moved from more "traditional" research activity into feedback and change efforts in the stations. Changes in interest and leadership, lack of station-level project linkers, and the very nature of the organization all played a part in this. Future work like this should, we feel, concentrate the effort in a smaller number of research stations.

We see many parallels between ourselves and Forest Service researchers as we both attempt to get our work applied. Reward, support, people-multiplier, and momentum-maintenance parallels are discussed.

INTRODUCTION

In this brief chapter we will take a critical look at the process of the project from the perspective of the "optimum" approach dictated in the "R&D Lab Model." We have learned quite a bit about what works and what does not in the model, and need to share this kind of information. Such discussions are too infrequent in the research literature, which concentrates too much on the findings and too little on the details and dynamics of the process. In the first section we will suggest approaches which now, in retrospect, we think would have worked better.

We will also draw back from the work we have done, contrasting what we learn about the research utilization process from two levels: (1) what we see in the Forest Service as research attempts to get its knowledge used, and (2) what we saw happening as we tried to get our findings and process put to use in Forest Service research. We see parallel problems in both "them and us" in terms of reward systems, work flow and project momentum,

knowing the client, supports, and the effects of changes in the organizations involved. Even if these similarities highlight problems in application about which neither we nor the Forest Service should be proud, they at least give us confirmation that our problems are shared by others.

THE PROJECT AS SEEN FROM THE MODEL

The "R&D Lab Model" takes a very detailed and logical approach to organizational problem-solving and "action-research," in which empirical data about the various focus areas serve as sensitizers and the basis for problem identification and solution-building. Unfortunately, the real project as we experienced it got increasingly difficult to control, manage, and carry out as time passed and as we moved into and through the data feedback phase. There are several forces which may account for this, and which need to be identified for the benefit of researchers and R&D organizations who might want to use this model in the future.

Time was always the biggest adversary in this project: either the amount of it available at any given point, or the simple flow of it, bringing changes to Forest Service research, CRUSK, and the work itself. Many things could and did happen in the amount of time required to work through the model as far as we went. The task was one of maintaining project momentum and Forest Service commitment across the time necessary for our model to work. Let's look at some of the things which happened across time:

(1) Problem Formulation

In the first phase a lot of learning took place on both sides, as we indicated early in this report. We were able to devote one scientist man year to the effort. We visited stations, users, and Washington, and got the Forest Service "inside team" working. Looking back, we see now that it would be better to get mutual agreement on the activities of the whole project at once, rather than working on a year-to-year basis. This would allow our clients to see the full scope and complexity of the work. Further, we would ask for a team composed of both top and middle-level staff. Perhaps the level of our team was too high: while the team provided powerful access to and information about the Forest Service and the research branch, all members were, in effect, donating time out of very busy schedules. A better approach would be to have at least two individuals at about the G.S. 13 level assigned to work with the project, its perspectives and its issues from inside.

(2) Diagnostic Data Collection

This step went surprisingly well: the team helped us create a powerful instrument, we got excellent cooperation from the organization and the respondents, etc. Unfortunately the rate of movement and psychological commitment we felt as a result of the first year were hampered by budget reductions (to a total of one half a man year). There is a point for both funders and researchers to learn here: any project requires a certain level of critical mass and momentum simply to keep going. As project staff are required to reduce their activity level the momentum starts to drop, but the researchers

begin (because of their psychological commitment) to borrow time for the project from their other work. Of course, the researchers, if engaged in research full-time, have to begin proposing and initiating other, unrelated projects at the same time. The sponsor also feels the reduction in effort as the project recedes somewhat into the background.

The first major stumbling block in the project came when we failed to evoke sufficient interest to get the project expanded into NFS and S&PF, the primary "user" agencies within the Forest Service. This limited what we could say -- the data came only from researchers. It also precluded what could have been useful chances to bring together the researchers and users for joint problem-solving.

A change in research branch leadership affected the project, as well. Any project gets somewhat tied to the "administration" which fosters it; new leaders bring their own priorities and approaches, but more importantly, a sense of "a new beginning." The impact on our work was by no means serious, but rather, the whole system seemed to undergo somewhat of a shift in interest.

(3) Review (Feedback) and Intervention Design

At this stage momentum and funding began to build again, as stations contributed funding for analysis of their own data and for feedback. At this point, though, we began to get into what we will call the "multiplier problem." We never did get staff members in stations funded to work with us as "inside change agents," and we were limited as to the amount of time we could spend at each station. We were moving into an area of work which is not familiar for scientists, either in doing it or receiving it, and this makes visibility even more important. The work we attempted to do requires almost constant exposure, to develop discussion and anticipation within the organization. Internal people were not available to pick up where we left off, and we left off too soon in most stations. We think we tried to spread ourselves too thin: it would have been better to have continued to work in depth with only a few stations; but on the other hand, it is hard to turn down a request.

Timing of feedback was a constant problem. Due to the delays during data collection and analysis the results got older and older as the work went on. This meant the data lost the urgency provided by newness, and that more time was required in validating the findings ("are things still the same?").

In some stations we never did get sufficient access time to let staff see the power and utility of both the data and the action research problem-solving process. Two hours at a staff meeting was simply inadequate. Where a small group was able to spend a couple of days, the benefit was much greater -- in part because this is closer to the process for staff work with which the Forest Service is familiar.

Later we will suggest a revised process which would guarantee fresh data, access and visibility, and sufficient external and internal staff support.

(4) Using Multiple Change Processes

The model assumes that the researchers will be involved with the organization as it moves to change problems identified during data feedback. The model also stresses an experimental approach to studying the change effort. In brief, though, we never got this far.

A few stations did follow through on selected recommendations of the feedback and problem-solving groups, but the process after the group work quickly became "routinized" in the normal, formal hierarchy of the stations. Typically, the recommendations were seen as "staff work" and referred to the Station Director, who selected certain things as good ideas. We assume that he then delegated responsibility for initiating the changes to appropriate station personnel. From the model standpoint this approach is a mixed blessing: it is good because the normal problem-solving routine of the organization is brought into play; but it is bad because this routine itself limits the organization's ability to get wide involvement in evaluating changes, and the changes are not seen as a trial or experimental attempt to solve a problem. What the model is asking for is a more open process (involving more people throughout) which takes an "error-embracing" approach to changes.

Were we to do this again, we would probably work through a focus-point of a person in the station who was assigned to carry the "change agent" process. This person would have to link between the traditional hierarchical problem-solving structure and the project's feedback groups. The group would be kept alive as an informal monitor and reference point. Some stations already have something like a "Director's Advisory Committee" which operates in the mode we are suggesting.

The experimental approach to changes is very difficult for the organization to adopt. The first indication of this was when we learned, very early in the project, that stations would not "hold still," or be willing to serve as control groups. The same view would, we suspect, occur within stations also. It is hard to imagine a Director saying that some change will be tried out on only a part of the station, or that the change is to be made for only a short time, and then evaluated as to its utility. The "policy inertia" is so great that once the change process converts it into momentum it seems difficult (and perhaps confusing to the staff) to redirect it or stop it and try something else.

(5) Evaluation, Implementation, and Skill-Building

As we've said, there has been some implementation of change. There have been some people who have gained new knowledge and skills -- but many have moved on to other jobs, and the skill-building was informal, rather than anything approaching a training program. Evaluation of the overall project and changes in the organization has evoked no interest, and would not be really possible, given the lack of any field experimental design for the change effort.

Our interests have changed somewhat, too. We now have less interest in repeating the large measurement effort. For one thing, changes resulting from our work are limited, and cannot be isolated from those produced for other reasons. Moreover, we have become more concerned with turning our instruments approach into a procedure a station can use as a monitor and diagnostic process over time. An example is the brief instrument we constructed as a management information device. The intent was to give station leadership periodic assessments of the measures found to be important in our analysis, together with regularized methods of collecting, analyzing, interpreting, and using the information.

If we were to go on with the work this approach to measurement would be crucial. We would work intensively with a few (one or two) stations at a time, training staff and helping set up a problem-solving capability based on the data to be collected. We would work as advisors, letting station staff collect and analyze data, for example. One of the strong points of the approach is that it does not require a social scientist to collect data, disappear for a long time for complex analysis, etc. The draft instrument, for example, (shown in Figure 13-1) ask questions in such a way that what would normally be correlations (e.g., between "freedom" and "scientific contribution") show up as a simple percentage (e.g., the percentage of staff who think the amount of freedom they have has a negative effect on their ability to make a contribution).*

A DESIGN FOR CONTINUATION

Many of the elements of what we see as the way to go on have already been presented. Our focus has moved to the station, primarily to make the effort manageable, and to provide the intensity of involvement the work requires. The biggest factor thus becomes station leadership concerned enough about these issues to be innovative and willing to be "risk-takers" (in Michael's sense of the term).

Another reason for working with a few stations at a time, either in future work in Forest Service, or in a repetition of this project elsewhere, is that it allows the steps of the model flow in a more continuous manner, eliminating the long delays between the steps. This keeps the project more active in the organization and the data more current. New stations could be added as the previous ones move into stages in which local staff carry more of the work. This approach would also allow tailoring of instruments to meet local needs.

In any such effort we feel that client groups should be a part of a local guidance and advisory team. Part of the effort should be directed toward monitoring actual client linkages and impacts over time, with improvements as well in the important first step of client access to research planning and need-sensing. Clients should be brought in from the beginning (again, in stations or repetitions elsewhere) to insure that the project does not become viewed as the "baby" of the research unit.

*This approach has been part of our work in adapting the model to another R&D environment (medical research) in an organization somewhat smaller than a Forest Service research station. See Congdon, et al. (1976).

FIGURE 13-1

RESEARCH ORGANIZATION ASSESSMENT

This form is designed to give you and your organization a rapid assessment of personal and organizational conditions. First, please indicate how satisfied you are with each of the factors and goals listed below.	Very Dis-satisfied	Dis-satisfied	Neither Satisfied nor Dis-satisfied	Satisfied	Very Satisfied	Don't Know or Doesn't Apply	
ORGANIZATIONAL FACTORS							
A. Freedom given individuals.	1	2	3	4	5	9	1:06
B. Challenge work provides.	1	2	3	4	5	9	1:07
C. Degree of dedication to work	1	2	3	4	5	9	1:08
D. Amount of informal communication	1	2	3	4	5	9	1:09
E. Organizational planning.	1	2	3	4	5	9	1:10
F. Physical environment (space, eqpt.). . .	1	2	3	4	5	9	1:11
G. Technical support services	1	2	3	4	5	9	1:12
H. Research administration.	1	2	3	4	5	9	1:13
I. Supervisor's emphasis on doing work. . .	1	2	3	4	5	9	1:14
J. Supv's emphasis on personal relations. .	1	2	3	4	5	9	1:15
K. Supv's technical and admin. skills . . .	1	2	3	4	5	9	1:16
L. Org'l. support for client linkage. . . .	1	2	3	4	5	9	1:17
M. Organizational rewards for work done . .	1	2	3	4	5	9	1:18
INDIVIDUAL FACTORS							
N. Opportunities for training	1	2	3	4	5	9	1:19
O. Chances for promotion, advancement . . .	1	2	3	4	5	9	1:20
P. Chances for own career growth.	1	2	3	4	5	9	1:21
Q. Chances for interaction w/colleagues . .	1	2	3	4	5	9	1:22
R. Chances to work on important problems. .	1	2	3	4	5	9	1:23
The amount of stimulation you receive to perform well from...							
T. ..your own ideas, curiosity.	1	2	3	4	5	9	1:24
U. ..your colleagues.	1	2	3	4	5	9	1:25
V. ..your supervisor, administrators. . . .	1	2	3	4	5	9	1:26
W. ..client or sponsor problems	1	2	3	4	5	9	1:27
LOCAL ISSUES TO BE ADDED:							
X. _____ . .	1	2	3	4	5	9	1:28
Y. _____ . .	1	2	3	4	5	9	1:29
Z. _____ . .	1	2	3	4	5	9	1:30
GOALS How satisfied are you with...							
1. your contribution to scientific knowledge in your field.	1	2	3	4	5	9	1:31
2. your contribution to applications of research findings	1	2	3	4	5	9	1:32
3. your work and job in this organization. .	1	2	3	4	5	9	1:33

Now, please indicate whether each of the factors below helps or hinders you in reaching each goal listed on the right. Take each goal separately, and scan down all of the factors. If you think the way things are now with each factor helps you in reaching the goal, circle a "+" for that factor, if you think the factor hinders you in reaching this goal, circle a "-".

INDIVIDUAL GOALS

- = 1
B = 2
+ = 3

	1. Scientific Contribution	2. Applied Contribution	3. Satisfaction with Job/Work	
ORGANIZATIONAL FACTORS				
A. Freedom given individuals.	- +	- +	- +	1:34-36
B. Challenge work provides.	- +	- +	- +	1:37-39
C. Degree of dedication to work	- +	- +	- +	1:40-42
D. Amount of informal communication	- +	- +	- +	1:43-45
E. Organizational planning.	- +	- +	- +	1:46-48
F. Physical environment (space, eqpt.). . .	- +	- +	- +	1:49-51
G. Technical support services	- +	- +	- +	1:52-54
H. Research administration.	- +	- +	- +	1:55-57
I. Supervisor's emphasis on doing work. . .	- +	- +	- +	1:58-60
J. Supv's emphasis on personal relations. .	- +	- +	- +	1:61-63
K. Supv's technical and admin. skills . . .	- +	- +	- +	1:64-66
L. Org'l. support for client linkage. . . .	- +	- +	- +	1:67-69
M. Organizational rewards for work done . .	- +	- +	- +	1:70-72
INDIVIDUAL FACTORS				
N. Opportunities for training	- +	- +	- +	1:73-75
O. Chances for promotion, advancement . . .	- +	- +	- +	1:76-78
P. Chances for own career growth.	- +	- +	- +	2:06-08
Q. Chances for interaction w/colleagues . .	- +	- +	- +	2:09-11
R. Chances to work on important problems. .	- +	- +	- +	2:12-14
The amount of stimulation you receive to perform well from...				
T. ..your own ideas, curiosity.	- +	- +	- +	2:15-17
U. ..your colleagues.	- +	- +	- +	2:18-20
V. ..your supervisor, administrators. . . .	- +	- +	- +	2:21-23
W. ..client or sponsor problems	- +	- +	- +	2:24-26
LOCAL ISSUES TO BE ADDED:				
X. _____ . .	- +	- +	- +	2:27-29
Y. _____ . .	- +	- +	- +	2:30-32
Z. _____ . .	- +	- +	- +	2:33-35

BACKGROUND (For each question below, circle the number of the category which applies to you)

1. Education: 1. High school graduate or less 2. Some college, or 2-year 3. College graduate (4-year) 4. Some graduate work (no degree) 5. Masters degree 6. Doctoral degree — 2:36

2. Years in Forest Service research: _____ (Write in) — 2:37-38

3. Job Title: 1. Technician 2. Scientist 3. Project Leader 4. Program Manager 5. Assistant Director 6. Other (Specify) _____ — 2:39

4. Location: _____ — 2:40-42

5. Project #: _____ — 2:43-46

PARALLELS IN RESEARCH AND KNOWLEDGE FLOW*

We have taken an extensive look at factors which affect the production, dissemination, and use of research in the Forest Service. At the same time we have been producing knowledge, disseminating it, and trying to get it put to use by our clients -- Forest Service research. We have become increasingly aware that there are strong parallels between what we've seen in Forest Service and what we ourselves do. The same factors affect dissemination and utilization at both levels. Most of the parallels are problems.

First, of course is the reward problem. It seems endemic; as much of a difficulty in the Forest Service as in academics in rewarding efforts to get research applied. It seems that the people in charge of research organizations are only beginning to move in the direction of emphasizing application and more so in the government than in academics; but neither group has taken the next required step of putting rewards where their verbalizations are.

A second parallel is the problem of maintaining a long-time sequence of projects. The Forest Service project is a four year effort, and we have had difficulty maintaining our momentum as a research team. Social Scientists are geared to work on short range things. Very few of us are psychologically keyed to not having an answer for the next four years. This, of course, ties immediately back into the reward system problems. All of these things interact. We see the same difficulties in some research projects in Forest Service: what do you do if you want to study the complete regeneration of a forest? It may take a generation before the project is done, creating a motivation and momentum problem.

Third, is another time problem parallel, that of turn-around time. Our analysis, being as detailed as it was, took something like a year or a year and one-half, and the organization moved out from under us. In the Forest Service, we hear the same thing. We hear clients complaining that, "By the time you guys came back with your solution to the problem we had simply flipped a coin for a solution and went on. That was last year's problem. This year's problem is x, y or z. What do you have to tell me on that?" It seems that researchers are still tied to the .01 level or even the .001 level of significance before they will say anything, even though the real world often makes decisions on the flip of a coin. Clients are saying to us all the time, "Why don't you give me a 60-40 guess?" If you stop and think about it many of us researchers change hats. We take off the conical peak hat of the academician and put on the hard hat of the consultant. We will go out into the real world and we will help people. When we do that we forget the data and fire from the hip. We use our hunches

*Much of this section is based on Lingwood (1976).

which are educated guesses based on what we think is going on. We are not staking a reputation and a probability level. Clients are asking both us and Forest Service researchers to do more of this even within our research projects. With both systems we have some problems doing this.

Fourth is familiarity with the client. This is a crucial factor in the success of research, primarily because of the fact that research must be designed to meet the needs of the clients. It is also required to help solve problems. We included a full year of problem formulation in order to learn the system. However, there are many pressures to get the research phase underway and completed which affect getting to know the client better, and which seem to operate on both us and the Forest Service researchers. Also, at both levels we see a continuing problem in learning to become more attuned to client needs when we formulate research problems.

Fifth is the problem of the R&D to client ratio. This ratio brings in the need for linkers and person multipliers. Our project used two people, and on the average less than one scientist man year on the project at any time. There are about 1000 researchers in the Forest Service R&D community; but at least 40,000 to 50,000 who could be potential users of the information they produce. That ratio is very large. Something needs to be put into the middle. We all have learned that people make better people multipliers than impersonal media: both we and the Forest Service are interested in training other people to translate knowledge and pass it along. The Department of Agriculture started the extension concept; but somehow there has been a problem in carrying the concept over into the Forest Service.

The sixth parallel is that we all have to learn that researchers cannot take all of the blame for lack of use of knowledge. Again it goes back to what people are rewarded for. We have seen a few reward problems, in that we demanded a fair amount of time from station staff members. Time was needed to derive solutions based on what we had found, but researchers who were involved on our feedback and the problem-solving teams may not get rewarded for giving us this time. Forest Service researchers have the same problem. It does not say in a Forester's job description; "one of the things you will do and get rewarded for is listening to the researchers." It is rare to find any job descriptions in any agency written this way, and general pronouncements in the Forest Service Manual are not specific enough to help much.

Seventh is the parallel of organizational support, the thing that we saw was so important for applied contribution. Social science is still overly concerned with the academic image and rewards researchers for contributions made in narrow scientific specialties, as judged by scientists themselves. R&D organizations seem to be unable to break the mold, provide support for their staff, and put pressure on the larger academic community that what the lab and its people do is valuable and important. Organizational supports for application in the Forest Service are still under a difficult development process, and are often more verbal than operational.

The eighth parallel is the "musical chairs problem." Just about the time we in our research got someone trained in one of the stations to know-what we are talking about, or just about the time that the Forest Service research branch gets one of the people in the regional office trained, the person is gone. The job turnover time seems to be only a few years; and then one must start all over again. We have not been too bad off because our client ratio was still 2:1000 or so, and there are probably only about 150 top administrators in the system. Usually when people leave from a station at which we have worked they either go out to retirement or they go up. Many have moved up or across to other stations. People that we worked with earlier showed up in other useful places. We suspect that this does not happen so often with the clients in Forest Service research because when clients "go up" they tend to get moved to another region, away from the station's territory. The implication is that we all need to think of mechanisms which will make our application efforts "transfer-proof."

The ninth and final point involves the need to work in teams. We needed to work in a team because we have been concerned both with doing good social science and with the group processes required to get our results and model put to use. We also needed team members who "know the territory" of natural resources. The Forest Service is also moving more to interdisciplinary teams as it comes to work on more "real-life" problems. Most researchers are too narrowly trained to be able to do justice to the scope demanded in most "real" problems.

In conclusion, these parallels stress the importance of providing organizational conditions and supports (particularly rewards) which permit researchers to contribute to both science and application at the same time. The dual contribution makes tremendous demands on researcher and organization alike, and means we have much to learn about being timely, involved, broad-based, and relevant to our clients.

BIBLIOGRAPHY

Allen T. (1969) "Information Needs and Uses," in C. Cuadra (ed.), Annual Review of Information Science and Technology, Vol. 4, pp. 1-29.

Bass, B.M. (1960) Leadership, Psychology, and Organizational Behavior, New York: Harper.

Baumgartel, H. (1957) "Leadership Style as a Variable in Research Administration," Administrative Science Quarterly, Vol. 2, pp. 344-375.

Blake, R.R. and Mouton, J.S. (1964) The Managerial Grid, Houston: Gulf Publishing Company.

Barnowe, J.T. (1973) Scientific and Applied Effectiveness of Research Installations in the U.S. Forest Service. Unpublished Doctoral Dissertation, University of Michigan.

Bowers, D.G., and Franklin, J.L. (1976) Survey-Guided Development: Data Based Organizational Change, Ann Arbor: Center for Research on Utilization of Scientific Knowledge, Institute for Social Research.

Bowers, D.G., and Seashore, S.E. (1966) "Predicting Organizational Effectiveness with a Four-Factor Theory of Leadership," Administrative Science Quarterly, Vol. 11, pp. 238-293.

Butterfield, D.A. (1968) An Integrative Approach to the Study of Leadership Effectiveness in Organizations. Unpublished Doctoral Dissertation, University of Michigan.

Campbell, D.T., and Fiske, D.W. (1959)"Convergent and Discriminant Validation by the Multitrait-Multimethod Matrix," Psychological Bulletin, Vol. 56, pp. 31-105.

Cartter, A.M. (1966) Assessment of Quality in Graduate Education, Washington, D.C.: American Council on Education.

Chapple, E., and Sayles, L. (1961) The Measure of Management, New York: MacMillan.

Cole, J.R., and Cole, S. (1973) Social Stratification in Science, Chicago: University of Chicago Press.

Cole, S., and Cole, J.R. (1967) "Scientific Output and Recognition: A Study in the Operation of the Reward System in Science," American Sociological Review, Vol. 33, pp. 397-413.

Coleman, J.S., Katz, E., and Menzell, H. (1966) Medical Innovation, a Diffusion Study, New York: Bobbs-Merril Company.

Congdon, C.C., et al. (1976) Management and the Achievement of Research Goals, Knoxville: University of Tennessee, Memorial Research Center (mimeo).

Crane, Diana (1969) "Social Structure in a Group of Scientists: A Test of the 'Invisible College' Hypothesis," American Sociological Review, Vol. 34, pp. 28-41.

Crane, Diana (1971) "Information Needs and Uses," in C. Cuadra (ed.), Annual Review of Information Science and Technology, Vol. 6, pp. 1-39.

Crane, Diana (1972) Invisible Colleges: Diffusion of Knowledge in Scientific Communities, Chicago: University of Chicago Press.

Crawford, Susan (1971) "Informal Communication Among Scientists in Sleep Research," Journal of American Society for Information Science, Vol. 22, pp. 301-310.

Cronbach, L.J. (1951) "Coefficient Alpha and the Internal Structure of Tests," Psychometrika, Vol. 16, pp. 297-334.

Dickerman, M.B. (1975) Organization of Forest Research in Reference to Planning and Application. Paper presented by the Deputy Chief for Research at the Workshop for Planning and Application Assistant Directors, Denver, Colorado.

Emery, F.E. (1967) "The Next Thirty Years: Concepts, Methods and Anticipations," Human Relations, Vol. 20, pp. 199-237.

Ford, L.R., Jr. (1957) "Solution of a Ranking Problem from Binary Comparisons," American Mathematics Monthly, Vol. 64, Part II, pp. 28-33 (Appendix A).

Fox, D.J., and Guire, K.E. (1973) Documentation for MIDAS, Second Edition, Ann Arbor: University of Michigan Statistical Research Laboratory.

Franklin, J.L. (1973) A Path Analytic Approach to Describing Causal Relationships Among Social-Psychological Factors in Multi-Level Organization. Unpublished Doctoral Dissertation, University of Michigan.

Golembiewski, R.T. (1965) "Small Groups and Large Organizations," in March, J.G. (ed.), Handbook of Organizations, Chicago: Rand McNally.

Guilford, J.P. (1956) Fundamental Statistics in Psychology and Education, New York: McGraw Hill.

Gurin, Patricia, et al., (1969) "Internal-External Control in the Motivational Dynamics of Negro Youth," Journal of Social Issues, Vol. 25, pp. 29-53.

Havelock, R.G. (1969) Planning for Innovation through Dissemination and Utilization of Knowledge, Ann Arbor: Center for Research on Utilization of Scientific Knowledge, Institute for Social Research.

Havelock, R.G., and Lingwood, D.A. (1973) R&D Utilization Strategies and Functions: An Analytical Comparison of Four Systems. Final report to the Manpower Administration, U.S. Department of Labor, Contract #82-26-72-04. Ann Arbor: Center for Research on Utilization of Scientific Knowledge, Institute for Social Research.

James, L.R., and Jones, A.P. (1974) "Organization Climate: A Review of Theory and Research," Psychological Bulletin, Vol. 81, pp. 1096-1112.

Katz, D. and Kahn, R.L. (1968) The Social Psychology of Organization, New York: Wiley.

Kluckhohn, F.R., and Strodtbeck, F.L. (1961) Variation in Value Orientations, Evanston, Ill.: Row, Peterson.

Koch, J.L. (1970) Technicians in the United States Forest Service, Los Angeles: Socio-Technical Systems, Graduate School of Business, University of California.

Leavitt, H. (1965) "Applied Organizational Change in Industry: Structural Technological and Humanistic Approaches," in Marsh, J.G. (ed.), Handbook of Organizations, Chicago: Rand-McNally.

Likert, R. (1961) New Patterns of Management, New York: McGraw Hill.

Likert, R. (1967) The Human Organization, New York: McGraw Hill.

Lingwood, D.A. (1969) Interpersonal Communication, Research Productivity, and Invisible Colleges. Unpublished Doctoral Dissertation, Stanford University.

Lingwood, D.A. (1976) "Action Research on the Research of the U.S. Forest Service," in Jolly, J.A. and Creighton, J.W., (eds.), Technology Transfer in Research and Development, Monterey, Cal.: Naval Postgraduate School, pp. 64-85.

Lipetz, B. (1970) "Information Needs and Uses," in Cuadra, C. (ed.), Annual Review of Information Science and Technology, Vol. 5, Chicago: Encyclopaedia Britannica, pp. 1-32.

Mann, F.C. (1967) "Achieving an Effective Staff," in Eisle, C.W. (ed.), The Medical Staff in the Modern Hospital, New York: McGraw Hill.

Mann, F.C. (1968) "The Researcher and His Working Environment," in Arm, D.L. (ed.), Vistas in Science, Albuquerque, N.M.: University of Mexico, pp. 25-47.

Menzell, H. (1958) The Flow of Information Among Scientists: Problems, Opportunities, and Research Questions, New York: Columbia University Bureau of Applied Social Research.

Michael, D.N. (1968) The Unprepared Society: Planning for a Precarious Future, New York: Basic Books, Inc.

Michael, D.N. (1971) On the Social Psychology of Organizational Resistances to Long-Range Social Planning, Ann Arbor: Center for Research on Utilization of Scientific Knowledge, Institute for Social Research.

Michael, D.N. (1973) On Learning to Plan and Planning to Learn: The Social Psychology of Changing Toward Future Responsive Societal Learning, San Francisco: Jossey Bass.

Morris, W.C. (1970) The Information Influential Physician: The Knowledge Flow Process Among Medical Practitioners. Unpublished Doctoral Dissertation, University of Michigan.

Morris, W.C., and Lingwood, D.A. (1973a) Forest Service Research: Knowledge Flow in An Applied R&D System. First Year Report. Ann Arbor: Center for Research on Utilization of Scientific Knowledge, Institute for Social Research (mimeo).

Morris, W.C., and Lingwood, D.A. (1973b) The Forest Service Research Study: An Analysis of Job Role and Scientific and Applied Contribution. Ann Arbor: Center for Research on Utilization of Scientific Knowledge, Institute for Social Research.

Morris, W.C. and Sashkin, M. (1976) Integrated Problem Solving, St. Paul, Minn.: West Publishing Company.

Nunnally, J. (1967) Psychometric Theory, New York: McGraw Hill.

Paisley, W.J. (1965) The Flow of (Behavioral) Science Information: A Review of the Research Literature, Palo Alto: Stanford University, Institute for Communication Research.

Paisley, W.J. (1968) "Information Needs and Uses," in Cuadra C. (ed.), Annual Review of Information Science and Technology, Vol. 3, Chicago: Encyclopaedia Britannica, pp. 1-30.

Paisley, W.J., and Parker, E.B. (1968) "The AAPOR Conference as a Communication Medium," Public Opinion Quarterly, No. 32, pp. 65-73.

Parker, E.B., Lingwood, D.A., and Paisley, W.J. (1968) Communication and Research Productivity in An Interdisciplinary Behavioral Science Research Area, Palo Alto: Stanford University, Institute for Communication Research.

Pelz, D.C. (1967) "Creative Tensions in the Research and Development Climate," Science, Vol. 157, pp. 160-165.

Pelz, D.C. (1970) "What It Takes to Make a Problem Solver Productive," Innovation, No. 9.

Pelz, D.C., and Andrews, F.M. (1966) Scientists in Organizations: Productive Climates for Research and Development, New York: John Wiley and Sons, Inc.

Price, D.J. de S. (1963) Little Science Big Science, New York: Columbia University Press.

Rice, A.K. (1958) Productivity and Social Organization: The Ahmedabad Experiment, London: Tavistock Publications.

Rogers, E.M., with Shoemaker, F.F. (1971) Communication of Innovations: A Cross-Cultural Approach, New York: Free Press.

Roose, K.D., and Anderson, C.J. (1970) A Rating of Graduate Programs, Washington, D.C.: American Council on Education.

Rosenthal, R.A., and Weiss, R.S. (1966) "Problems of Organizational Feedback Processes," in Bauer, R. (ed.), Social Indicators, Cambridge: MIT Press, pp. 302-340.

Rotter, J.B. (1966) "Generalized Expectancies for Internal Versus External Control of Reinforcement," Psychology Monographs, Whole No. 609, pp. 1-28.

Schon, D.A. (1967) Technology and Change, New York: Dell Publishing Company.

Schreyer, R.M. (1974) Individual Orientation and Research Factors Influencing Scientific Effectiveness in the U.S. Forest Service. Unpublished Doctoral Dissertation, University of Michigan.

Seashore, S. (1954) Group Cohesiveness in the Industrial Work Group, Ann Arbor: Survey Research Center, Institute for Social Research.

Sonquist, J.A., and Morgan, J.N. (1964) The Detection of Interaction Effects, Ann Arbor: Survey Research Center Monograph No. 35, Institute for Social Research.

Tannenbaum, A.S. (1968) Control in Organization, New York: McGraw Hill.

Trist, E., and Bamforth, K. (1951) "Some Social and Psychological Consequences of the Longwall Method of Coal-Getting," Human Relations, Vol. 4.

UNESCO (1973) "International Comparative Study on the Organization of Research Units," (a questionnaire), Paris: UNESCO NS/ROU/295/RU.

U.S. Forest Service, Manual, Series 1000, Application of Research Results.

Weick, K.E. (1969) The Social Psychology of Organizing, Reading, Mass.: Addison-Wesley.

APPENDIX A

QUESTIONNAIRE AND CODING MATERIALS

ISR

CENTER FOR RESEARCH ON UTILIZATION OF SCIENTIFIC KNOWLEDGE / INSTITUTE FOR SOCIAL RESEARCH / THE UNIVERSITY OF MICHIGAN
ANN ARBOR, MICHIGAN 48106

MEMORANDUM

TO: Station Directors

FROM: Bill Morris and Dave Lingwood,
The University of Michigan

DATE: February 27, 1973

We are ready to mail the study questionnaires to our contact person, _____, at the station. He or she has instructions and guidelines included with the material. For your information, however, we don't think it would be a good idea to distribute the questionnaries until the staff has had a short note from you indicating that they are coming.

We are enclosing copy of the questionnaire for you. We thought perhaps you might like to fill it out yourself; then tuck it away someplace until we have the data analyzed; and then bring it out and compose your perceptions with scientists and technicians at the station. All ADs, PLs, and scientists are being asked to aprticipate, plus at lease one-third (randomly chosen) of your technicians. Only the support services staff has not been asked to participate in the study.

/jvj

ISR

CENTER FOR RESEARCH ON UTILIZATION OF SCIENTIFIC KNOWLEDGE

INSTITUTE FOR SOCIAL RESEARCH, UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN 48106

FOREST SERVICE RESEARCH STUDY

Dear Forest Service Researcher:

During the past two years we at CRUSK have been working with Forest Service Research leadership in a study designed to diagnose the strengths of the organization, as well as to identify and work on areas where improvements may be made. We are concentrating on the fields of:

(1) organizational planning and goal setting

(2) organizational climate, process, and leadership

(3) the activities, rewards, and opportunities of scientists, administrators, and technicians

(4) the relations between scientists and the users of knowledge they produce, that is, the important topic of how research gets sent to and utilized by users.

In the first year of our work we talked to many individuals inside Research about these areas. Now we have developed a survey instrument which will be used to give us a complete picture of the whole Research system. You, together with all other scientists and administrators, and a random sample of technicians, are being asked to fill out this questionnaire.

This study is not just an academic exercise. Results will be ***used***, beginning next year, to reinforce strengths and help design changes where needed in the system.

The questionnaire will ask you to describe and give your opinions about each of the four areas above, and also for information about yourself. After each section of questions you will be invited to write any comments you have about that topic on separate sheets provided. The questions we ask in the four areas are drawn from what we have learned about Forest Service Research in the past two years, suggestions from a consulting team (WO and field) we have asked to guide our work, and from past research in the four areas. The questions we ask about you at the end of the questionnaire are necessary in our analysis so we may understand answers given in the four topic areas.

In any study where we ask for opinions and information about people, we are obligated to protect the anonymity of our respondents. We guarantee that your answers will be completely confidential, and that you will not be identified in any way in our reports to the Forest Service, or in the sessions we will have with stations to help you and your leadership understand our results and use them to design changes. Obviously, however, we need to know who you are in order to control administration of the survey and to save you the inconvenience of further mailings once you have returned the forms. The identification number on the questionnaire serves this purpose; but remember please, only the two of us will ever have access to this confidential information.

Specific instructions are given on the next page. When you have completed the questionnaire, please seal it in the envelope provided, and mail it directly to us.

Thank you for your help.

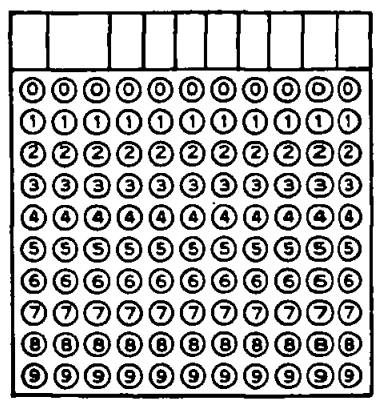
Sincerely yours,

William C. Morris

William C. Morris, Ph.D.
Project Director, CRUSK

David A. Lingwood

David A. Lingwood, Ph.D.
Project Director, CRUSK



INSTRUCTIONS:

Most questions can be answered by filling in one of the circular answer spaces. If you do not find the answer which exactly fits you, please estimate, or use the answer which is closest.

This form is designed for *automatic processing*. Please follow these requirements:

- Fill in the answer circles completely and darkly, using ONLY a soft lead pencil (No. 2 is best).
- Erase completely any answers you wish to change.
- Where written numbers or short answers are called for, stay well inside the designated response areas.
- Make NO stray marks or comments anywhere on the form. Use the green section for your comments.

I. ABOUT PLANNING:

Below we would like you to tell us how you feel about research planning in your station. How are goals set, who does it, who plans how to get to the goal, and how is the process evaluated?

I-1. To what extent does your station emphasize each of the following factors regarding research planning? (Be sure to fill in one and only one circle for each factor below.)

	To no extent	To a little extent	To some extent	To a great extent	To a very great extent	Don't know	Doesn't apply to me
a. Participation of all scientific staff levels in planning	O	O	O	O	O	O	O
b. Use of special planning units	O	O	O	O	O	O	O
c. User group participation in planning	O	O	O	O	O	O	O
d. Projecting the future based on present trends	O	O	O	O	O	O	O
e. Specifying long range goals	O	O	O	O	O	O	O
f. Examining the basic assumptions (about resources, society, etc.) on which plans are based	O	O	O	O	O	O	O
g. Handling interpersonal or conceptual conflicts which arise during planning	O	O	O	O	O	O	O
h. Integrating research plans with broader FS plans	O	O	O	O	O	O	O
i. Depending on plans made in the Washington office	O	O	O	O	O	O	O
j. Learning from mistakes made in past plans	O	O	O	O	O	O	O
k. Changing plans in mid-course to meet new conditions	O	O	O	O	O	O	O
l. Using plans involving high risks, but which have great potential payoff	O	O	O	O	O	O	O
m. Using adequate time frames in planning	O	O	O	O	O	O	O

I-2. The items below refer to planning at several different levels in the Forest Service. To what extent are you satisfied with:

a. Your own level of participation in short range research project planning	O	O	O	O	O	O	O
b. Your own level of participation in station long range planning	O	O	O	O	O	O	O
c. The way your station as a whole does long range planning now	O	O	O	O	O	O	O
d. The way Forest Service Research as a whole does long range planning now	O	O	O	O	O	O	O
e. The way the Forest Service as a system does long range planning now	O	O	O	O	O	O	O

I-3. What else would you like to say about PLANNING? (At the end of each section we will ask you if you would like to add anything about that subject. We have included a section of green sheets at the end of the questionnaire to be used for this purpose. Each time, if you have additional comments to make, please turn to the green section to make your remarks.)

II. ABOUT YOUR STATION

Here we are interested in the station in which you work. (For each pair of extreme statements below, please darken the circle in the column which most accurately describes your opinion. Be sure to fill in one, and only one circle for each pair of statements. If you do not know, or if the statements do not apply to you at all, fill in the circle in the appropriate column. These instructions will apply in all of the sections below in which we use these paired-statement questions.)

A	A applies	Tends to A	Intermediate	Tends to B	B applies	B	Don't know	Doesn't apply to me
a. The quality of statistical assistance and services is completely satisfactory	O	O	O	O	O	The quality of statistical assistance and services is completely unsatisfactory	O	O
b. The quality of editorial assistance and services is completely satisfactory	O	O	O	O	O	The quality of editorial assistance and services is completely unsatisfactory	O	O
c. The restrictions imposed on scientists and engineers of the station by administrative regulations are minimal	O	O	O	O	O	The restrictions imposed on scientists and engineers of the station by administrative regulations are excessive	O	O
d. The station is willing to overlook deviations from policies or procedures when such deviations are done to improve the station	O	O	O	O	O	The station is opposed to any and all deviations, and actively enforces adherence to all policies and procedures	O	O
e. The station has done very well in adapting to changing circumstances -- that is, keeping up with the times	O	O	O	O	O	The station has done very poorly in adapting to changing circumstances	O	O
f. There is an atmosphere of dedication to work in the station	O	O	O	O	O	There is the feeling that everyone in the station only works there to make a living	O	O
g. The research activities of the station are extremely interesting and conceptually exciting	O	O	O	O	O	The research activities are uninteresting and unexciting	O	O
h. The research program of the station is highly coherent	O	O	O	O	O	The research program is utterly fragmented	O	O
i. I feel free to seek information I need from persons outside the station	O	O	O	O	O	I do not feel free to seek information I need from persons outside the station	O	O
j. I am very satisfied with the amount of information I get about what is going on in the station	O	O	O	O	O	I am very dissatisfied with the amount of information I get about what is going on in the station	O	O
k. It is very easy for me to exchange information and ideas about my work with people like myself from other projects in the station	O	O	O	O	O	It is very difficult for me to exchange information and ideas about my work with people like myself from other projects in the station	O	O
l. Scientific and technical staff meetings are convened very frequently in the station	O	O	O	O	O	Scientific and technical staff meetings are very rare in the station	O	O
m. I am very satisfied with the way evaluation panels are working in the station	O	O	O	O	O	I am very dissatisfied with the way evaluation panels are working in the station	O	O
n. I am very satisfied with the way research is carried out in the station	O	O	O	O	O	I am very dissatisfied with the way research is carried out in the station	O	O
o. All in all, the station does an excellent job of fulfilling its objectives and achieving its goals	O	O	O	O	O	All in all, the station does a very poor job of fulfilling its objectives and achieving its goals	O	O

II-2. What else would you like to say about YOUR STATION? (Please use the green section at the end.)

III. ABOUT YOUR WORK ENVIRONMENT OR LOCATION

Here we are interested in the place you do your work: your laboratory, facility, or site.

A	A applies	Tends to A	Intermediate	Tends to B	B applies	B	Don't know	Doesn't apply
a. There are few distractions (noise, phone calls, unforeseen visits, etc.) to interrupt the work at my location	O	O	O	O	O	There are so many distractions that work is practically impossible	O	O
b. There is a very high degree of cooperation among people at my location	O	O	O	O	O	There is very little cooperation among people at my location	O	O
c. There are many opportunities for informal discussions among scientists at my location	O	O	O	O	O	There are very few opportunities for informal discussions among scientists at my location	O	O
d. There is an atmosphere of dedication to work at my location	O	O	O	O	O	There is a feeling that everyone at my location only works there to make a living	O	O
e. My location makes contact with non-FS researchers in my scientific discipline very easy	O	O	O	O	O	My location makes contact with non-FS researchers in my scientific discipline very difficult	O	O
f. My location makes contact with the rest of the station very easy	O	O	O	O	O	My location makes contact with the rest of the station very difficult	O	O
g. My location makes contact with user groups very easy	O	O	O	O	O	My location makes contact with user groups very difficult	O	O
h. My location is close to sources of data I need for my research	O	O	O	O	O	My location is isolated from sources of data I need for my research	O	O
i. The way in which scientific equipment is shared at my location is completely satisfactory	O	O	O	O	O	The way in which scientific equipment is shared at my location is completely unsatisfactory	O	O
j. My access to library and information services is completely satisfactory	O	O	O	O	O	My access to library and information services is completely unsatisfactory	O	O
k. My location is a good place to live	O	O	O	O	O	My location is not a very good place to live	O	O

III-2. What else would you like to say about YOUR LOCATION? (Use the green section.)

IV. ABOUT YOUR UNIT

Here we are interested in the most immediate organizational grouping in which you do your work: your project, program, or branch.

a. The space available for the work of my unit is completely adequate	O	O	O	O	O	The space available for the work of my unit is inadequate	O	O
b. My unit is very well equipped	O	O	O	O	O	My unit is very poorly equipped	O	O
c. When any change involving my unit is underway, there is usually a lot of information about it available to me	O	O	O	O	O	When any change involving my unit is underway, almost no information is usually available to me	O	O
d. My unit is not at all isolated from a desirable intellectual and research environment	O	O	O	O	O	My unit is extremely isolated from a desirable intellectual and research environment	O	O
e. I have many regular contacts on job-related questions with the members of my unit	O	O	O	O	O	I have few regular contacts on job-related questions with the members of my unit	O	O
f. Technical and service staff are very often invited to participate in staff meetings of the unit	O	O	O	O	O	Technical and service staff are very rarely invited to participate in staff meetings of the unit	O	O

A	A applies	Tends to A	Intermediate	Tends to B	B applies	B	Don't know	Doesn't apply to me
Most of my unit's work requires cooperation of scientists from different disciplines	O	O	O	O	O	Most of my unit's work involves scientists from a single discipline	O	O
h. Co-ordination between research units is very frequently required in my work	O	O	O	O	O	Co-ordination between research units is rarely required in my work	O	O
i. All of my unit's research results find follow-up or practical application	O	O	O	O	O	None of my unit's research results find any follow-up or practical application	O	O
j. There is persistent and strong pressure from outside my unit to ensure that its results find follow-up or practical application	O	O	O	O	O	There is no pressure from outside my unit to ensure that its results are made use of	O	O
k. There is persistent and strong pressure from within my unit to ensure that its results find follow-up or practical application	O	O	O	O	O	There is no pressure from within my unit to ensure that its results are made use of	O	O
l. Unit staff often serve as consultants with user groups regarding applications of our work	O	O	O	O	O	Unit staff never serve as consultants with user groups regarding applications of our work	O	O
m. My unit has made an outstanding contribution to scientific or technical development in its field	O	O	O	O	O	My unit has made little contribution to scientific or technical development in its field	O	O
n. The work of my unit is well known and highly regarded in the Forest Service as a whole	O	O	O	O	O	The existence of my unit passes largely unnoticed in the Forest Service as a whole	O	O

IV-2. What else would you like to say about YOUR UNIT? (Use the green section.)

ABOUT YOUR SUPERVISOR

In this section we will ask you several questions about your immediate supervisor. We are interested in the person to whom you report directly for the largest proportion of the work you do.

V-1. What is your supervisor's title?

Station Director ····· O
A.D. ····· O
W.O. Division staff member or director ····· O
Program manager ····· O
P.L. ····· O
Scientist ····· O

V-2. Now we would like to ask some general questions about your supervisor.

a. My supervisor is very concerned with getting work done	O	O	O	O	O	My supervisor is not at all concerned with getting work done	O	O
b. My supervisor is very concerned with keeping his subordinates satisfied and happy	O	O	O	O	O	My supervisor is not at all concerned with keeping his subordinates satisfied and happy	O	O
c. My supervisor keeps up-to-date on the the scientific and technical skills he needs in his discipline	O	O	O	O	O	My supervisor does not keep up-to-date on the scientific and technical skills he needs in his discipline	O	O
d. My supervisor does a good job relating to outside groups, agencies, and 'clients'	O	O	O	O	O	My supervisor does not do a very good job relating to outside groups, agencies, and 'clients'	O	O
e. My supervisor frequently offers new ideas for solving job-related problems	O	O	O	O	O	My supervisor rarely offers new ideas for solving job-related problems	O	O
f. My supervisor is very concerned that I w and 'get ahead' professionally	O	O	O	O	O	My supervisor is not very concerned that I grow and 'get ahead' professionally	O	O
g. My supervisor is very friendly and easy to approach	O	O	O	O	O	My supervisor is not very friendly or easy to approach	O	O

A	A applies	Tends to A	Intermediate	Tends to B	B applies	B	Don't know	Doesn't apply to me
h. I can influence the activities and decisions of my supervisor to a great extent on matters that are of concern to me	O	O	O	O	O	I can't influence the activities and decisions of my supervisor on matters that are of concern to me	O	O
i. My supervisor encourages people who work for him to exchange opinions and ideas among themselves	O	O	O	O	O	My supervisor discourages people who work for him from exchanging opinions and ideas among themselves	O	O
j. I am kept well informed of my supervisor's assessment of my performance	O	O	O	O	O	I am not kept informed of what my supervisor thinks of my performance	O	O
k. My supervisor is highly concerned with maintaining high standards of performance	O	O	O	O	O	My supervisor is not very concerned with maintaining high standards of performance	O	O
l. My supervisor uses very general supervision; e.g., I am definitely on my own to carry out the basic tasks of my job	O	O	O	O	O	My supervisor uses very close supervision; e.g., he doesn't put me on my own to carry out the basic tasks of my job	O	O
m. My supervisor shows interest in my work and periodically discusses it with me	O	O	O	O	O	My supervisor shows little interest in my work and rarely discusses it with me	O	O
n. My supervisor is always up-to-date on policies, rules, and regulations of the FS and of the station	O	O	O	O	O	My supervisor is rarely up-to-date on policies, rules, and regulations of the FS and of the station	O	O
o. Taking all things into consideration, I am very satisfied with my supervisor	O	O	O	O	O	Taking all things into consideration, I am very dissatisfied with my supervisor	O	O

V-3. What else would you like to say about YOUR SUPERVISOR? (Use the green section.)

VI. ABOUT YOUR JOB

VI-1. Below are several general questions about your job.

a. I work under much less time pressure than I think would be optimal for me	O	O	O	O	O	I work under much more time pressure than I think would be optimal for me	O	O
b. I have a feeling of complete security in my work	O	O	O	O	O	I have a feeling of extreme insecurity in my work	O	O
c. I never consider leaving F S. research	O	O	O	O	O	I would leave FS research if I had a suitable opportunity to do so	O	O
d. My responsibilities are in excess of my capabilities	O	O	O	O	O	My responsibilities are far below my capabilities	O	O
e. My present work is extremely challenging	O	O	O	O	O	My present work is not very challenging	O	O
f. Most of my research is basic in orientation	O	O	O	O	O	Most of my research is applied in orientation	O	O
g. My present work is likely to make a very substantial contribution to scientific or technical knowledge in my field	O	O	O	O	O	My present work is not likely to make a substantial contribution to scientific or technical knowledge in my field	O	O
h. My present work is likely to make a very substantial contribution to practical application or use 'on the ground'	O	O	O	O	O	My present work is not likely to make a substantial contribution to practical application or use 'on the ground'	O	O
i. Forest Service leadership encourages and rewards me for getting 'on the ground' applications of my research	O	O	O	O	O	Forest Service leadership does not encourage or reward me for getting 'on the ground' applications of my research	O	O

A	A applies	Tends to A	Intermediate	Tends to B	B applies	B	Don't know	Doesn't apply to me
j. The opportunities I have for advanced technical or managerial training are completely satisfactory	O	O	O	O	O	The opportunities I have for advanced technical or managerial training are completely unsatisfactory	O	O
. Technical information systems are available for my use whenever I need them	O	O	O	O	O	Technical information systems are not available to me at all	O	O
l. The number of publications I have is extremely important in getting a promotion in my station	O	O	O	O	O	The number of publications I have is of little importance in getting a promotion in my station	O	O
m. The quality of work I do is extremely important in getting a promotion in my station	O	O	O	O	O	The quality of work I do is of little importance in getting a promotion in my station	O	O
n. I am very satisfied with my chances for promotion in this station	O	O	O	O	O	I am very dissatisfied with my chances for promotion in this station	O	O
o. As I think about my career and getting ahead in the FS, I would say I have made great progress	O	O	O	O	O	As I think about my career and getting ahead in the FS, I would say that I have made little progress	O	O
p. Considering my job as a whole -- all aspects of it -- I like my job extremely well	O	O	O	O	O	Considering my job as a whole -- all aspects of it -- I do not like my job at all	O	O

VI-2. Now we would like you to consider your personal preferences concerning different conditions for doing your research

a. I prefer working on problems that are capable of quick solution	O	O	O	O	O	I prefer to work on problems with a long time frame	O	O
b. I prefer projects that are clearly defined and well structured right from the beginning	O	O	O	O	O	I prefer projects that may be unclear and have little structure in the beginning	O	O
c. I prefer to work on abstract problems that may have no immediate practical application	O	O	O	O	O	I prefer to work on projects that are directly relevant to practical application	O	O
d. I prefer to generalize in research as much as possible, mapping out broad features of important new areas, leaving detailed study to others	O	O	O	O	O	I prefer to specialize in selected narrowed areas, probing as deeply and thoroughly as possible	O	O
e. I do not mind undertaking projects that involve considerable risks of failure if the problem interests me	O	O	O	O	O	I prefer undertaking projects that do not involve considerable risks of failure	O	O
f. I prefer to take personal responsibility for working 'on the ground' with users to get practical application of my research	O	O	O	O	O	I prefer to leave to others the responsibility for applying my research 'on the ground'	O	O
g. I prefer to work in close association with others in doing research projects	O	O	O	O	O	I prefer to work by myself on research projects	O	O
h. I prefer to work deductively: deriving specific instances out of abstract principles	O	O	O	O	O	I prefer to work inductively: deriving general principles out of specific observations	O	O
i. I prefer to prepare myself any interpretations, and popularized articles based on my work	O	O	O	O	O	I prefer to leave the preparation of abstracts, interpretations, and popularized articles to others	O	O
j. I prefer to consider many aspects of a problem at the same time	O	O	O	O	O	I prefer to consider only a few aspects of a problem at the same time	O	O

Prepared and Processed by: NATIONAL COMPUTER SYSTEMS, 4401 W. 76th St., Minneapolis, Minnesota 55435

VI-3. Listed below are different kinds of opportunities which a job might afford. First, if you were to seek another job, how much importance would you personally attach to each of these (disregarding whether or not your present job provides them)? (Rate all items A through P under 'Importance.') Second, to what extent does your present job actually provide an opportunity for each of these factors? (Rate all items A through P on 'Opportunity.')

	Importance You would attach					Opportunity Present job provides				
	A little	Moderate	Great	Very great	Utmost	A little	Moderate	Great	Very great	Utmost
a. to make full use of my present knowledge and skills	O	O	O	O	O	O	O	O	O	O
b. to grow and learn new knowledge and skills	O	O	O	O	O	O	O	O	O	O
c. to earn a good salary	O	O	O	O	O	O	O	O	O	O
d. to advance in administrative authority and status	O	O	O	O	O	O	O	O	O	O
e. to advance in the professional respect of colleagues and chiefs	O	O	O	O	O	O	O	O	O	O
f. to work with colleagues of high technical competence	O	O	O	O	O	O	O	O	O	O
g. to have congenial co-workers as colleagues	O	O	O	O	O	O	O	O	O	O
h. to work under chiefs of high technical competence	O	O	O	O	O	O	O	O	O	O
i. to associate with top executives in the organization	O	O	O	O	O	O	O	O	O	O
j. to work on difficult and challenging problems	O	O	O	O	O	O	O	O	O	O
k. to have freedom to carry out my own ideas	O	O	O	O	O	O	O	O	O	O
l. to contribute to broad technical knowledge in my field	O	O	O	O	O	O	O	O	O	O
m. to work on problems of central importance to the station	O	O	O	O	O	O	O	O	O	O
n. to be evaluated fairly in proportion to what I contribute	O	O	O	O	O	O	O	O	O	O
o. to have stability of employment	O	O	O	O	O	O	O	O	O	O
p. to work on problems of central importance to the station's user groups	O	O	O	O	O	O	O	O	O	O

VI-4. To what extent does each of the sources below offer you the most stimulus to perform well in your job?

Extent to which each factor Stimulates me to perform well	To no extent	To a little extent	To some extent	To a great extent	To a very great extent
a. My own standards	O	O	O	O	O
b. My supervisors	O	O	O	O	O
c. Colleagues in this station	O	O	O	O	O
d. Colleagues elsewhere	O	O	O	O	O
e. My own previous work or plans	O	O	O	O	O
f. Problems arising in practical applications	O	O	O	O	O
g. NFS or S&PF user groups	O	O	O	O	O
h. User groups outside the FS	O	O	O	O	O
i. My own curiosity	O	O	O	O	O

Do not write in the box above.

VI-5. Now we would like to know how you actually spend your time on the various activities related to your job with the Forest Service.

First, in an average week, how many hours (paid or unpaid) do you actually spend in work and work-related activities?

(Write the number of hours in this box)

TOTAL HOURS PER WEEK:

Of this total work time, how many hours do you spend on each of the following types of activities? (If it varies, strike an average. Again, write completely within the boxes provided.)

a. Scientific or technical work ..... HOURS:

Of the a hours, how many do you spend on each of the following six activities?

For each activity, would you like to spend more, less, or about the same amount of time as you do now?

		More	Same	Less
My own work (including reading and writing)	HOURS:	O	O	O
Preparing research documentation such as study plans, work unit descriptions, etc.	HOURS:	O	O	O
Supervising the scientific or technical work of others	HOURS:	O	O	O
Consulting with other scientists: giving or getting scientific or technical help	HOURS:	O	O	O
Communicating with or training user groups	HOURS:	O	O	O
Other scientific or technical	HOURS:	O	O	O

b. Administrative or other non-scientific or non-technical work ..... HOURS:

Of the b hours, how many do you spend on each of the following three activities?

		More	Same	Less
Internal administration: expediting services, etc.	HOURS:	O	O	O
Communicating with higher-ups	HOURS:	O	O	O
Other non-scientific or non-technical	HOURS:	O	O	O

c. Teaching and training ..... HOURS:

Of the c hours, how many do you spend on each of the following three activities?

		More	Same	Less
Receiving own training	HOURS:	O	O	O
University or other course teaching	HOURS:	O	O	O
Other teaching and training	HOURS	O	O	O

VII. ABOUT USERS OF YOUR RESEARCH

Now we would like to turn our attention to the processes by which the research you produce or supervise gets transmitted to, and used by, your important 'users.'

VII-1. Let's begin by identifying who these important user groups are. Below are listed several groups which might be potential audiences for the research you produce or supervise, i.e., people who would find it relevant to their own interests. Blacken two circles for each group: first, the extent to which this group is now a part of your actual audience; and second, the extent to which you think the group should be a part of your audience.

	To what extent is this group part of your actual audience?						To what extent should this group be a part of your audience?					
	To no extent	To a little extent	To some extent	To a great extent	To a very great extent	Don't know or doesn't apply	To no extent	To a little extent	To some extent	To a great extent	To a very great extent	Don't know or doesn't apply
a. Researchers inside of the Forest Service	O	O	O	O	O	O	O	O	O	O	O	O
b. Researchers outside of the Forest Service	O	O	O	O	O	O	O	O	O	O	O	O
c. National Forest Systems, FS	O	O	O	O	O	O	O	O	O	O	O	O
d. State and Private Forestry, FS	O	O	O	O	O	O	O	O	O	O	O	O
e. WO Research branch policy makers and administrators	O	O	O	O	O	O	O	O	O	O	O	O
f. Other Federal policy makers and administrators	O	O	O	O	O	O	O	O	O	O	O	O
g. State forestry agency and other state policy makers and administrators	O	O	O	O	O	O	O	O	O	O	O	O
h. Business or industrial groups	O	O	O	O	O	O	O	O	O	O	O	O
i. Environmental groups	O	O	O	O	O	O	O	O	O	O	O	O
j. The mass media	O	O	O	O	O	O	O	O	O	O	O	O
k. The general public	O	O	O	O	O	O	O	O	O	O	O	O

VII-2. Listed below are several activities having to do with relationships between Forest Service Research an its user groups. We would like you to indicate two things for each activity: first, please indicate the extent to which researchers in your station do that activity now; and second, to what extent do you believe researchers in your station should be doing that activity.

	To what extent do researchers in your station do these activities now?						To what extent should researchers in your station be doing these activities?					
a. Helping user groups develop a capacity to solve their own problems	O	O	O	O	O	O	O	O	O	O	O	O
b. Developing and using regular mechanisms for determining what users' needs are	O	O	O	O	O	O	O	O	O	O	O	O
c. Transforming users' needs into problem statements and researchable questions	O	O	O	O	O	O	O	O	O	O	O	O
d. Doing research which is directly applicable 'on the ground'	O	O	O	O	O	O	O	O	O	O	O	O
e. Doing work on problems at the time they are most important to users	O	O	O	O	O	O	O	O	O	O	O	O
f. Producing summaries, abstracts, and reviews of research findings	O	O	O	O	O	O	O	O	O	O	O	O
g. Rewriting research products in the language of each important user group	O	O	O	O	O	O	O	O	O	O	O	O
h. Determining who the important users should be for each finding to be transmitted	O	O	O	O	O	O	O	O	O	O	O	O

	To no extent	To a little extent	To some extent	To a great extent	To a very great extent	Don't know or Doesn't apply	To no extent	To a little extent	To some extent	To a great extent	To a very great extent	Don't know or Doesn't apply
i. Finding someone in each user group to help in the dissemination and implementation	O	O	O	O	O	O	O	O	O	O	O	O
j. Selecting the most appropriate channels to be used to reach each user most efficiently	O	O	O	O	O	O	O	O	O	O	O	O
k. Designing ways to get users and researchers working together on joint projects	O	O	O	O	O	O	O	O	O	O	O	O
l. Organizing ways users and researchers can get together to exchange information	O	O	O	O	O	O	O	O	O	O	O	O

VII-3. What else would you like to say about USERS OF YOUR RESEARCH? (Use the green section.)

VIII. SCIENTIFIC COMMUNICATION

VIII-1. How many of the following have you authored or co-authored within the past five years? (Include those accepted but not yet published where appropriate. Estimate if necessary.)

	None	1–2	3–5	6–10	More than 10
a. Books written or edited	O	O	O	O	O
b. Book chapters	O	O	O	O	O
c. Published abstracts or book reviews	O	O	O	O	O
d. Journal articles	O	O	O	O	O
e. Popularized articles	O	O	O	O	O
f. Station publications (scientific)	O	O	O	O	O
g. Station publications ('how to do it')	O	O	O	O	O
h. Unpublished technical reports or manuscripts	O	O	O	O	O
i. Invited or contributed papers at meetings or symposia	O	O	O	O	O

VIII-2. How many of the following events have you attended in the past two years? (Estimate if necessary.)

a. Work-related continuing education courses	O	O	O	O	O
b. Scientific/Technical events:					
1. Regional or national meetings or symposia	O	O	O	O	O
2. International meetings or symposia	O	O	O	O	O
3. Workshops and seminars	O	O	O	O	O
c. Researcher — User events:					
1. Workshops and seminars	O	O	O	O	O
2. Public meetings and hearings	O	O	O	O	O
3. User interest group meetings (e.g., with cattlemen, loggers)	O	O	O	O	O
4. Planning meetings in public or private sector	O	O	O	O	O

VIII-3. Here we are interested in the informal communication which takes place in your station, related to your work.

a. How often do others in your station come to you for advice in each of the following areas?

	Never	Rarely	Sometimes	Often	Very often
1. Advice on scientific or technical matters	O	O	O	O	O
2. Advice on administrative problems	O	O	O	O	O
3. Advice on planning and goal setting	O	O	O	O	O
4. Advice on getting applications 'on the ground'	O	O	O	O	O

b. How often do you go to others in your station for advice in each of these same areas?

1. Advice on scientific or technical matters	O	O	O	O	O
2. Advice on administrative problems	O	O	O	O	O
3. Advice on planning and goal setting	O	O	O	O	O
4. Advice on getting applications 'on the ground'	O	O	O	O	O

VIII-4. In the past month, how many of the following have you read, related to your work? (Estimate the number if necessary.)

	None	1–2	3–5	6–10	More than 10
a. Books	O	O	O	O	O
b. Reviews	O	O	O	O	O
c. Journal articles or reprints	O	O	O	O	O
d. Station publications	O	O	O	O	O
e. Trade publications	O	O	O	O	O
f. Unpublished papers and pre-prints	O	O	O	O	O
g. FS Manual sections or other policy guidelines	O	O	O	O	O

Prepared and Processed by: NATIONAL COMPUTER SYSTEMS, 4401 W. 76th St., Minneapolis, Minnesota 55435

IX. ABOUT YOU

These questions are necessary for our analysis, to help us interpret the answers you have already given.

IX-1. What is your present age? (Write the number in the box, then blacken the circles corresponding to the digits.) YEARS

IX-2 What is the highest level of education you have completed? (Blacken only one circle.)

a. High school graduate or less ○
b. Some college, or 2-year ○
c. College graduate (4-year) ○
d. Some graduate work (no degree) ○
e. Masters degree ○
f. Doctoral degree ○

IX-3. About the level of education you mentioned above ....

a. How many years since completed? (Write the number in the box, then blacken the circles corresponding to the digits.) YEARS

b. From which institution? (Write name of institution inside box below.)

c. Field of specialization? (Write field inside box below.)

d. Are you now working in a field other than that in which you were trained?

YES ○
NO ○

e. If you answered 'YES': specify the field in which you are working now. (Write name of field in box below.)

IX-4. How many years have you been:

a. Employed by Forest Service Research? YEARS:

b. Employed at this station? YEARS:

c. Working on or supervising your present line of research (i.e., that area directly contributing to your present assignment)? YEARS:

(For each, write the number in the box, then blacken the circles corresponding to the digits. If any are less than one year, enter '01'.)

IX-5. How many years (if any) were you employed full time by:

a. NFS and/or S&PF? YEARS:

b. Business or industry YEARS:

c. College or university YEARS:

d. Other govern-mental YEARS:

(Same instructions as above. If you have never worked for one of the above, enter '00'.)

IX-6. What is your present working title?

a. Technician ○
b. Scientist ○
c. Project Leader ○
d. Program Manager ○
e. Asst. Director ○
f. Other (Specify inside the box below.) ○

IX-7. What is your present GS Grade Level? ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

X. We have asked many different questions about your work and FS Research, but few about changes you see as necessary. If you had the power tomorrow to make any realistic change you wanted in FS Research, what would you do, and why? (This question is OPTIONAL. If you would like to answer, use the appropriate part of the green section.)

THANK YOU FOR YOUR HELP!!!

ISR

CENTER FOR RESEARCH ON UTILIZATION OF SCIENTIFIC KNOWLEDGE / INSTITUTE FOR SOCIAL RESEARCH / THE UNIVERSITY OF MICHIGAN
ANN ARBOR, MICHIGAN 48106

February 27, 1973

MEMO TO: Forest Service Team
FROM: Judith Kaplan
SUBJECT: Study Questionnaires

Under separate cover you will be receiving the questionnaires for the main part of our study. These are to be distributed to all the scientists at your station and one-third of the technicians (with the exception of Research Support Services). You will find each person's name on the outside of the sealed envelopes.

Please do not distribute the questionnaires until after your Station Director has sent a memo around to all concerned. As you can see by the enclosed questionnaire, we have done everything possible to protect each respondent's anonymity and have instructed them to return their form directly to us in the return envelope.

Please return to me the questionnaire of any person no longer at your station. If you have any question feel free to contact me at (313)-764-6108.

Thanking you in advance for all your cooperation!

JK/jd

ISR

CENTER FOR RESEARCH ON UTILIZATION OF SCIENTIFIC KNOWLEDGE / INSTITUTE FOR SOCIAL RESEARCH / THE UNIVERSITY OF MICHIGAN
ANN ARBOR, MICHIGAN 48106

March 27, 1973

MEMO TO: Forest Service Researcher

FROM: Bill Morris and Dave Lingwood

Our records show that we have not yet received your questionnaire from the Forest Service - CRUSK Study. While we realize you are very busy, we would appreciate your response at your earliest possible opportunity. If your copy of the questionnaire has strayed from your desk, please contact us and we will forward a replacement.

If you've already returned your completed questionnaire, thank you, and please disregard this notice.

BM/DL/jd

ISR

CENTER FOR RESEARCH ON UTILIZATION OF SCIENTIFIC KNOWLEDGE / INSTITUTE FOR SOCIAL RESEARCH / THE UNIVERSITY OF MICHIGAN
ANN ARBOR, MICHIGAN 48106

April 16, 1973

Memo to: Forest Service Researcher
From: Bill Morris and Dave Lingwood

We have not yet received your completed copy of the Forest Service - CRUSK Study questionnaire. As of this date 84% of all scientists, technicians and station administrators throughout the country have responded. If you plan to have your information included in this total, please mail your questionnaire within the next seven days.

If this note passes your questionnaire in the mails, thanks a lot.

WM/DL/jsk

CODES FOR EDUCATION AND TRAINING FIELDS

1. NATURAL RESOURCES

    11 Forestry
    12 Wildlife
    13 Range

2. NATURAL SCIENCE

    21 Biological science; General
    22 Agriculture
    23 Botany
    24 Zoology
    25 Microbiology
    26 Entomology

3. PHYSICAL SCIENCE

    31 Physical science; General
    32 Physics
    33 Chemistry
    34 Mathematics
    35 Geology

4. SOCIAL SCIENCE

    41 Social science; General
    42 Sociology
    43 Economics
    44 Geography

5. ENGINEERING

    51 Engineering; General
    52 Civil engineering
    53 Chemical engineering
    54 Electrical engineering
    55 Mechanical engineering

6. MISCELLANEOUS

    61 Architecture
    62 Arts and humanities; General

7 GENERAL

    71 General studies

NOTE: Cross-discipline programs involving forestry were coded under natural resources; e.g., "forest economics". In case of multiple fields, the first-mentioned was used. A more detailed field list is available from the authors on request.

UNIVERSITY STATUS CODES

FIELD	TOP-RANKED DEPARTMENTS	SECOND-LEVEL DEPARTMENTS
Forestry (5)*	Calif. (Berkeley), Michigan, Minnesota, Washington, SUNY (Syracuse) No. Carolina St., Yale	Georgia, Michigan St., Duke, Colorado St., Oregon St., Penn. St., Virginia Poly. Inst.
Wildlife (6)	Calif. (Berkeley), Wisconsin, Michigan, Utah St.	Purdue, Oregon St., Minnesota, Cornell, Penn. St., Michigan St., Washington (Fisheries only), Miami (fisheries only), Colorado St., Ohio St.
Range (7)	Utah St., Colorado St., Texas A&M, Texas Tech.	Arizona, New Mexico St., Calif. (Davis), Calif. (Berkeley)
Agriculture (8)	Calif. (Davis), No. Carolina St., Michigan St., Iowa St., Cornell	Purdue, Penn. St., Oregon St., Wisconsin, Illinois
Botany (1)	Calif. (Berkeley), Michigan, Harvard, Wisconsin, Calif. (Davis), Duke, Indiana, Stanford, Texas	Cal. Tech., UCLA, Michigan St., Illinois, Cornell, Purdue, No. Carolina, Yale, Claremont, Minnesota
Zoology (1)	Calif. (Berkeley), Harvard, Stanford, Johns Hopkins, Yale, Rockefeller Inst., Indiana, Wisconsin, Michigan	UCLA, Princeton, Illinois, U. Chicago, Cornell, Duke, Western Reserve, Pennsylvania, Columbia, Washington, Texas, Purdue
Biology (9)	Calif. (Berkeley), Wisconsin, Cornell, Yale, Michigan, Purdue, Illinois, Calif. (Davis), Michigan St.	Minnesota, Rutgers, Penn. St., No. Carolina St. Iowa St., Conn., Ohio St., SUNY (Syracuse), Kansas St., Florida, Mass.
Microbiology (1)	Calif. (Berkeley), Rockefeller Inst. Cal. Tech., Harvard, Illinois, Wisconsin, Stanford	Washington, Johns Hopkins, Minnesota, Calif. (Davis), Western Reserve, Purdue, Yale, Texas, Indiana, Brandeis, Michigan, Penn., U. Chicago, Rutgers, N.Y.U.
Entomology (1)	Calif. (Berkeley), Cornell, Illinois	Kansas, Wisconsin, Minnesota, Calif. (Davis), Ohio St.
Physics (1)	Princeton, Cal. Tech., Stanford, Harvard, Calif. (Berkley), MIT, Cornell, Illinois	Wisconsin, U. Chicago, Yale, Columbia, Rochester, Michigan, Washington, Penn., Maryland, Minnesota, Johns Hopkins

* See "Rating Notes" below.

FIELD	TOP-RANKED DEPARTMENTS	SECOND-LEVEL DEPARTMENTS
Chemistry (1)	Harvard, Cal. Tech., Calif. (Berkeley), MIT, Stanford, Illinois, Wisconsin, UCLA, Columbia	Cornell, U. Chicago, Princeton, Yale, Northwestern, Minnesota, Iowa St., Michigan, Johns Hopkins, Ohio St., Washington, Purdue, Rice
Mathematics (1)	Princeton, Harvard, Calif. (Berkeley), Stanford, MIT, U. Chicago, Yale, Wisconsin, Cornell	Cal. Tech., Michigan, NYU, Illinois, Washington, Columbia, Minnesota, Brandeis, Brown, UCLA, Northwestern
Geology (1)	Harvard, Calif. (Berkeley), Cal. Tech., Stanford, Princeton, Columbia, MIT	Yale, Penn. St., UCLA, Texas, Johns Hopkins, Wisconsin, Minnesota, Rice, Michigan
Physical Science, General (2)	Princeton, Cal. Tech., Stanford, Harvard, Calif. (Berkeley), MIT, Wisconsin	Cornell, Illinois, U. Chicago, Yale, Columbia, Michigan, Washington, Minnesota, Johns Hopkins, UCLA, Northwestern
Sociology (1)	Harvard, Calif. (Berkeley), Michigan, U. Chicago, Columbia	Wisconsin, Princeton, Cornell, Minnesota, No. Carolina, Northwestern, Stanford, Johns Hopkins, UCLA
Economics (1)	MIT, Harvard, Yale, Stanford, Calif. (Berkeley), Princeton, U. Chicago	Wisconsin, Michigan, Northwestern, Carnegie Tech., Johns Hopkins, Minnesota, Columbia, Penn.
Geography (1)	Wisconsin, U. Chicago, Calif. (Berkeley), Washington	Minnesota, Northwestern, SUNY (Syracuse), UCLA, Michigan
Social Science, General (4)	U. Chicago, Harvard, Calif. (Berkeley), Stanford, Wisconsin	Penn., Michigan, Cornell, UCLA, Yale, Columbia, MIT, Princeton, Northwestern, Johns Hopkins
Engineering General (3)	MIT, Cal. Tech., Stanford, Calif. (Berkeley), Illinois	Minnesota, Harvard, Michigan, Purdue, Cornell, Princeton, Northwestern, Wisconsin
Civil Engineering (1)	Calif. (Berkeley), Illinois, Stanford, MIT, Cal. Tech.	Purdue, Cornell, Michigan, Northwestern, Wisconsin, Washington
Chemical Engineering (1)	Wisconsin, Princeton, Minnesota, Calif. (Berkeley), Delaware, MIT, Michigan, Illinois	Stanford, Northwestern, Cal. Tech., Texas, Carnegie Tech., Rice, Washington
Electrical Engineering (1)	Stanford, MIT, Calif. (Berkeley), Illinois, Cal. Tech., Harvard	Michigan, Brooklyn Poly., Princeton, Johns Hopkins, Purdue, Wisconsin, Cornell, Carnegie Tech.
Mechanical Engineering (1)	MIT, Cal. Tech., Stanford, Calif. (Berkeley)	Minnesota, Harvard, Michigan, Purdue, Brown, Cornell, Princeton, Illinois, Western Reserve, Johns Hopkins, Northwestern

FIELD	TOP-RANKED DEPARTMENTS	SECOND-LEVEL DEPARTMENTS
Architecture (10)	Michigan, Penn., Harvard, Calif. (Berkeley), SUNY (Buffalo, Columbia	Pratt Inst., Washington Univ., MIT, Illinois, Minnesota, Rice, No. Carolina St.

CODES: 3 = Top-ranked; 2 = Second-level; 1 = Other.

RATING NOTES:

(1) Taken from Cartter (1966) list of "Leading Departments, by Rated Effectiveness of Graduate Program." "Extremely attractive" schools were rated as "top-ranked," "Attractive" schools as "second level."

(2) Composite rating derived from Cartter's (1966) evaluation of chemistry, physics, mathematics, geology, and geography.

(3) Composite rating derived from Cartter's (1966) evaluation of civil, chemical, electrical, and mechanical engineering.

(4) Composite rating derived from Cartter's (1966) evaluation of anthropology, economics, geography, history, political science, and sociology.

(5) Rating derived from panel of nine University of Michigan professors of forestry, and evaluation of accreditation representative of the Society of American Foresters.

(6) Rating derived from panel of seven University of Michigan professors of Wildlife and Fisheries.

(7) Rating derived from combined evaluation of range researchers from the Range and Wildlife Habitat Ecology and Management Section, Division of Forest Enviornment Research, Washington Office, U.S. Forest Service, and Chairman, Dept. of Range Management, Utah State Univ.

(8) Combination of ratings supplied by Assistant Dean for Resident Instruction, College of Agriculture, Michigan State Univ., and former Vice President for Research, University of Michigan.

(9) Rating taken from Roose and Anderson (1970).

(10) Rating derived from members of the faculty, College of Agriculture, University of Michigan.

APPENDIX B

DEVELOPMENT OF THE SCIENTIFIC AND APPLIED CONTRIBUTION INDICES

APPENDIX B

DEVELOPMENT OF THE SCIENTIFIC AND APPLIED CONTRIBUTION INDICES

THE PROBLEM

A major theme in our analysis of the Forest Service researcher study has been examining the most important outcomes or products of the organization. The research branch is a mission-oriented R&D organization: its prime products are knowledge per se, and knowledge applied to solving resource-related problems. That is, the system produces scientific information, and it works to get applications of this knowledge "on the ground." Our immediate problem, then, is to produce measures at the individual level of the extent to which the researcher makes a contribution to scientific knowledge and to applications of knowledge. These are required in our search for conditions in the person or organization which relate to high or low contribution.

We suspect that these two types of contribution are related, even though there is no precedent research as a guide. The R&D model used by Forest Service research implies that knowledge suitable for consumption by the scientific community can and must be translated into applicable forms. On the individual level, we realize that something must be produced first before it can be made applicable, and that the same individual is likely to become involved in both kinds of activities. Whether or not this is true, there are two kinds of contribution he may make: a contribution to his scientific field and the fund of knowledge it has available, and a contribution to the solution of real life problems. The problem is what to use as indicators of both types of contribution.

We have been talking about characteristics of the knowledge produced, but we cannot, due to the design and budget limitations of the study, analyze all of the information produced by researchers, nor the applications actually achieved, in order to produce ratings of individual scientists. The survey questionnaire format adopted in our study is not suited for this task, but rather, forces us to concentrate on the behaviors and attitudes of our respondents. Thus, our options in developing our measures are: counting <u>output behaviors</u>, and assessing the individual's <u>feelings</u> about his outputs.

When we count output, however, we find ourselves in the familiar problem of researchers studying science: the quality-quantity problem. Previous researchers (e.g., Cole and Cole, 1967) have shown that quantity (measured by number of papers produced) correlates positively with quality (judged by citations to the scientist's work by others), even though the latter relates more strongly to reward and recognition accorded the scientist. In part we depend on this relationship whenever we measure output behaviors in this study.

We cannot, however, put our trust in the Cole and Cole finding and go on simply counting outputs with the assumption that these are acceptable measures of the scientist's "true" scientific contribution. Nor can we generalize

their finding to cover the applied contribution area which has not been examined in this regard before. Thus, an important part of our measure development effort will consist of checking our indices against external criteria taken from different sources than the individual's self-report. Even this, however, will not be completely satisfactory, since we must then be concerned with the reliability and validity of these criteria themselves. Even when we have made all of the checks possible with the existing data we will eventually come to the point at which we must rely on the face validity of the measures, and on the way they relate to other concepts (what might be called "relational validity").

We will discuss these tests later. First, however, we will present the measures we can construct from the data.

CONTRIBUTION ITEMS IN THE INSTRUMENT

For a question to have been included in our instrument it must have survived a process of conceptual testing, almost a projective analysis which took place in our heads, and in the minds of the Forest Service "inside team" (and to some extent the pretest respondents through their comments). We were all asking, "what is the concept, and what are the observable indicators of that concept?" On our part our available "item pool" comes from our previous research, and from the literature. The inside team considered the items from their position of familiarity with the Forest Service research system. We put in measures of output behavior almost as a matter of course, given the prevalence of such measures in our previous research, and that of others. We bolstered these measures by attitudinal questions asking the person to assess his scientific and applied contribution directly. The output behavior questions measure scientific and applied communication, which means we must code as scientific contribution those communications carried in media we judge to be aimed at the scientific community, and as applied contribution those outputs in media judged to be used by appliers. Similar logic was applied to the items assessing the researcher's attendance at events: are they scientific or scientist-applier events? Thus, we have three sets or types of measures for both scientific and applied contribution. These are listed below.

	Scientific Contribution	Applied Contribution
Output Behaviors	(Q. VIII-1) No. of each of the following authored in past five years: books, book chapters, abstracts or reviews, journal articles, scientific station publications, papers at meetings or symposia.	(Q. VIII-1) No. of: popularized articles, "how to do it" station publications.

	Scientific Contribution	Applied Contribution
Events Attendance	(Q. VIII-2b) No. of scientific/technical events attended in past five years: regional or national meetings or symposia, international meetings or symposia, workshops and seminars.	(Q. VIII-2c) No. of researcher-user events attended in past five years: workshops and seminars, public meetings and hearings, user interest group meetings, planning meetings in public or private sector.
Attitudes or Perceptions	(Q. IV-m) "My unit has made an outstanding (vs. little) contribution to scientific or technical development in its field."	(Q. IV-i) "All (vs. none) of my unit's results find follow-up or practical application."
	(Q. VI-g) "My present work is likely (vs. not likely) to make a very substantial contribution to scientific or technical knowledge in my field."	(Q. VI-h) "My present work is likely (vs. not likely) to make a very substantial contribution to practical application or use 'on the ground'."

These groupings of items are based on our conceptual arrangement, rather than on empirical factoring or clustering. While some such analyses have been performed, factoring or clustering cannot consider functional equivalence among items: if two alternative media, for example, were used to reach an audience -- for example, if the individual used either journals or station publications, but not the other -- then the items might not "load" in the same empirical factor or cluster. We are not so much interested here in items which are rated similarly, as in items which do a similar job.

The interesting question now is how the six types of items above relate to each other, even though conceptually we may wish to place even highly correlated sets or types in different indices eventually. The matrix below tells the story. Within each item set questions were converted to standard (z) scores, and these summed to give an index for the set. These six type indices were then correlated for all 1,178 respondents, and for 936 scientists and PLs separately.

One way to approach these correlations is through the logic of convergent and discriminant validation (Campbell and Fiske, 1959), to learn the effects of concepts (applied and scientific contribution) and measures (the three different item types or sets). If there were strong similar concepts running through each of the sets of items, then we would find high correlations in the four "mono-concept, hetero-method" blocks in the matrix (e.g., those correlations marked "a" in Table B-1). Conversely, if there are strong method effects due to the similarities in format of the items, then the correlations in the shaded "mono-method, hetero-concept" blocks would be higher. When one is truly

TABLE B-1

Correlations Among Six Sets of Contribution Items
(Non-significant *r*'s omitted)

		Scientific			Applied		
		Attitudes	Outputs	Events	Attitudes	Outputs	Events
Scientific	Attitudes		.19	.17	.53	.11	.18
	Outputs	a .22		.48	.12	.26	.49
	Events	.22	.40			.39	.30
Applied	Attitudes	.53	.15			.15	.23
	Outputs	.12	.20	.33	.16		.31
	Events	.19	.43	.24	.26	.28	

All 1,178 cases

936 Scientists and PLs

contrasting concepts with completely different methods, then one hopes the method block correlations will be much lower than the concept blocks, showing that the concepts do hold up across different ways of measuring them. Here, the interpretation is somewhat different, primarily because we are not contrasting two concepts which we demand be independent, and also because of the notion of functional equivalence among types of contribution. Thus, we do not require that the concept block correlations be high, and greater than the method block correlations. Indeed, only moderate concept block relationships would indicate that, were the types put together in an index, reliability would be relatively low (as measured by inter-set correlation), but validity or predictive power would probably be quite high (for the same reason a "heterogeneous" test battery has high power or validity, see Guilford, 1956).

In the table, we do in fact find only moderate positive correlation among the three types of items for either scientific or applied contribution. Even though all of the concept block correlations are significant, there is still a high degree of independence among them: contribution through one type does not necessarily mean contribution through another.

On the other hand, the strongest correlations in the matrix are between the scientific and applied attitudinal type scores. This probably results from a true methods artifact due to a "response set" developed as respondents answered the opinion items, that is, a general evaluative or "positiveness-negativeness" factor. We suspect that there is a large amount of truth in the relationships, however. That is, that the respondents may be telling us that if their work makes a contribution to the scientific field they think it will also be applied.

The matrix also shows us that the correlations between outputs and events are stronger than between these two types and the attitudinal measures. Again, placement of items or format might account for this (both outputs and events are "counting distributions" based on number of behaviors, for example). Another interpretation rests on the time orientation of the items. Events and outputs refer to the past five years, while the attitudinal items ask the respondent to project the effects his present work will have.

There are some additional interesting relationships here, as well. For example, the strongest correlate of attendance of applied events is scientific output; but the converse is not true, the strongest correlate of scientific events is not applied output, but rather scientific output again. We can account for a researcher's attendance of applied events better by knowing his scientific output than by knowing his applied output. One is very tempted, knowing the direction of effort implied in the R&D model (from the more basic to the more applied), to make a causal statement here: i.e., that scientific output produces attendance at applied events. However, the opposite interpretation cannot be overlooked: applied events may stimulate the researcher to produce scientific output by making him more aware of needs for research in the real world.

Our overall conclusion must be that there are method artifacts in the data, particularly involving the opinion measures, but that there is a very modest convergence and discrimination for outputs and events attended. Another way of saying this is that if we omitted the opinions about contributions indices composed of events and outputs measures would correlate better internally and be more independent across the scientific and applied concepts. The question finally resolves to this: do we want independent measures based only on countable output behaviors, or correlated measures which include opinions about contributions? We will opt to include the opinions.

THE CONTRIBUTION INDICES

We could devote much more attention to speculation about this correlation matrix, but the more important task is to create indices for scientific and applied contribution so that we may get on with the large analysis task facing us.

We have mentioned our desire to construct the indices based on item content, allowing for functional equivalence, rather than by the empirical relations among items. That is, we are choosing to construct broad, heterogeneous,

battery-like measures rather than factorial, homogeneous ones. Each contribution index, therefore, will be built by combining the three types of items listed above. The next important problem involves just how we will put the two indices together.

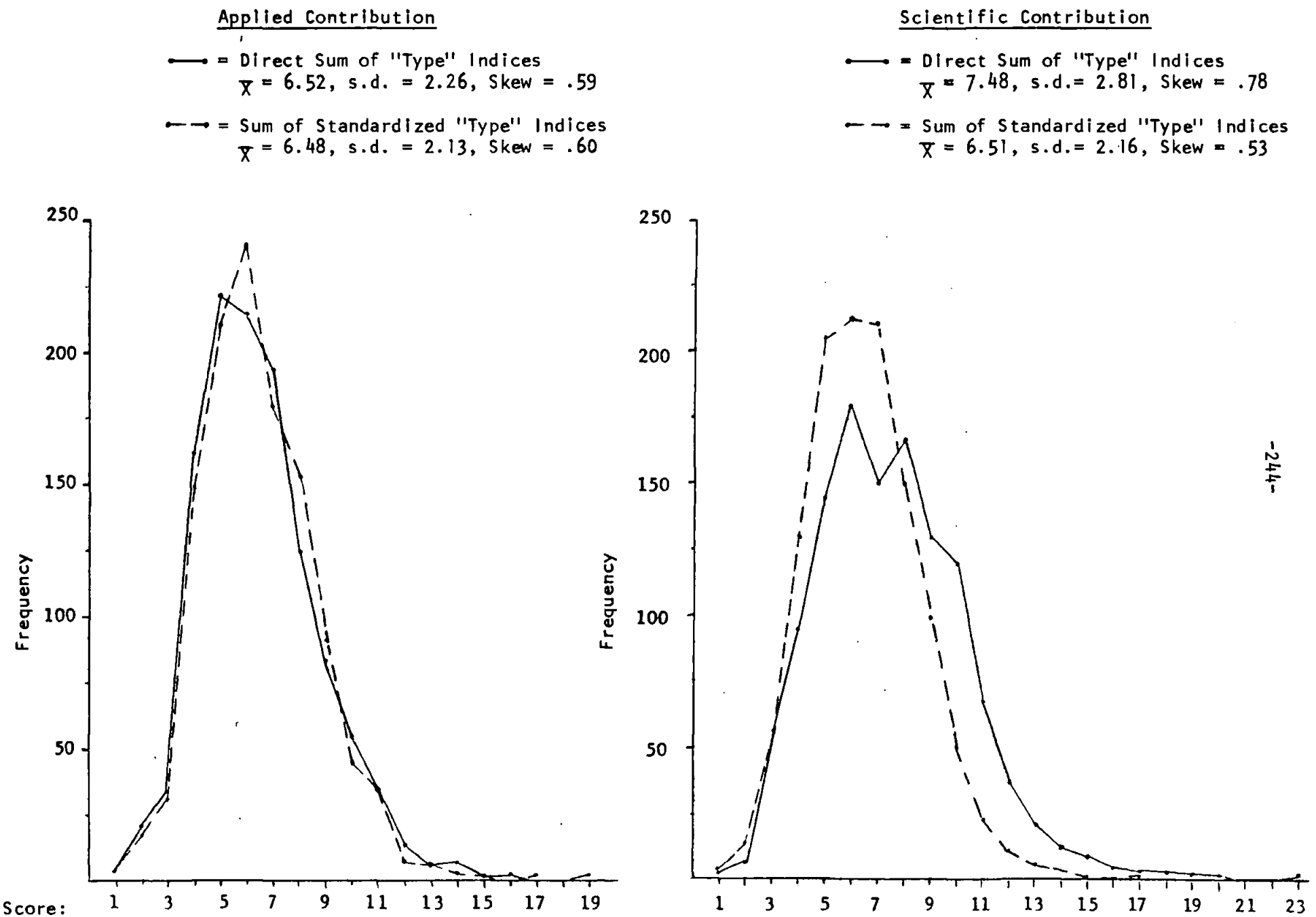
There are two separate issues here: first, whether or not we want the two indices to be correlated or independent, and second, the form in which we put together the component parts of each index to derive one score.

The first issue has been partially settled in our desire to cluster the items together from a conceptual, rather than empirical basis. Were we to factor analyze the items and produce homogeneous (orthogonal) factor scores, the result probably would be two perfectly unrelated indices. Even with conceptually based indices we could regress each on the other, so that, for example, the applied contribution measure would be interpreted as applied contribution with that portion of the measure attributable to scientific contribution statistically removed. Another way of saying this is that applied contribution would be expressed as the difference between the raw applied score and that applied value we would predict knowing scientific contribution. There are advantages of this procedure, particularly in using the indices in multivariate analyses, but the interpretation of the measures would be difficult and not closely related to "real life" as represented in the data.

For conceptual reasons, as well as for ease in data feedback, we have chosen to build the measures directly, without removing the effects of the other index. We are thus accepting the fact that the measures will no doubt be high correlated: that is simply the state of affairs in the data. We will also make use of the correlation below, and in subsequent analysis, by creating a measure which reflects both indices at the same time.

The second issue, that of exactly how to sum the components of each index, can be approached from both a conceptual and empirical basis in deciding between the two most logical methods. The first method we tried was a simple sum of the three type indices for each area of contribution. Since the type indices were summative z scores of the items in each, the result is the same as just adding the standard scores for all scientific contribution items together in one index, and all applied items in the other. At this point the empirical perspective enters. The distributions for the two indices formed by simple summation are graphed in Figure B-1 as the dotted lines. Both indices exhibit a fair amount of skewness, and the means and standard deviations differ. The reasons for this become obvious when we remember that more items were included in the scientific contribution measure than in the applied because there were more items reflecting scientific output (six) than applied output (two). This accounts for the differences in means and deviations. Furthermore, it is known that "counting distributions" usually are positively skewed: more individuals have low scores than we would find in a normal distribution. This is particularly a problem when substantial numbers of individuals have no behaviors of the type counted. Since there were more scientific than applied output items, we can see why there is greater skew in the scientific contribution index than in the applied index.

FIGURE B-1 Distributions of Scientific and Applied Contribution Indices



A partial solution to the skew problem, and a complete fix of the differences in means and standard deviations is produced by going back to the notion of types of items which we discarded in the indices above. There are three types of items in each index, and if we could give the types equal weight, then the differences attributable to adding different number of items would be solved. We make this decision not so much for the methodological as for the conceptual appeal, however. There are no truly satisfactory ways to weight the different kinds of contribution without arbitrary decisions that, for example, outputs should be twice as important as events, etc. We can compensate for the possible dangers of equal weighting by doing separate analyses for each type of contribution when such a procedure is necessary or illuminating, and by using the overall indices as our best-available shorthand summary of all kinds of contribution.

The easiest way to build equally-weighted indices is to standardize each of the type indices before adding them together. Since each standardized type index now has a mean of zero and a standard deviation of one, they will contribute equally, overcoming the effect of more items in the scientific output set, and since three things are being put in each index, the distribution statistics should be more equal. These distributions are shown in the solid lines in Figure B-1. We can see that skew has been reduced for the scientific contribution index, but not for applied, since there were so few applied output items; also, the means and standard deviations are almost equal. These, then, are the indices on which we will base our analysis of scientific and applied contribution, again noting that we will use the components separately in some analyses.

One minor technical detail remains. The actual distributions had negative scores which complicate matters of analysis through the statistical package used (Michigan's MIDAS system), and require more storage space in the data files. For this reason we added a constant of seven (since minus seven was the lowest score) to both distributions to make all scores positive, then "coded" the real number values into integer form by truncating, or dropping the fractional parts. The coding step did not alter the shape of the distributions noticeably, nor was the correlation between them reduced significantly.

At this point it may be helpful to specify the steps in building the indices in detail:

1. Scores of the four attitudinal measures were reversed by subtracting each value from six. This gave a range from 1=low contribution to 5=high.

2. All items were converted to standard (z) scores by the usual formula:
$$z_i = \frac{(X_i - \bar{X})}{s.d.}$$

3. Six type indices were created, three for each area of contribution, by adding together the standard scores. The table given earlier gives the items and the type index into which they were placed.

4. Each type index was standardized.

5. The three standardized type indices for each area of contribution were added together giving two real-number distributions (scientific: mean = .24, s.d. = 2.15; applied: mean = -.37, s.d. = 2.1).

6. A constant of seven was added to each index to remove negative values.

7. Scores were converted to whole numbers of dropping fractional parts. This is equivalent to coding the range from (e.g.) 4.000 -- 4.999 to the whole number of 4. (The final means, etc. are given in Figure B-1.)

CREATING A SCIENTIFIC/APPLIED CONTRIBUTION PATTERN VARIABLE

Our suspicion that the two contribution indices would be positively related is borne out by a .53 correlation between them for all cases (1,175 actually, three had missing data). The correlation is .50 for the 936 scientists and PLs only. Thus, about one fourth of the variation in one index can be accounted for if we know the individual's score on the other. As the cross-tabulation of the two indices in Table B-2 shows, most cases are found along the main diagonal: as scientific contribution increases, so does applied.

There are exceptions, of course, since the correlation is not perfect. There are individuals high on one form of contribution, but moderate or low on the other. These are less frequent than individuals on the main diagonal, but they represent important "pure types" for us: there are scientists in the traditional sense of the word who have little or no applied contribution, and appliers who are low on scientific contribution.

The cases on the diagonal are types, also. Some individuals are simply low contributors on both, and others are high on both. Finally, there are a great number of respondents in the middle, as there have to be with two correlated and reasonably normal distributions.

These types are important, since much of our concern in the analysis to follow involves the combination of the two indices. If a mission-oriented R&D system is to exist, both scientific and applied contribution must be considered simultaneously. When we research that system, we must do the same. We must ask questions such as: what are the attitudes, job behaviors, and characteristics of scientists who are making both an applied and a scientific contribution, or are low on both? Who are the scientists who contribute in one area but not in the other?

From the data in Table B-2 we can block out the five types of scientists mentioned above. Why five? Again, because there are a large number of cases in the middle on both distributions, and if we were to split them at the mean, for example, we would be adding many cases with a great deal of error in classification into the four groups formed by dichotomizing both types of contribution into high and low. Not only would we have a classification with a great

TABLE B-2 Cross-Tabulation of the Two Contribution Indices

SCIENTIFIC CONTRIBUTION

APPLIED CONTRIBUTION	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(17)
					-1s.d.	Mean		+1s.d.								
(1)	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
(2)	2	3	3	2	3	2	0	1	0	0	1	0	0	0	0	0
			Group 1: "low-low"									*Group 2: "pure researchers"*				
(3)	0	2	6	8	9	4	2	0	0	0	0	0	0	0	0	0
(4)	1	3	21	38	33	20	18	7	6	1	0	0	0	0	0	0
-1s.d. →																
(5)	0	3	8	33	52	43	38	19	6	3	3	1	0	0	0	0
(6)	0	2	5	32	54	49	42	36	12	6	2	0	0	0	1	0
Mean →					*Group 5: moderates*											
(7)	0	0	8	7	22	39	43	20	23	11	3	3	1	0	0	0
(8)	0	0	1	4	18	32	32	33	15	8	7	1	2	0	0	0
+1s.d. →																
(9)	0	0	0	1	10	12	22	19	18	6	1	1	1	0	0	0
(10)	0	0	0	0	4	10	7	7	7	8	2	1	0	0	0	0
(11)	0	0	0	0	1	2	6	7	8	6	4	0	1	0	0	1
(12)	0	0	0	0	0	0	0	1	4	0	1	1	0	0	0	0
			Group 3: "appliers"									*Group 4: "high-high"*				
(13)	0	0	0	0	0	0	1	0	1	0	0	3	0	1	0	0
(14)	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0
(15)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
(17)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0

deal of built-in error, but this error would probably show up in reduced predictive power of the classification in later analysis.

We are working toward a classification variable representing both types of contribution at the same time -- groups of scientists created by their scores on the two indices. We started by removing the middle group we discussed above. This was done by taking out all individuals who were within one standard deviation of the mean on both scientific and applied contribution. These are the "moderates." If we imagine the table with these 572 cases missing, then we could divide both distributions at the mean to produce four additional groups:

Group 1: below both means; low contributors in both areas

Group 2: high on scientific, and low on applied contribution; we call them the "pure scientists"

Group 3: high on applied, but low on scientific contribution; "the appliers"

Group 4: high on both types of contribution.

(Group 5 will be the moderates.)

This technique of removing the middle, then splitting the remaining cases at the means does produce some anomalies. For example, cases with a score of four on applied, and a six on scientific contribution are scored as low-low (Group 1), even though their scientific contribution is equal to or higher than some cases put in the moderate group. Still, there is less classification error than if we had split all cases at the means. We have elected not to go to more groups, e.g., moderate applied and low scientific, in order to keep groups large enough to be meaningful in later analysis -- this is particularly a problem for groups two and three.

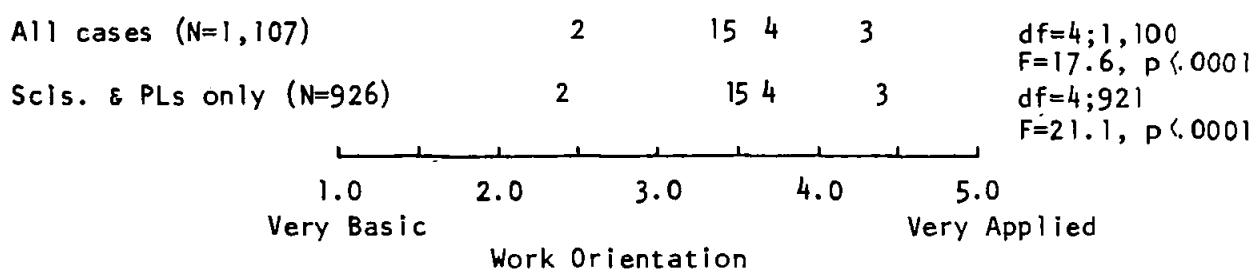
We now have a pattern variable, a categorical measure which denotes the relatioship between scientific and applied contribution. Let us preface the analyses to be reported later in order to demonstrate the power, and the face validity of the categories. One good test is to compare means of each group for the questionnaire item which asked respondents to rate their work on a continuum from "basic research" to "applied research." As we see in Table B-3, the five groups are substantially and meaningfully different on the basic-applied measure. Those we classed as the "pure scientists" rate their work as most basic; the "appliers" as most applied in orientation. The three other groups (those along the main diagonal or regression line between the two indices) are intermediate. This is true for all cases, and for scientists and PLs alone.

It is of interest that those whose contribution levels are balanced, regardless of the level, are inclined to see their work as intermediate, or neither very basic nor very applied. Since this is a mission-oriented system, however, "intermediate" for those with balanced contribution tends to be toward the applied end of the scale, rather than at the numeric center of 3.0.

TABLE B-3

Means of Five Scientific/Applied Contribution Groups on Basic-Applied Work Orientation

Group Mean Plots*



*Groups are: 1=low-low; 2="basic scientists"; 3="appliers"; 4=high-high; 5="moderates"

This result increases our confidence in the measure, though it cannot validate it beyond the context of the questionnaire itself. Further tests are needed to do that.

CORRECTION FOR DISCIPLINE DIFFERENCES

Early in the analysis we realized that both contribution scores varied by disciplines in which researchers were working. This is, of course, a finding of great substantive interest, and has been covered in the "Disciplines" section, Appendix C. The discipline differences pose a methodological hinderance, however, when we want to relate contributions to other ratings of organizational and individual factors, etc.: if we looked at the relation of contribution with such factors, we would not be able to tell if the effects found were due to differences in contribution or discipline.

Therefore, we decided to remove discipline differences statistically by expressing each researcher's contribution scores as differences from the mean of his discipline group. This correction was applied to both scientific and applied contribution (and to the "component" indices which make up these scores) before undertaking any of the analyses in this report or used in feedback.

From this point forward in this section, then, we will be talking about contribution scores adjusted for discipline differences.

VALIDATION OF THE INDICES WITH OTHER MEASURES

We realized early that, internally consistent as the questionnaire items and indices might be, we would need some external comparisons to test our confidence in the validity of the measures. Since no data are perfect, however, our validity checks really assess the power of all sources of data on individual scientists, as we will see below. We would have liked to have had data on all respondents from other sources, but cost factors forced us to select two stations for the analyses reported here.

Station records contain a great deal of information on each employee. Yearly reviews by supervisors, and results of peer review panels are found in the files, together with background information. These gave us a good start, particularly since these data are archival records of dimensions on which scientists are evaluated and rewarded by the system. We sought to expand these data with ratings of each individual on the two dimensions of most interest to us here: scientific and applied contribution. Direct peer evaluation would have been the best route, but costs again limited us to ratings made by ADs. Data collection visits to two stations thus provided us with the following items of information:

1. Rankings by ADs of scientific and applied contribution (in the form of "client linkage") of each scientist and PL.

2. Job profile performance ratings made by scientist's immediate supervisor.

3. "Factor 4" scores from peer evaluation panels which assess the scientific contribution of the individual, though more broadly than our measures.

Our concern is the extent to which these measures assess the same things, and particularly if the questionnaire data correlate meaningfully with the station records and AD ratings. Part of the analysis will look at the extent to which there is agreement among the non-questionnaire data, also.

Two methodological points are needed before we look at the correlations. First, the ratings made by ADs were processed by the routine suggested by Ford (1957) for producing combined rank orderings of individuals rated by several judges (who may use different numbers of sorting categories). This technique was used by Pelz and Andrews (1966), and is fully documented in their fine work. Our modification was made, however: the Ford scores are ordinal, and would force us to use rank order statistics for all comparisons, which makes partialling difficult. We must use partial correlations for the factor four scores from panels, since these are used to decide promotions, and hence are directly tied to GS grade. So, we have dichotomized the AD rankings at the median of each distribution to produce groups of scientists rated high and low on scientific contribution and client linkage. The second note involves the correlations for the supervisor performance review factors. Respondents whose jobs do not include responsibilities on a given factor are given

missing data, since they receive no rating from their supervisor on that dimension. Thus, the missing data correlations for the 16 factors have bases which shift substantially. In fact, two of the factors could not be correlated since so few scientists were given ratings on them by supervisors. This shift means that we must be careful in examining correlations since the levels of r needed to reach significance change with the number of cases involved. It is useful, therefore, to judge the relationship more by the attained significance than by the level of the correlation. Finally, because of the cost of collecting ratings from ADs and incorporating panel and performance ratings, we will discuss results from only two stations here.

With this preparation we are ready to examine the correlations in Table B-4. Although this table looks somewhat formidable at first glance, it can be broken down into components for interpretation. The first division is vertically: to the left of the heavy line we have the correlations among the items taken from station records and from the AD ratings. The correlations involving the questionnaire measures are on the right. Let's begin with the relationships among the non-questionnaire items.

Correlations Among AD Ratings and Records. Here we are interested, as a prologue, in the degree of relationship among the data collected from station files and from ADs. The first finding of note is that peer panels (in their derived "factor 4" scores) demonstrate no significant relationships with ADs' ratings of scientific or applied contribution. The two AD ratings do correlate positively, however (.30).

In the lower left of the table, we see that there were four supervisor ratings which correlated with panel ratings, but none of these survived the control on G.S. grade. Thus, the relationship between supervisor's ratings and those of the panels seems to come from the fact that both the supervisor and the panel give higher scores to researchers with higher G.S. grades.

Comparing the AD and the supervisor we find that researchers who are rated as higher on scientific contribution by ADs are seen by their supervisors as higher on the quality and quantity of work they produce, and higher on accepting responsibility, evaluation skills, and leadership. Those getting high ratings from ADs on client linkage are those who are rated higher by their supervisors on accepting responsibility, again, and on research leadership and (we are happy to note) on oral communication and dealing with outsiders.

The small number of significant correlations in these comparisons is frankly surprising; there is, we see, quite a bit of independence between peer panel, AD, and supervisor data. It is interesting that the panel ratings are not sensitive to supervisor ratings of quantity of work while the AD rating (of scientific contribution, at least) is. If we make the assumption that the supervisor is the closest and most knowledgable judge of the scientist, then it appears that the ADs are quite external in their judgment dimensions, and must judge more on quantity while the peer panels get "inside" the individual to the extent of relating to quality of output. On the client

TABLE B-4 Correlations Among Station, AD, and Questionnaire Indices

	Data from Two Stations	Peer Panel Eval. F4		AD Ratings		QUESTIONNAIRE CONTRIBUTION MEASURES Indices:		Components of Indices: Scientific:			Applied:		
		Raw Factor 4	Partial Factor 4	Scientific Contrib.	Client Linkage	Scientific Contribution	Applied Contribution	Attitudes	Output	Events	Attitudes	Output	Events
Peer Panel	Raw Factor 4 Score* (N=131)**	--	--	--	--	.49[b]	.38[b]	.36[b]	.55[b]	--	--	.43[b]	.28[a]
	Partialled Factor 4	--	--	--	--	--	--	--	.25[a]	--	--	.24[a]	--
AD Ratings	Scientific Contribution (93)	--	--	--	--	.37[b]	--	--	.40[b]	.31[b]	--	--	--
	Client Linkage (93)	--	--	.30[b]	--	.36[b]	.39[b]	--	.30[b]	.27[b]		.31[b]	.33[b]
Supervisors' Annual Performance Review	Work Quantity (74)	--	--	.29[a]	--	.50[b]	.33[a]	.48[b]	--	--	.32[a]	.36[a]	--
	Work Quality (152)	.24[a]	--	.17[a]	--	.32[b]	--	.33[b]	--	.34[b]	--	--	--
	Following Policy & Procedures (23)	--	--	--	--	--	--	--	--	--	--	--	--
	Scientific & Technical Skill (86)	--	--	--	--	--	--	--	--	--	-.32[b]	--	--
	Oral Communication (77)	--	--	--	.29[a]	--	--	--	--	.55[b]	--	--	.42[a]
	Written Communication (185)	--	--	--	--	--	--	--	--	--	--	--	--
	Accepting Responsibility (176)	.19[a]	--	.26[b]	.27[b]	.39[b]	.34[b]	.31[b]	.26[a]	.29[a]	--	.33[b]	.26[a]
	Adapting to New Situations (39)	--	--	--	--	--	--	--	--	--	--	--	--
	Showing Creativity (187)	--	--	--	--	--	--	--	--	--	--	--	--
	Evaluating Facts & Decision Making (156)	.27[b]	--	.18[a]	--	--	--	--	--	.27[a]	--	--	--
	Planning & Organizing (177)	--	--	--	--	--	--	--	--	--	--	--	--
	Research Leadership (158)	.24[a]	--	.22[b]	.28[b]	.38[b]	--	--	.30[a]	.31[b]	--	--	--
	Getting Along with Others (49)	--	--	--	--	--	--	--	--	--	--	--	--
	Dealing with Outsiders (105)	--	--	--	.34[b]	.31[a]	.46[b]	--	--	.31[a]	--	.31[a]	.41[b]
	Supervising Others (113)	--	--	--	--	--	--	--	--	--	--	--	--

KEY: a = $p<.05$; b = $p<.01$; (N = 93 for all questionnaire indices)

*Number of cases who have ratings on each dimension. The number of cases in each correlation vary widely as a function of missing data, particularly for relationships involving the supervisor ratings. Readers should pay attention to presence and level of significant relationships, rather than to sizes of the correlation co-efficients.

**Partialled on G.S. grade.

linkage dimension the ADs appear to relate to the individual's leadership ability and responsibility contact through "dealing" and oral communication.

Correlations with the Questionnaire Indices. Our first conclusion from the right side of Table B-4 is that our indices correlate moderately well with the data from panel, AD, and supervisor ratings.* Our two contribution indices correlate with both the AD ratings and with the "raw" panel scores. Again, however, the panel scores do not correlate when adjusted for G.S. grade. The AD ratings of scientific contribution correlate with scientific contribution index (.37), but not with our applied index. On the other hand, the AD rating of client linkage relate equally to our scientific (.36) and applied (.39) indices. There is none of the hoped-for higher correlation with our applied measure. This may be an indication that ADs do not identify applied contribution unless the researcher is also making a contribution to his field at the same time.

Both of our indices relate to the supervisor's ratings of work quantity, responsibility, and dealing with outsiders, but only our scientific contribution measure correlates with work quality and leadership. It is interesting, too, that work quality relates a bit better to our scientific than to our applied index, while the reverse is true for dealing with outsiders. If we put equal value on both types of contribution the "quantity and quality" results may not be too appealing, though they seem predictable given the organization's past (and present?) favoring of scientific over applied contributions.

We can get a more detailed picture by considering the correlations involving the components of each index. For example, we find here that panel scores, even when controlling for G.S. grade differences, tend to be higher for researchers who produce more written outputs of either a scientific or applied nature. We can also qualify the results for ADs: their ratings do not correlate with the researcher's attitudes about contributions, but relate exclusively to outputs and attendance of events -- just those things the AD can see from a distance.

On the other hand, the supervisor's ratings of work quantity or quality do not relate to written scientific outputs, though the quantity rating correlate with written applied outputs. The supervisor seems to be rating intangibles, perhaps the same thing covered in the researcher's opinions about contribution.

*Of interest here are the differences we find across stations. In the first draft of this paper, we had data from only one station, and there were many fewer significant correlations between questionnaire and station ratings, and different patterns among the station-data correlations. It is probably the case that some stations are better than others in the extent that contribution evaluations, of many different kinds, agree with one another. This itself might be a very useful diagnostic contribution for data feedback.

The supervisor ratings of various communication skills provide some hoped-for and some curious findings. Oral communication skills and dealing with outsiders are rated higher for researchers who, according to our data, attend more events of either a scientific or applied nature -- this is what we would hope to find in attempting to validate our measures. Curious is the lack of correlation of written communication skill with our written output measures.

The final notable result here is that researchers who have more positive opinions about the applied contribution they have or will have made are rated lower by their supervisors on scientific and technical skill.

In summary, we see a moderate degree of agreement, in terms of what we would expect to find if our measures are "working" between the indices and their components and the panel, AD, and supervisor ratings, even though we saw earlier that our measures are not independent. Our measures do seem to fit a bit better with the supervisor's ratings than to those of ADs or panels, however. This is what we hoped to find. More distressing for the various Forest Service evaluation mechanisms, however, is the fact that there is not a great deal of agreement among the panel, AD, and supervisor scores themselves: ADs and supervisors fit on several dimensions, but AD ratings don't correlate at all to panel scores, and the relationships between panels and supervisors is accounted for by the way ratings differ across G.S. grades. It sounds as if the whole system needs to work on how to develop common and acceptable methods to evaluate researchers. Our measures may be a key in such work, since they share something in common with all of the various ratings from within the organization.

What we have, then, are two concepts which give us a broad overview of the two kinds of contribution, and which relate moderately well to more traditional measures from within the organization (which don't look very good themselves, however). None of us would make the claim that our measures get at the actual scientific or applied contributions of Forest Service researchers, in terms of the individual's "true impact" on his field or on the ground. Our perspective remains biased by the limitation of measuring contributions from within the organization, and by the assumption that communication behavior has some relation to ultimate impact. Even though we have kept the (perhaps over optimistic) attitude measures to help overcome this, and have added events to help counter the written-word syndrome, we must still remember that we are still looking at communication, which at best is a necessary condition for impact. This is not good, but it is the best we can do for now. The current methods of evaluation within Forest Service share the same weaknesses of the view from inside and the communication emphasis. They probably are not very good either, and we all need to look to see if they are the best we can do.

APPENDIX C

DIFFERENCES AMONG DISCIPLINES

APPENDIX C

DIFFERENCES AMONG DISCIPLINES

INTRODUCTION

One question which we have not yet answered in our analyses of Forest Service researchers is: what differences are there in the relation of men to the organization, satisfaction, and outputs or contribution across the different disciplines represented in the organization? We know, for example, that resource scientists, and in particular individuals trained in forestry research, make up the majority of the organization. They, together with natural scientists, come from backgrounds and have skills most closely aligned with the traditional major concerns of forest land management, and hence, of Forest Service Research itself. Thus, they may react more positively to their jobs than scientists in "minority" discipline groups. The simple fact of being in the majority or minority may also have effects on the availability of satisfying collegial relationships, as well.

The analyses we will present here take a first cut at examining differences across disciplines in which men are working, in the areas of job and organizational attitudes, working relationships, motivation and stimulation, information processing, and finally, the scientific and applied contribution of researchers.

DISCIPLINE DIFFERENCES IN JOB STATUS

We need to begin with a simple analysis of organizational mobility of men trained in and working in the major discipline categories in which we have coded them. Part of our concern, too, is the simple tabulation of how many individuals there are in each of the discipline categories. In the table below (Table C-1) we list the percentages of Scientists and Project Leaders (PLs) and Program Managers (PMs) for two measures: fields in which the men were trained, and fields in which they are now working.

TABLE C-1

Job Status by Discipline

Field or Discipline	...in Which Trained		...in Which Man is Working Now	
	Scientists	PL-PMs	Scientists	PL-PMs
Natural Resources	55.5%	62.5%	57.7%	62.5%
Natural Sciences	28.2	24.7	26.2	24.3
Physical Sciences	8.2	4.0	7.2	4.4
Social Sciences (including economics)	2.1	4.0	2.9	4.0
Engineering	5.4	4.8	5.4	4.8
Misc. (architecture, arts. humanities, etc.)	.6	--	.4	--
	681=100%	251=100%	679=100%	251=100%
	χ^2=9.8	p <.05 @ 4 df	χ^2=4.0	n.s. @ 4 df

In looking at these data we are struck, though not surprised, with the fact that the PL-PM group seems to come more often from a Natural Resource background, compared with the percentage of Scientists with this training. Chi-square tests indicate (with the Misc. group removed) that, compared with Scientists, PL-PMs do come disproportionately from Natural Resources, and that Physical Scientists in particular are underrepresented in the PL-PM ranks, compared to what we would predict based on the simple distributions of both job status and training discipline. There are no significant differences between the job status groups and fields in which men are working now, however.

Thus, there are several alternative explanations which we might suggest. (1) It may be that the organization does select PLs for characteristics which tend to give advantages in advancement to men trained in the fields of natural resources. (2) Men may "compensate" by switching fields during their careers, since there are no differences in status according to fields in which they now work. (3) The organization may have changed its discipline emphases in hiring younger men from fields other than natural resources, men who are still Scientists. While it is of interest to search for reasons for these differences, there are even more interesting discipline differences to which we need to turn now.

WORK DISCIPLINE DIFFERENCES IN THE QUESTIONNAIRE INDICES

At this point we will turn to the large set of indices we have developed to measure the relation of the man to the organization, individual attitudes and motivations, information processing, and dissemination and utilization (D&U). These are the indices reported earlier by the authors. We will concern ourselves only with the discipline in which Scientists and PL-PMs are working now, since it is present activity, not past history with which we are most interested.

We know that the indices, and discipline also, relate strongly to personal and job-related characteristics. At this point, however, we are after questionnaire differences, not "demographic" differences, so we need to control for or remove statistically those portions of the questionnaire index scores which are accounted for by education, job status, experience, G.S. Grade, and so on. Since we will be spending quite a bit of time looking at these analyses, it may be useful to give one example in detail here. Table C-2 compares work discipline means on total satisfaction with job and the station. The means for each group have been "adjusted" by removing that portion of satisfaction which we can account for by a linear function of each of the "covariate" variables.

TABLE C-2

Adjusted* Mean Satisfaction

Work Discipline	Mean	
Natural Resources	2.57	F=3.0
Natural Sciences	2.56	p= <.02
Physical Sciences	2.78	(1=high satisfaction--
Social Sciences	2.80	5=low satisfaction)
Engineering	2.77	

*Covariates: education (n.s.), years in F.S. research ($p < .0001$), title ($p < .05$), G.S. Grade (n.s.), whether or not man had changed his field since his education (n.s.).

Further examination of the covariates (not shown) indicated that it is PL-PMs and more experienced men who have higher satisfaction levels. With the satisfaction index adjusted to remove these effects, however, there are still significant differences across the work disciplines, with natural resource and natural science workers indicating greater levels of satisfaction than men working in other disciplines. Perhaps this reflects the fact that these two fields do share more in common with the overall thrust of F.S. research, or that this correspondence puts the man's work clearly "on track" in terms of his career growth. The difference might also reflect the number of colleagues available, since the smaller groups show lower satisfaction.

We generally find that the "adjustment" in scores for the covariates produces little actual movement on the five-point scales used in the indices. In the plots for discipline means shown in Figure C-2 at the end of this paper, therefore, we will indicate the "real" or unadjusted means, but we will not discuss a difference unless it remained significant when the job and personal background factors were accounted for.

Satisfaction is just one example of the many areas measured in the questionnaire (see Morris and Lingwood, 1973b for a complete report on the indices as they relate to job and contribution differences). Let us go on to summarize what we have found across all of the index areas. After we do this we will try to pull all of the differences in disciplines into a set of descriptive profiles. Remember, that the differences we will talk about below are independent of differences in education, job status, experience, G.S. grade, and change in field.

Planning. Total satisfaction with planning (both own participation and with the system's planning) is lower among physical and social scientists than among the other discipline groups.

Satisfaction. As we've mentioned above in the example, total satisfaction is higher in the natural science and natural resource groups than in other work disciplines. The same patterns hold for the two components of satisfaction: satisfaction with the individual's station, and (a trend only when controlled for job and background factors) with his job.

Man-in-Organization. The indices reflecting "challenge and dedication" and "freedom" indicate greater perceptions of these attributes among natural resource and natural science researchers. There is a trend for these groups to be more satisfied with their chances for promotion. No differences were found for evaluations of the work environment, statistical or editorial services, or the extent to which respondents are engaged in cooperative research activities. The "client linkage" and "internal project communication" indices also showed no differences across discipline. Scientific information exchange, however, was rated better by engineers and natural resource scientists than by others.

Information Input. In terms of scientific media use, engineers stand out lower than the other four groups; conversely, applied media are used least by physical scientists, and most by social scientists.

Supervision: There were absolutely no discipline differences in evaluating characteristics of or satisfaction with supervisors.

Important Job Factors, and Opportunity For Them: Engineers, followed by social scientists, see the chance to advance in administrative status, plus chances to associate with top levels, as more important than the other work disciplines. The opportunity for stability of employment and perhaps (a statistical trend only) opportunity to have skilled, congenial interaction with peers are seen as lower by engineers, and highest by natural resource scientists.

Sources of Stimulation: There is only one difference in this area: physical and natural scientists rate internal, personal stimuli higher, and engineers rate this stimulus source lower than the other groups. We need to remember, however, that internal stimuli are the highest rated type of stimulation for all of the groups.

Audiences for Research: Natural scientists are highest in rating other researchers as their ideal audience, and social scientists score lowest on this measure. Resource scientists are highest, and engineers lowest on both the extent to which F.S. users are part of their actual and ideal audiences. Coversely, engineers rate business and industry higher as both ideal and actual than do the other groups. Physical and natural scientists rate ideal and actual lowest here, compared with other disciplines. We need to note, as well, that business and industry is the one audience engineers rate above all other audiences in terms of both their actual contact and the importance of this client.

Attitudes Toward D&U: There are few differences in attitudes toward present or ideal dissemination and utilization activities across the five work disciplines. Social scientists say that "doing client-centered research" is more important as an ideal, compared to the other four groups. There is also a trend for social scientists to rate as better the knowledge transmission and translation activities presently used in their stations, though the group differences are small.

These differences are difficult to grasp at once, so let us first summarize the findings in tabular form (Figure C-1), then use this summary to draw a "profile" of the five groups. We need to remember, in looking at the Figure, that "high" and "low" only make sense horizontally, that is, across the five disciplines. If there is no entry for a group on a given index, this means they were not noticeably above or below other disciplines on that index. Thus, the profiles we will build below must alll be prefaced: "compared with other work disciplines..." Also, the tabulations, and hence the profiles, are not sensitive to indices on which all of the groups score uniformly high or low.

If we used this tabulation as a base, what would comparative discipline profiles look like, and what comments might we make about them? We will move on to these questions now.

FIGURE C-1

Tabulation of Discipline Differences on Questionnaire Indices

NATURAL RESOURCES	NATURAL SCIENCES	PHYSICAL SCIENCES	SOCIAL SCIENCES	ENGINEERING
Hi satisfaction Hi challenge & ded. Hi satis.w/promotion	Hi satisfaction Hi challenge & ded. Hi satis.w/promotion			
				Hi sci. info exchange
		Lo applied media use	Hi applied media use	Lo sci, media use
			Hi importance of status advance.	Hi importance of status advance.
Hi opportunity for employ stability Hi opportunity for congenial interact.				Lo opportunity for employ stability Lo opportunity for congenial interact.
	Hi internal stimuli	Hi internal stimuli		Lo internal stimuli
Hi actual F.S.client Hi ideal F.S. client				Lo actual F.S. client Lo ideal F.S. client
	Hi ideal rsch.client		Lo ideal rsch.client	
		Lo bus.&ind. ideal client	Lo bus.&ind. ideal client	Hi bus.&ind. ideal client
		Lo bus.&ind. actual client	Lo bus.&ind. actual client	Hi bus.&ind. actual client
			Hi importance of doing client-ctrd. research	
			Hi actual station transmission and translation activities	

Resource Scientists (compared to the other four work disciplines) seem to reflect a good fit to the organization, as evidenced in their satisfaction, feelings of challenge and dedication, and with the congenial interaction of peers (remember, they are the largest group). They appear secure in their careers, given their higher scores on opportunity for job stability, and satisfaction with chances for promotion. This all sounds like the meshing of individual and organizational styles, goals, and objectives. We have often been told by such men that F.S. research is "where the action is" for men like themselves. Resource scientists also, perhaps for these reasons, seem dedicated to intra-F.S. users for their research. If we adopt the notion that clients will tend to be much like the researcher, then it follows that F.S. clients should be so important for this group, given that most resource managers work within the large F.S. system.

Natural Scientists (compared to other disciplines) seem to share much of the satisfaction and organizational fit of the resource scientists, though they do not see their job stability as quite as great. These men seem to be in a "self-motivating" discipline, and one geared to other researchers as ideal audiences. If we could characterize the natural resource scientists as gearing their output for the F.S. team, then we might best characterize the natural scientist as oriented instead to his discipline or toward scientists as a whole.

Physical Scientists (compared with the other four disciplines) give us little to go by -- they were usually found in the middle of the discipline group means on most indices. There is some indication these men are internally-motivated individuals (like the natural scientists) who play down applications of their research, at least to the extent this can be inferred from their lower use of applied input media and the low rating they give to business and industrial clients.

Social Scientists (compared to the other groups) appear to be more applications-oriented in their views, though they do not show up as high in regard to actual applied research audiences. They are relatively low in perceptions of business and industrial clients, and in the extent to which other researchers are an ideal audience. There might be two explanations for this, one good, and one not so good: research audiences might be rated lower because these men are highly dedicated to getting their findings put to use, or because they think they have little to say from their work which would interest other researchers. We can't say which of these alternatives might be most correct, but we bring up the second because of the great isolation difficulties which could result if this is true, since the social scientists exist in such a minority in F.S. research.

Finally, the Engineers (and again the caution: compared to the other four disciplines) seem a bit more marginal, given their lower scores on opportunities they see for employment stability, and for congenial peer interaction. They also are a small group, and lack the compensation the also-small physical scientists group has in being internally oriented -- in fact, the engineers are lowest in terms of stimuli from within themselves.

Even though they say employment stability is lower, relative to the other groups' responses, the ability to link to top levels of the organization is more important to engineers than to the others. The information picture for engineers seems to be one of relatively high satisfaction with scientific information, even though their actual use of scientific media is lower than the scientific groups. Perhaps the informational needs of engineers are lower. In terms of clients, the engineers seem externally-oriented, vis-a-vis the F.S.: they were lower than the other groups in seeing F.S. users as actual or ideal audiences, but their external orientation is not toward science or outside appliers, but to business and industry -- which may indeed be the best reference group for engineering outputs, and a client group which would provide peer support, given the number of engineers employed in this sector.

We realize that these statistically-based profiles may not fit any one individual, and we also need to reiterate that important parts of the profiles may be left out, since they are not absolutes, but are only comparisons with other work disciplines. Still, there is a vague face validity of the profiles with what we have learned by talking with many members of the organization over the past three years.

At this point we will leave these indices to pursue another question about the disciplines: that is, possible differences in scientific and applied contribution. The findings above will come back into play when we seek to account for contribution differences of the groups, however.

DISCIPLINE DIFFERENCES IN SCIENTIFIC AND APPLIED CONTRIBUTION

We have seen that there are many differences in the indices according to discipline. It may be, also, that the outputs differ across fields of work, bringing up the question of the relation of discipline to scientific and applied contribution. Indeed, we already have some clues -- for example, the low applied media use of physical scientists, and the researcher-client orientation of natural scientists which point to potential contribution differences.

We have approached our analyses of contribution in a manner similar to that used above: means for the work discipline groups were adjusted to remove the effects of background and job characteristics on contribution. The first set of comparisons is found below in Table C-3.

We can see in the table that men working in the natural sciences are highest on the scientific contribution index, with physical scientists scoring lowest. When we look at applied contribution, however, physical scientists are still lowest, but social scientists are now the highest group. Thus, natural scientists are highest in terms of written outputs, events attended which are geared for other scientists as audiences, and in the extent to which they think their outputs will affect their fields. On the other hand, the social scientists are writing more in applied channels, attend more user-oriented events, and think their work will have a higher impact on "on the ground" applications.

TABLE C-3

Scientific and Applied Contribution by Discipline

Work Discipline:	Adjusted* Mean: Scientific Contribution	Adjusted* Mean: Applied Contribution
Natural Resources	6.76	6.83
Natural Sciences	7.20	6.33
Physical Sciences	6.54	5.94
Social Sciences	6.92	7.70
Engineering	6.72	6.60
F & p	2.7 <.05	6.5 <.0001
*t's of Covariates with contribution index:		
Education level	1.9[a]	-3.1[b]
Years in F.S. Research	-.9	.0
Title (1=sci., 2=PL-PM)	5.6[d]	7.5[d]
G.S. Grade	8.3[d]	3.8[d]
Change from educational field?	-1.1	.0

a=p ≤.05; b=p ≤.01; c=p ≤.001; d=p ≤.0001

What factors may be contributing to these differences? Several possibilities might be suggested?

(1) There might be different norms within the disciplines, and rewards by peers and supervisors, which stress contribution in scientific areas for natural scientists, and in the applied for social scientists.

(2) Differences in the work performed may be very important. For example, a project which was designed to be very applied might not make much of a scientific contribution, etc., and disciplines may vary considerably in the basic-applied orientation of their work.

(3) Relationships to the work organization, team, and job may affect both kinds of contribution. We are thinking of the individual and organizational factors which are known to help or hinder productivity.

All of these are possibilities which we must check out through further analyses before we can make any statements about the effects of discipline *per se* on contribution. The approach we will use is that of trying to make the discipline differences disappear by adding additional covariate or control variables along the lines of those suggested above.

Specifically, if a given discipline is higher in scientific contribution not so much because of the discipline itself, but rather, because members are more satisfied with their jobs, and satisfaction in turn relates to

increased contribution, then the differences for disciplines should disappear if we adjust contribution for differences in individual satisfaction. We will be seeking the smallest set of additional control indices which can eliminate the differences in discipline means.

Where do we go for candidates to have their effects on contribution controlled? The indices on which the disciplines differ, as shown earlier in Figure C-1 are good candidates, since we know that contribution relates positively to higher scores on almost every one of the questionnaire indices. We will also select other indices and questionnaire items which make conceptual sense as controls over contribution, or which are tied closely to the three possible explanations we discussed above.

By introducing covariate or control variables in this way we are really testing a model which says that discipline has an impact through its effects on the relationships of man and organization, motivation, etc., and (when the nature of the work, and job and individual characteristics are held constant) these relationships make the difference in contribution.

We began this series of analyses using as added covariates all of the indices which showed differences across the disciplines in Figure C-1, plus additional items and indices which made conceptual sense. Most of the indices are highly correlated among themselves, however, so some had their effects on contribution "wiped out" by the stronger predictive power of other indices. So, we have since used only those indices which showed significant independent predictive power over contribution. The analyses using these indices are shown in Table C-4. We made two additional refinements to the set of covariates, too: first, we added important items from the instrument (for example, the basic-applied nature of the work); second, we separated some indices which, conceptually, should affect only scientific or applied contribution. Also, we controlled each contribution index for the other, to "purify" the different types of contribution. This was necessary since there is a .50 correlation between scientific and applied contribution.

Let's begin our discussion with the analyses of scientific contribution. The first column (marked "A") adjusts the discipline means for the job and demographic variables we used before, plus:

--basic-applied nature of the work
--challenge and dedication
--applied contribution
--stimuli from within the self

With any differences on these measures controlled for, we still find significant differences among the disciplines, with natural scientists still higher, though now social scientists have replaced physical scientists as the lowest group. Thus, the additional controls can account for some of the difference across the disciplines (since the level of significance of the mean differences is lower), but the controls cannot account for all of the differences.

We know that information gathering is a strong predictor of contribution, and also that the disciplines differ on ratings of their scientific information exchange and their use of scientific media. When we also control

TABLE C-4

Contribution Differences by Discipline,
Controlling for Important Indices

	Scientific Contribution adj.* means		Applied Contribution adj.* means	
	A	B	C	D
Natural Resources	6.76	6.79	6.80	6.79
Natural Sciences	7.16	7.11	6.49	6.50
Physical Sciences	6.87	6.70	6.29	6.38
Social Sciences	6.67	6.71	7.56	7.48
Engineering	7.01	7.02	6.75	6.79
F & p	2.8 <.05	2.0 <.1(n.s.)	4.3 <.005	3.3=.01
*Adjusted for these covariates (t listed)				
Education level	2.8[c]	2.5[b]	-2.1[a]	-2.0[a]
Years in F.S. Rsch.	-1.7[a]	-2.1[a]	-.1	-.1
Title (1=sci, 2=PL)	2.1[a]	2.1[a]	3.8[c]	3.6[c]
G.S. Grade	7.4[d]	7.6[d]	-.3	-.2
Field change?	-.6	-.2	.4	.4
Basic-applied work (1=basic→5=applied)	-7.4[d]	-6.8[d]	5.8[d]	5.7[d]
Challenge & dedication	4.7[d]	3.5[c]	.2	.4
Covariates for scientific contribution only:				
Applied contribution	15.5[d]	14.4[d]	--	--
Internal stimuli	4.7[d]	4.2[d]	--	--
Sci. Info exchange	--	5.3[d]	--	--
Sci. media use	--	3.9[d]	--	--
Covariates for applied contribution only:				
Scientific contribution	--	--	12.8[d]	12.1[d]
Client linkage	--	--	7.8[d]	7.7[d]
Client stimuli	--	--	7.2[d]	6.7[d]
Applied media use	--	--	--	4.1[d]

a=p ≤.05; b=p ≤.01; c=p ≤.001; d=p ≤.0001

for input (in column "B"), we find that the scientific contribution differences across the disciplines are no longer significant. (This results from the downward adjustment of scientific contribution for natural scientists and physical scientists, and a shift upward for the social scientists -- that is, the natural and physical scientists dropped since part of their higher contribution score was due to somewhat greater information gathering.)

So, most of the scientific contribution differences in the disciplines can be explained by the fact that the disciplines vary on the nature of their work (basic-applied), challenge and dedication, internal stimuli, and information gathering. This is not to say that discipline is unimportant; we have simply pinned down how discipline may have its effect on scientific contribution.

The story is somewhat different for applied contribution, even when we control for job and background factors, plus:

--basic-applied nature of work
--challenge and dedication
--scientific contribution
--perceptions of organizational support for D&U activities
--stimuli from clients

We still find (in column "C") social scientists scoring significantly higher in applied contribution, and physical scientists lower. Even when we add applied media use (in column "D") as an additional control, the differences remain, though they are reduced somewhat.

It is always hard to say when we have searched long enough for additional factors which we need to control out. All we can say here is that the factors we have controlled for do not account for the discipline differences in applied contribution. There is still the possibility that other factors might account for the differences in discipline means, but we have not yet found them in these analyses.

There are several questions thus remaining which we might pursue, or at least think about: Do the social scientists feel an obligation to application which pushes their applied contribution scores up? Is it the type of person they are? Are clients more accessible? Or -- what else? We cannot say now, though we hope to be able to continue this search for explanation in the future.

CONCLUSION

We have found striking differences in the work disciplines in terms of how they relate to their organization, satisfaction, motivations, and client relationships. Many of these differences must relate to the "man-environment fit," given the fact that resource and natural scientists are working in an organization which closely matches their training and career lines. There are some clear implications here for the other disciplines (physical and social scientists and engineers). What can the system do to provide additional support

for such men, to insure that they do not become estranged from either F.S. research or their own disciplines? Is the small size of these groups an important factor by itself?

The analyses of contribution indicate that scientific contribution differences can be accounted for by organizational, motivational, and information gathering factors, though this is not necessarily true for applied contribution. For scientific contribution, then, it would not seem to matter too much if we were to pay attention to discipline differences in trying to improve this type of output, since if we were to work on the other factors directly (e.g., feelings of belongingness, challenge, etc.), we would probably have the same effect for all disciplines. For applied contribution, however (assuming we cannot account for the differences with additional control variables in the future), we may have found that the disciplines have different contribution levels in this area which do relate directly to the discipline in which the man works. We might thus need to approach the problem of increasing applications somewhat differently in each discipline.

FIGURE C-2

INDEX SCORES FOR FIVE WORK DISCIPLINE GROUPS
(1=nat. res.; 2=nat. sci.; 3=phys. sci.; 4=soc. sci.; 5=engrs.)

INDICES:	Means: 1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	ANOVA F & p≤
PLANNING	LOW								HIGH	
Satisfaction with own participation in planning				34	2 1 5					1.7 NS
Satisfaction with system's long range planning			4 3 521							1.4 NS
Overall satisfaction with own participation and system's planning combined			4 3	5 2 1						2.3 .05
SATISFACTION	HIGH								LOW	
Satisfaction with the station					1 2	5 43				3.5 .01
Satisfaction with own job			12 35	4						2.5* .05
Total satisfaction with job and station				2 1	534					4.0 .005

*= ANOVA n.s. when covariates added

INDEX SCORES FOR FIVE WORK DISCIPLINE GROUPS
(1=nat. res.; 2=nat. sc 3=phys. sci.; 4=soc. sci.; 5=engrs.)

INDICES:	Means: 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 (HIGH … LOW)	IOVA F & p<
"MAN-IN-ORGANIZATION"		
Physical work environment	4 1 5 2 3	1.2 NS
Statistical and editorial services	1 3 2 4 5	1.2 NS
Activity in cooperative research	3 5 1 2 4	1.5 NS
Challenge and dedication	1 2 3 5 4	4.0 .005
Freedom	1 2 4 5 3	4.1 .005
Satisfaction with chances for promotion	2 1 3 4 5	2.1 NS, but p<.01 with covariates

*= ANOVA n.s. when covariates added

INDEX SCORES FOR FIVE WORK DISCIPLINE GROUPS
(1=nat. res.; 2=nat. sci.; 3=phys. sci.; 4=soc. sci.; 5=engrs.)

INDICES:	Means: 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0	ANOVA F & p≤
"MAN-IN-ORGANIZATION" cont.	HIGH LOW	
Adequacy of scientific information exchange	5 2 1 34	2.3 NS (.1)
Informal, internal communication with work team, etc.	1 3 5 2 4	1.5 NS
Organizational support for client linkage activities	1 5 4 3 2	1.7 NS
INFORMATION GATHERING	LOW HIGH	
Use of scientific input media	5 1 4 3 2	7.1 .0001
Use of applied input media	3 5 2 1 4	5.1 .0001

*= ANOVA n.s. when covariates added

INDEX SCORES FOR FIVE WO"" DISCIPLINE GROUPS
(1=nat. res.; 2=nat. sc: 3=phys. sci.; 4=soc. sci.; 5=engrs.)

INDICES:	Means: 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0	ANOVA F & p
IMPORTANCE OF AND OPPORTUNITY FOR FACTORS IN JOB	LOW Opportunity job provides → 4 5 2 3 1 ; Importance the man attaches HIGH	1.9 NS
To work on station and users' problems	3 2 1 4 5	NS
Scientific and career growth	3 5 4 2 1	1.8 NS
	5 4 2 1 3	3.5* .01
Status (administrative advancement & associate with top)	3 4 2 1 5	NS
	3 2 1 4 5	5.6 .0005
Stability of employment, $, and fair evaluation	5 3 4 2 1	2.1 NS p<.05 when covaried
	1 3 2 4 5	NS
Skilled, congenial interaction with peers and chiefs	5 2 3 4 1	2.0 NS (<1)
	5 1 2 4 3	1.8 NS

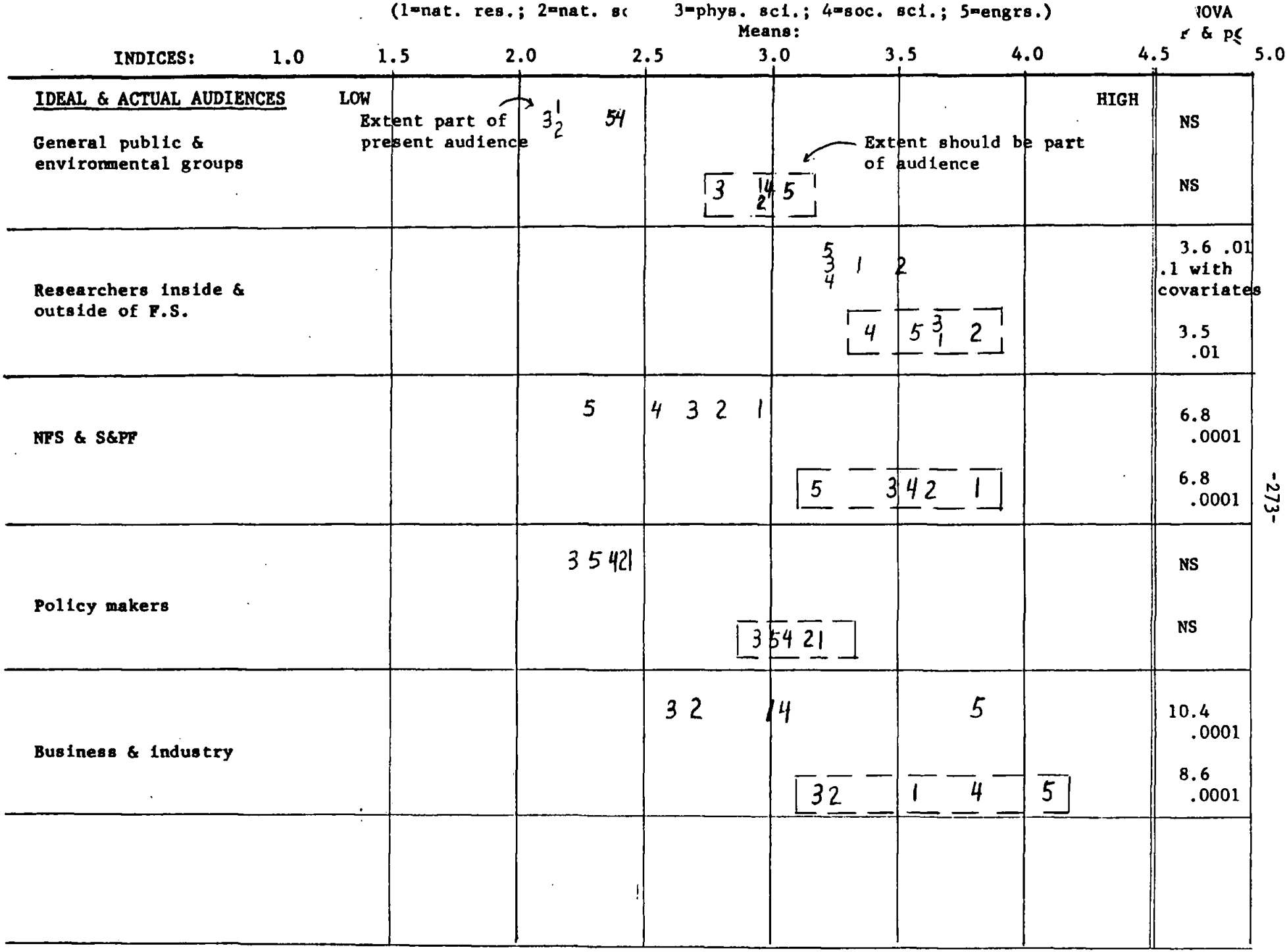
*= ANOVA n.s. when covariates added

INDEX SCORES FOR FIVE WORK DISCIPLINE GROUPS
(1=nat. res.; 2=nat. sci.; 3=phys. sci.; 4=soc. sci.; 5=engrs.)

INDICES:	Means: 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0	ANOVA F & p≤
EXTENT FACTORS STIMULATE MAN TO PERFORM WELL ON JOB	LOW HIGH	
Internal, personal stimuli	5 1 4 2 3	2.4 .05
Stimulus from supervisor	5 1 2 3 4	NS
Stimulus from colleagues	4 5 1 3 2	1.7 NS
Stimuli from internal and external clients, and problems in applications	2 5 3 4 1	2.3* .05

*= ANOVA n.s. when covariates added

INDEX SCORES FOR FIVE WORK DISCIPLINE GROUPS
(1=nat. res.; 2=nat. sc 3=phys. sci.; 4=soc. sci.; 5=engrs.)



*= ANOVA n.s. when covariates added

INDEX SCORES FOR FIVE WORK DISCIPLINE GROUPS
(1=nat. res.; 2=nat. sci.; 3=phys. sci.; 4=soc. sci.; 5=engrs.)

INDICES:	Means: 1.0 – 1.5 – 2.0 – 2.5 – 3.0 – 3.5 – 4.0 – 4.5 – 5.0	ANOVA F & p≤
DISSEMINATION & UTILIZATION ATTITUDES LOW		
Extent stn. rschrs. involved now	1235 4	NS
Extent should be active	1 2354	NS
Helping users develop problem solving capacity		
Sensing users' needs	1 52 4 3	NS
	2153 4	NS
Doing client-centered research & solution building	31 5 2 4	NS
	32 51 4	3.5 .01
Translation & transmission channel selection & use	3 124 5	2.7 .05
	5 3412	NS
"Microsystem" (person-to-person, interpersonal) linkages	1 2 5 3 4	NS
	2 1 4 53	NS

*= ANOVA n.s. when covariates added

APPENDIX D

INDICES

APPENDIX D

INDICES

INDEX CONSTRUCTION

Index construction was both a necessary and a formidable task -- necessary to reduce the large number of questions asked to a smaller set, leading to a manageable analysis; formidable because of the high inter-correlation of most of the opinion items, and the fact that questions were asked in "sets." The goal was to produce indices to meet two criteria:

(1) Indices should make theoretical or conceptual sense.

(2) Questions should not be placed in the same index unless they exhibit a strong inter-correlation.

What we are thus reaching for is an index which fits together both logically and empirically. This is easier to say than to do.

There is a strong "general evaluation or positiveness" factor running through the opinion items which we must account for, or get beneath, to determine which items to cluster together. Second, the question sets add another general factor to be controlled. The best way to explain this is to list all of the components which, we believe, make up a response to any question, or control the variation of that question. Briefly these are:

(1) The "true," item-specific variation in the question

(2) The variation controlled by the item set; e.g., "station," "location," or "job" questions share a component coming from the individual's overall reaction to or satisfaction with that topic

(3) The variation which comes from the individual's overall satisfaction with the organization and his role in it, what we have called the "general positiveness" factor

(4) Response factors such as positiveness or negativity toward the task of filling out the questionnaire; response set factors due to the consistent placement of positive poles of paired statements at the left (reverse placement would have been superior methodologically, with randomly selected questions "flopped over," but our early discussions with the Forest Service team led us to the view that this procedure would be confusing and tiring in an already long and tiring instrument)

(5) Error variation from respondent and scoring mistakes, unclarities in questions, and other unidentifiable sources

What we hoped to do was to isolate the "true" variation from all of the rest, realizing that we could get some control only over the second, or "item set" variation.

We discovered early in examining the correlations among the items that correlations were stronger within the item sets than across them. Our first factor and cluster analyses showed, rather predictably in hindsight, strong "station," "location," etc. factors which masked what we knew had to be true

clusterings based on the content of the questions themselves. For example, there were items in both the station and location sets dealing with dedication to work, yet these did not factor out together.

The procedure used to circumvent the item set factors was one of controlling for item set through the following steps:

(1) There were 51 questions from the station, location, unit, and job sections. These questions were converted to standard (z) score form to equivalence their means and variances.

(2) Within each item set an overall index was formed by summing together all of the items in that set; e.g., all of the station-set items were added together to produce a summative z score station index.

(3) Taking each of the 51 questions in turn, the standard score on that item was subtracted from the overall set score for each individual, giving two measures: (a) the standardized question, and (b) the summative score for all other items in the set.

(4) The standardized question score was regressed on the revised summative score, giving a residual score which can be interpreted as the score for the question, controlling the common effects of all other items in the set combined.

(5) With the item set effects thus controlled for, the 51 regressed item scores were then correlated, using data for Scientists, PLs, and PMs.

The correlation matrix produced by this procedure became the input for all of the factor and cluster analysis used in deciding on which items to put together in indices.

Various factor and cluster analyses were performed with this matrix. Principal components factor analysis with Varimax rotation gave completely independent factors as a starting point, then oblique and targetted factor analyses were used to produce factors which could have some correlation to each other. Different clustering approaches were then used, and since this procedure assigns an item entirely to one cluster, the effect was one of producing intercorrelated clusters. The results from all of these analyses were compared, and we assigned tentative "concept labels" to each of the factors or clusters, weighing the relative theoretical or "common sense" implications of each grouping of items.

The final decision process often appeared similar to a legal debate, with one of our team taking the logical view of where an item should be placed, and the other taking the empirical (analysis-based) side of the argument. It was never really difficult to determine the "core" items in the concepts as they emerged from the process, though there were difficulties with items which belonged equally, and marginally to more than one index/conceptual area. In some cases these items were discarded, and not placed in any index; in other cases we let the logical or common-sense criteria take over in placing these questions.

The result for our work on these 51 questions was a set of 11 indices representing the station, location, unit, and first section of the job item sets. These are the indices listed in the first three and one half pages of the index documentation below.

Index construction for other areas in the questionnaire followed a similar procedure, minus the preliminary correction to remove item set effects.

A NOTE ON ITEM AND INDEX SCORING

The only disadvantage in the optical scanning equipment used to score the questionnaires is that the machine insists that a consistent direction be used, either left to right, or right to left, in assigning numbers to the response circles on the instrument. As we set it up, numbers for scales always increased from left to right across the page. This decision produced some problems for the polar-scale questions which make up the body of the instrument. We had placed the generally "favorable" or "positive" polar statements on the left of the page, in most cases, so the result was that positive responses are indicated by lower numerical values in the data. We could have converted the data early in our analysis, but did not do so for cost reasons. The consequences of this probably faulty decision remain with us. One simple rule serves in interpreting means and correlations based on these items and the indices derived from them:

> If the item or index is based on polar-pair statements found on pages three through the top half of page seven in the instrument, then low numerical scores represent high or positive responses to the question or concept.

The indices (not the items) used by Schreyer (1974), found in the "personal preferences for research" part of the job section, were not scored this way. Schreyer decided, rather sensibly we think, to reverse his index scores so that high numbers have positive values on the index.

The indices themselves were constructed as follows:

(1) For each index, each respondent was given a score produced by computing the average for all items in the index. That is, if one respondent had scores of 2, 1, 1, and 3 on four items assigned to a given index, he would be given a score of 7/4 or 1.75 on that index.

(2) Index scores were multiplied by a constant of 100, and the result trimmed to a whole number for storage on the computer. This step preserves two decimal places for personal averages on the items in an index. The reasons for this are not obvious, but have to do with the fact that the analysis software system used allows data to be stored in either integer (whole number) or real (numbers with fractional parts) form, and integer numbers require half the computer disk storage space; an asset since disk space costs money.

This approach to index construction weights all items in an index equally, which is not necessarily an advantage, but it maintains the original scale metric in a way that summing standardized scores or assigning factor scores cannot. For example, a score of 200 (2.00) on an index based on the polar

scale items would have a meaning of "Tends to A," or moderately positive on the conceptual area. This ties the responses to the original scale meaning, in a way that a standard score, with a mean of zero and a standard deviation of one, cannot. A second reason was also very important in preparing for data feedback. This format allows us to look across indices, to see which got higher or lower average ratings in a given station or other group, in comparison with the nationwide data.

We did run some tests on indices created this way, versus indices formed in the more standard, summative z score manner. The correlation between alternate forms of indices was always above .90. Seeing this, and the relative ease of interpreting means for the "individual average" indices, we discarded the z score approach quickly.

FORMAT FOR THE LISTING OF INDICES

On the pages to follow we have adopted a simple method for presenting the various indices used in the project. Indices are listed within broad areas, based on the sections of the instrument from which they are drawn. Each index has been given a title, listed in capital letters, which best summarizes the content or conceptual area of the index. Below this we have listed all of the items which make up the index. Question numbers from the instrument are listed, together with the variable numbers assigned the items and index for computational purposes (these have little value beyond the data, however).

Two sets of statistics are provided for each index. The first value is the alpha coefficient of internal consistency reliability for the index (see Cronbach, 1951). This statistic assesses the relationship between the index, composed of the items which currently make it up, with other possible or theoretical indices measuring the same construct. Alphas in the range of .7 to .8 are adequate for developmental or predictive purposes, though we would not suggest that the indices shown here would be sufficiently reliable for applied tasks equivalent to those in aptitude or educational tests. By using the logical criteria of constructing items which made sense with what we know from theory or from our detailed observations of the Forest Service, we in effect lowered the reliability by widening the domain of items included.

We have also listed for each item in an index its correlation with the aggregate of all other items in the index. This is the "item-to-total correlation." This is not the correlation of the item with the index score, however, since such values would be artifactually high because the item itself is included in the index. Items are listed in decreasing order of item-to-total correlations, and this ordering most often agrees with other data (not presented here) on the loadings of variables in the original orthogonal factor analyses. Down toward the bottom of the item lists for some indices we find those questions which were placed in their index more on logical than on empirical grounds, and this accounts for their lower correlations. Some of these items correlate almost as well with items in other indices, so our logic-based placement serves to increase the correlation among indices in these instances.

INDICES FROM STATION, LOCATION, UNIT, AND JOB SECTIONS

Var. No.**	INDEX TITLE AND COMPONENT ITEMS	INDEX ALPHA α	ITEM-TO-TOTAL CORRS. r
(302)	"CHALLENGE AND DEDICATION"	.77	
(30) II-f.	My present work is extremely challenging		.63
(43) III-d.	There is an atmosphere of dedication to work at my location		.62
(31) II-g.	The research activities of the station are extremely interesting and conceptually exciting		.55
(85) VI-1e.	My present work is extremely challenging		.42
(84) VI-1d.	My responsibilities are in excess of my capabilities		.33
*(81) VI-1a.	I work under much more time pressure than I think would be optimal for me		.20
(303)	"EVALUATION OF STATISTICAL & EDITORIAL SERVICES"	.44	
(25) II-a.	The quality of statistical assistance and services is completely satisfactory		.28
(26) II-b.	The quality of editorial assistance and services is completely satisfactory		.28
(304)	"SATISFACTION WITH PROMOTION & TRAINING OPPORTUNITIES"	.77	
(94) VI-1n.	I am very satisfied with my chances for promotion in this station		.72
(95) VI-1m.	As I think about my career and getting ahead in the FS, I would say I have made great progress		.62
(37) II-m.	I am very satisfied with the way evaluation panels are working in the station		.53
(90) VI-1i.	The opportunities I have for advanced technical or managerial training are completely satisfactory		.44
(306)	"FREEDOM"	.64	
(27) II-c.	The restrictions imposed on scientists and engineers of the station by administrative regulations are minimal		.48
(28) II-d.	The station is willing to overlook deviations from policies or procedures when such deviations are done to improve the station		.48

* This item was reversed in scoring so that the left-hand polar statement is regarded as "high". The left-hand statement is listed here.

** Variable numbers are in parentheses, and refer to the numbers assigned in computation. They have little use beyond this.

Var. No.	INDEX TITLE AND COMPONENT ITEMS	INDEX ALPHA α	ITEM-TO-TOTAL CORRS. r
(307)	"PHYSICAL WORK ENVIRONMENT"	.60	
	(51) IV-a. The space available for the work of my unit is completely satisfactory		.49
	(52) VI-b. My unit is very well equipped		.49
	(40) III-a. There are few distractions (noise, phone calls, unforeseen visits, etc.) to interrupt the work at my location		.31
	(48) III-i. The way in which scientific equipment is shared at my location is completely satisfactory		.24
(308)	"CLIENT LINKAGE ACTIVITIES"	.70	
	(61) IV-k. There is persistent and strong pressure from within my unit to ensure that its results find follow-up or practical application		.56
	(60) IV-j. There is persistent and strong pressure from outside my unit to ensure that its results find follow-up or practical application		.54
	(62) IV-l. Unit staff often serve as consultants with user groups regarding applications of our work		.51
	(89) VI-li. Forest Service leadership encourages and rewards me for getting "on the ground" applications of my research		.38
	(46) III-g. My location makes contact with user groups very easy		.33
(358)	"ORGANIZATIONAL SUPPORT FOR CLIENT LINKAGE"	.65	
	(This index is a sub-set of "Client Linkage Activities," removing the items dealing with behavior and reward.)		
	(61) IV-k.		.55
	(60) IV-j.		.47
	(46) III-g.		.39
(309)	"ADEQUACY OF SCIENTIFIC INFORMATION EXCHANGE"	.79	
	(54) IV-d. My unit is not at all isolated from a desirable intellectual and research environment		.66
	(44) III-e. My location makes contact with non-FS researchers in my scientific discipline very easy		.61
	(45) III-f. My location makes contact with the rest of the station very easy		.56
	(49) III-j. My access to library and information services is completely satisfactory		.55

Var. No.	INDEX TITLE AND COMPONENT ITEMS	INDEX ALPHA α	ITEM-TO-TOTAL CORRS. r
(309)	"SCIENTIFIC INFO.", continued		
(35) II-k.	It is very easy for me to exchange information and ideas about my work with people like myself from other projects in the station		.49
(91) VI-lk.	Technical information systems are available for my use whenever I need them		.46
(33) II-i.	I feel free to seek information I need from persons outside the station		.27
(310)	"INFORMAL, INTERNAL/PROJECT COMMUNICATION"	.76	
(55) IV-e.	I have many regular contacts on job-related questions with the members of my unit		.54
(53) IV-c.	When any change involving my unit is underway, there is usually a lot of information about it available to me		.54
(34) II-j.	I am very satisfied with the amount of information I get about what is going on in the station		.52
(42) III-c.	There are many opportunities for informal discussions among scientists at my location		.51
(41) III-b.	There is a very high degree of cooperation among people at my location		.48
(56) IV-f.	Technical and service staff are very often invited to participate in staff meetings of the unit		.43
(36) II-l.	Scientific and technical staff meetings are convened very frequently in the station		.32
(311)	"INTERPROJECT, INTERDISCIPLINE (COLLABORATIVE) RESEARCH"	.68	
(57) IV-g.	Most of my unit's work requires cooperation of scientists from different disciplines		.52
(58) IV-h.	Co-ordination between research units is very frequently required in my work		.52
(312)	"SATISFACTION WITH, AND EVALUATION OF THE STATION"	.85	
(39) II-o.	All in all, the station does an excellent job of fulfilling its objectives and achieving its goals		.77
(38) II-n.	I am very satisfied with the way research is carried out in the station		.71
(32) II-h.	The research program of the station is highly coherent		.67
(29) II-e.	The station has done very well in adapting to changing circumstances -- that is, keeping up with the times		.64

Var. No.	INDEX TITLE AND COMPONENT ITEMS	INDEX ALPHA α	ITEM-TO-TOTAL CORRS. r
(313)	"SATISFACTION WITH OWN JOB AND WORK"	.63	
(96)	VI-1p. Considering my job as a whole -- all aspects of it -- I like my job extremely well		.58
(83)	VI-1c. I never consider leaving F S research		.52
(82)	VI-1b. I have a feeling of complete security in my work		.40
(50)	III-k. My location is a good place to live		.22
SUPERVISION INDICES			
(314)	"SUPERVISOR'S WORK AND GOAL EMPHASIS"	.78	
(66)	V-2a. My supervisor is very concerned with getting work done		.66
(76)	V-2k. My supervisor is highly concerned with maintaining high standards of performance		.66
(315)	"SUPERVISOR'S JOB FACILITATION AND INTEREST"	.78	
(70)	V-2e. My supervisor frequently offers new ideas for solving job-related problems		.64
(78)	V-2m. My supervisor shows interest in my work and periodically discusses it with me		.64
(316)	"SUPERVISOR'S INTERPERSONAL SUPPORT"	.85	
(67)	V-2b. My supervisor is very concerned with keeping his subordinates satisfied and happy		.78
(71)	V-2f. My supervisor is very concerned that I grow and "get ahead" professionally		.72
(72)	V-2g. My supervisor is very friendly and easy to approach		.68
(317)	"SUPERVISOR'S INTERACTION FACILITATION AND OPENNESS"	.68	
(73)	V-2h. I can influence the activities and decisions of my supervisor to a great extent on matters that are of concern to me		.60
(74)	V-2i. My supervisor encourages people who work for him to exchange opinions and ideas among themselves		.52
(77)	V-2l. My supervisor uses very general supervision; e.g., I am definitely on my own to carry out the basic tasks of my job		.40
(318)	"SUPERVISOR'S SKILLS"	.51	
(68)	V-2c. My supervisor keeps up-to-date on the scientific and technical skills he needs in his discipline		.35
(79)	V-2n. My supervisor is always up-to-date on policies, rules, and regulations of the FS and of the station		.35

PERSONAL PREFERENCES FOR DOING RESEARCH*

Var. No.	INDEX TITLE AND COMPONENT ITEMS		INDEX ALPHA α	ITEM-TO-TOTAL CORRS. r
(290)	"CONCEPTUAL ORIENTATION"		.50	
	(97) VI-2a.	I prefer to work on problems with a long time frame		.34
	**(99) VI-2c.	I prefer to work on abstract problems that may have no immediate practical application		.33
	(98) VI-2b.	I prefer to work on projects that may be unclear and have little structure at the beginning		.32
	(103) VI-2g.	I prefer to work by myself on research projects		.20
(291)	COMPLEX COGNITIVE STYLE"		.38	
	**(106) VI-2j.	I prefer to consider many aspects of a problem at the same time		.27
	**(100) VI-2d.	I prefer to generalize in research as much as possible, mapping out broad features of important new areas, leaving detailed study to others		.24
	**(104) VI-2h.	I prefer to work deductively: deriving specific instances out of abstract principles		.13

*These indices were developed by Schreyer (1974).

**All indices are scored so that 500=high. These indices were reversed before scoring.

PLANNING INDICES

Var. No.	INDEX TITLE AND COMPONENT ITEMS	INDEX ALPHA α	ITEM-TO-TOTAL CORRS. r
(320)	"SATISFACTION WITH OWN PARTICIPATION IN PLANNING" Satisfaction with:		.54
	(20) I-2a. Your own level of participation in short range research project planning		.36
	(21) I-2b. Your own level of participation in station long range planning		.36
(321)	"SATISFACTION WITH FOREST SERVICE AND STATION PLANNING: Satisfaction with:	.86	
	(23) I-2d. The way Forest Service Research as a whole does long range planning now		.83
	(24) I-2e. The way the Forest Service as a system does long range planning now		.71
	(22) I-2c. The way your station as a whole does long range planning now		.68

SOURCES OF STIMULUS TO PERFORM WELL

(344)	"STIMULUS FROM OWN WORK, STANDARDS, AND CURIOSITY"	.44	
	(139) VI-4a. My own standards		.31
	(147) VI-4i. My own curiosity		.30
	(143) VI-4e. My own previous work or plans		.23
(346)	"STIMULUS FROM COLLEAGUES"	.54	
	(141) VI-4c. Colleagues at this station		.37
	(142) VI-4d. Colleagues elsewhere		.37
(347)	"STIMULUS FROM CLIENTS AND APPLIED PROBLEMS"	.72	
	(146) VI-4h. User groups outside the Forest Service		.58
	(145) VI-4g. NFS or S&PF user groups		.55
	(144) VI-4f. Problems arising in practical applications		.50

IDEAL AND ACTUAL DISSEMINATION AND USE FACTORS*

Var. No.	INDEX TITLE AND COMPONENT ITEMS	IDEAL α	IDEAL r	ACTUAL α	ACTUAL r
I:(327) A:(322)	"DIRECT INTERACTION 'MICROSYSTEM'"	.76		.77	
I:(216) A:(204) VIII-2k.	Designing ways to get users and researchers working together on joint projects		.64		.67
I:(217) A:(205) VIII-2l.	Organizing ways users and researchers can get together to exchange information		.63		.63
I:(214) A:(202) VIII-2i.	Finding someone in each user group to help in the dissemination and implementation		.52		.53
I:(329) A:(324)	"SENSING USER NEEDS"	.71		.76	
I:(207) A:(195) VIII-2b.	Developing and using regular mechanisms for determining what users' needs are		.56		.61
I:(208) A:(196) VIII-2c.	Transforming users' needs into problem statements and researchable questions		.56		.61
I:(330) A:(325)	"DOING CLIENT-CENTERED RESEARCH"	.66		.66	
I:(209) A:(197) VIII-2d.	Doing research which is directly applicable 'on the ground'		.50		.49
I:(210) A:(198) VIII-2e.	Doing work on problems at the time they are most important to users		.50		.49
I:(331) A:(326)	"DISSEMINATION: TRANSLATION AND TRANSMISSION"	.77		.73	
I:(212) A:(200) VIII-2g.	Rewriting research products in the language of each important user group		.63		.58

*One item dealing with "USER PROBLEM-SOLVING" was not placed in any index, it is:

I:(206) A:(194) VIII-2a. Helping user groups develop a capacity to solve their own problems

IDEAL AND ACTUAL DISSEMINATION AND USE FACTORS, Continued

Var. No.	INDEX TITLE AND COMPONENT ITEMS "DISSEMINATION" continued		IDEAL α	IDEAL r	ACTUAL α	ACTUAL r
	I:(213) A:(201) VIII-2h.	Determining who the important users should be for each finding to be transmitted		.63		.57
	I:(215) A:(203) VIII-2j.	Selecting the most appropriate channels to be used to reach each user most efficiently		.53		.51
	I:(211) A:(199) VIII-2f.	Producing summaries, abstracts, and reviews of research findings		.49		.42

ACTUAL AND IDEAL AUDIENCES FOR RESEARCH *

Var. No.	INDEX TITLE AND COMPONENT ITEMS	IDEAL α	IDEAL r	ACTUAL α	ACTUAL r
I:(337) A:(332) "PUBLIC AND ENVIRONMENTAL"		.82		.78	
I:(191) A:(180) VII-1j.	The mass media		.74		.69
I:(193) A:(182) VII-1k.	The general public		.69		.64
I:(192) A:(181) VII-1i.	Environmental groups		.59		.55
I:(338) A:(333) "RESEARCH"		.64		.51	
I:(183) A:(172) VII-1a.	Researchers inside of the Forest Service		.47		.34
I:(184) A:(173) VII-1b.	Researchers outside of the Forest Service		.47		.34
I:(339) A:(334) "FOREST SERVICE"		.63		.62	
I:(185) A:(174) VII-1c.	National Forest Systems, FS		.46		.46
I:(186) A:(175) VII-1d.	State and Private Forestry, FS		.46		.46
I:(340) A:(335) "POLICY MAKERS"		.78		.72	
I:(188) A:(177) VII-1f.	Other Federal policy makers and administrators		.70		.63
I:(187) A:(176) VII-1e.	WO Research branch policy makers and administrators		.62		.56
I:(189) A:(178) VII-1g.	State forestry agency and other state policy makers and administrators		.53		.49

*The actual and ideal items dealing with "BUSINESS AND INDUSTRY" were kept separate:

I:(190) A:(179) VII-1h. Business or industrial groups

IMPORTANCE OF AND OPPORTUNITY FOR JOB FACTORS

Var. No.	INDEX TITLE AND COMPONENT ITEMS	IMPORTANCE α	IMPORTANCE r	OPPORTUNITY α	OPPORTUNITY r
I:(348) O:(353) "OWN SCIENTIFIC CAREER GROWTH"		.78		.87	
I:(116) O:(132) VI-3j.	To work on difficult and challenging problems		.63		.70
I:(118) O:(134) VI-3l.	To contribute to broad technical knowledge in my field		.61		.69
I:(117) O:(133) VI-3k.	To have freedom to carry out my own ideas		.52		.61
I:(111) O:(127) VI-3e.	To advance in the professional respect of colleagues and chiefs		.50		.68
I:(108) O:(124) VI-3b.	To grow and learn new knowledge and skills		.49		.63
I:(107) O:(123) VI-3a.	To make full use of my present knowledge and skills		.47		.68
I:(348) O:(353) "PROBLEM ORIENTATION"		.63		.70	
I:(119) O:(135) VI-3m.	To work on problems of central importance to the station		.46		.54
I:(122) O:(138) VI-3p.	To work on problems of central importance to the station's user groups		.46		.54
I:(350) O:(355) "STATUS ORIENTATION"		.68		.59	
I:(110) O:(126) VI-3d.	To advance in administrative authority and status		.52		.42
I:(115) O:(131) VI-3i.	To associate with top executives in the organization		.52		.42
I:(351) O:(356) "SALARY AND EMPLOYMENT STABILITY"		.62		.59	
I:(121) O:(137) VI-3o.	To have stability of employment		.48		.33
I:(109) O:(125) VI-3c.	To earn a good salary		.41		.47
I:(120) O:(136) VI-3n.	To be evaluated fairly in proportion to what I contribute		.39		.41

IMPORTANCE OF AND OPPORTUNITY FOR JOB FACTORS, continued

Var. No.	INDEX TITLE AND COMPONENT ITEMS	IMPORTANCE α	IMPORTANCE r	OPPORTUNITY α	OPPORTUNITY r
I:(352) O:(357) "SCIENTIFIC INTERACTION"		.58		.70	
	I:(114) O:(130) VI-3h. To work under chiefs of high technical competence		.44		.49
	I:(112) O:(128) VI-3f. To work with colleagues of high technical competence		.43		.58
	I:(113) O:(129) VI-3g. To have congenial co-workers as colleagues		.31		.49

CRUSK

ISR