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NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

AN ORGANIZATION DEVELOPMENT APPROACH TO
TECHNOLOGY TRANSFER IN THE
NATIONAL FOREST SERVICE

by

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and

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September 1981

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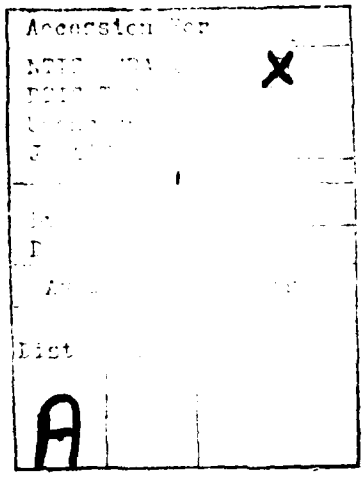
The conclusion identifies perceived weaknesses in the subcomponents of Structure and Communications, and a recommendation is proposed identifying a method of establishing a more viable communication/responsibility network through which technology transfer processes may flow.



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An Organization Development Approach to Technology Transfer in the National Forest Service

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ABSTRACT

Technology transfer efforts conducted by the National Forest Service since 1972 provide the base for this work. Problem areas, as identified by the Forest Service, include an inability to acceptably institutionalize technology transfer processes throughout its system and a concomitant hesitancy for technology transfer processing to become an integral part of daily operations.

The problems are examined, using an organization development approach, by applying a model which breaks down the Forest Service organization into several major subcomponents. The subcomponents comprising the model are: People, Structure, Technology, Communications, Tasks and Goals, and Environment. An analysis is then conducted to determine the measure of "fit" among the various subcomponents in terms of their contributions to or hindrance of the technology transfer effort.

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I. INTRODUCTION

The U.S. Forest Service has actively pursued technology transfer improvements for many years having achieved significant milestones in the process.

This concerted effort was further stimulated by a 1972 General Accounting Office survey of federal agencies designed to determine how effectively research dollars were being applied. Virtually all federal agencies were found deficient in their attempts to effectively make available to potential users the vast quantity of technology which had stockpiled for many years.

> "Scientific research and development accounts for some $28 billion worth of goods and services in the United States. More than half of this enormous enterprise is paid for by the federal government. Despite this large federal investment in R&D, there have been, until recently, only sporadic efforts to achieve fruitful technology transfer to and utilization by industry and the larger national community." [Ref. 1: p. v]

The Department of Agriculture, however, was far better off than most. Their research and extension program which had evolved from initial legislation in 1862 was generally considered to have been a most effective program. [Ref. 1: p. vi] Despite their efforts, there remained an urgent need to move masses of technological data from files and library shelves into the hands of the users.

Many federal agencies made attempts to improve their own positions. The Forest Service's plan included the establishment

of several new functional positions/units. These comprised (1) a National Research Information Service Advisory position to the Deputy Chief of Research; (2) a Technology Transfer Council (TTC), whose mission is essentially to encourage innovations; (3) a Central Technology Transfer Office to assist in technology transfer efforts throughout the Forest Service; and (4) the establishment of Assistant Director (AD) for Program Planning and Application positions at each experiment station with responsibility for research implementation.

The process of technology transfer, however, remains a complex and elusive undertaking. By definition, technology transfer is a "process of communication which includes activities designed to effectively link or couple the source of the needed knowledge with its eventual user." [Ref. 2, p. 1] Hence, an acceptance by implication is solicited to the notion that the mechanism of technology transfer is one of people as opposed to organizational entities. As such, the process becomes one of insuring effective communication links between the people representing various levels within an organization as well as between organizations. Technology transfer efforts become exponentially even more complex when the human element is introduced as a variable. Intuitively, this is attributed to factors such as attitudes, trust, morale, beliefs, motivation, rewards and incentives, to name only a few; all of which play an equally important role in effecting meaningful communications. Glenn P. Haney, Associate Deputy

Chief of Administration, U.S. Forest Service Headquarters, acknowledged the importance of good internal communication and the role of individuals, and further stated that what the Forest Service is doing that is new is trying to integrate technology transfer into daily operations. [Ref. 3: p. 51]

The objective of this thesis is to contribute to the efforts of the Forest Service in its attempt to fill the gap between user application of technological advances and the methodologies proposed in the literature to accomplish this end. This study will look at the technology transfer problem from an organization development perspective which applies a total systems approach to the study of organizations. Utilizing this approach in relation to the National Forest Service involved data collection from all levels; diagnosis of problems based on the data; evaluation of the congruence or fit between elements of the system (organization structure, tasks/goals, technology, people, and methods of communication); and action planning for recommended changes.

In the data collection phase current literature about technology transfer and about the Forest Service was examined. Quotations from these sources are interspersed throughout this study. Other information used to help determine findings was obtained through personal interviews with members at all levels of the Forest Service as well as members of the

California Department of Forestry. Telephonic interviews were conducted with members at the National Forest Service Headquarters, Washington, D.C., as well as with Forest Service representatives in other regions throughout the United States. Appendix A is a compilation of pertinent quotes from these interviews. In order to maintain anonymity, no names or positions are attached to the quotations. As the intent of the interviews with top management personnel in the Forest Service as well as users of the technology was to elicit frank, sincere, personal feelings as well as objective remarks, the anonymity aspect was considered vital.

Chapter II relates the applicability of the organizational development (OD) process to the problem of technology transfer. A model constructed in this chapter provides the basis for an examination of the Forest Service as a total system. Chapters III through VII give an in-depth analysis of each element of the model in relation to the technology transfer process. Based upon the analyses and diagnoses of the problems confronting the Forest Service in its technology transfer efforts as specified in Chapters III through VII, Chapter VIII provides a brief summary of conclusions as well as recommendations for a change effort which will provide direction toward a more viable technology transfer program within the Forest Service.

II. ORGANIZATION DEVELOPMENT APPLICABILITY

The concept of applying organization development techniques as an adjunct to the technology transfer effort appears to be a natural evolutionary flow.

A. COMMONALITIES BETWEEN ORGANIZATIONAL DEVELOPMENT AND TECHNOLOGY TRANSFER

Commonalities exist between the underlying focus of both of these endeavors. Those commonalities involve the effective management of communications and change. Although technically representing separate disciplines, they are by no means mutually exclusive. Conversely, each is particularly dependent upon the other. Organization development seeks to obtain self-directed change to which people are committed through the utilization of effective communication techniques. Technology transfer, by definition, is a communication process designed to link the source of new or needed knowledge with its ultimate user. The ultimate application of new technology will subsequently cause a change in the usual pattern of performing a particular function. The implication of self-directed change perhaps contains the essence of success versus failure in most technology transfer efforts.

Organizational change processes vary in size and complexity as well as time of onset and completion. Generally, a change in a complex organization will contain several aspects. These elements include:

(1) Diagnosing the present condition, including the need for a change;

(2) Setting goals and defining the new state or condition after the change;

(3) Defining the transition state between the present and the future;

(4) Developing strategies and action plans for managing this transition;

(5) Evaluating the change effort; and

(6) Stabilizing the new condition and establishing a balance between stability and flexibility. [Ref. 4: p. 16]

Change efforts generally comprise one-time major structural or functional modifications which have definitive boundaries relative to achieving an end state. Implementation of a viable technology transfer program, however, poses unique problems in that the change implications are continuous. As such, an organizational system through which this effort must flow must possess a willingness to arrive at the same end state or the effort will realize an early demise. Thus, an additional consideration is determining each subsystem's "readiness" for the change. Attitudinal analysis assessment within the various subsystems is generally required to ascertain both the readiness and capability of the organization to absorb the intended change effort.

Few organizational change efforts are managed without cost. Hence, the investment, once established, will have to be compared to the capability of the system to accept it.

David Gleicher [Ref. 4: p. 25] has developed a simple formula relative to the cost:

$$C = (ABD) > X$$

where C = change, A = level of dissatisfaction with the status quo, B = clear desired state, D = practical first steps toward the desired state, and X = the cost of the change. The formula suggests that within the subsystems, there must be sufficient dissatisfaction with the status quo (A), and the various subsystems involved in the change effort must be informed of and understand the desired end state (B). If these criteria are not met, the cost (X) is too high. The formula further suggests that if the subsystems are not attuned to the methods of attaining the first steps toward the desired state, little, if any, movement toward that state will occur.

The methodology involved in accomplishing these objectives requires an effective communication network. As previously mentioned, change management and communication effectiveness go hand in hand in assuring a successful technology transfer effort or any other form of change attempt.

B. DEVELOPMENT OF A CONCEPTUAL MODEL

Organization development's concern with both change and communication processes lends itself as an effective evaluating tool in helping organizational members to define problems, develop alternate solutions, implement changes and evaluate their effects. To facilitate this evaluative process, the utilization of an appropriate model is most beneficial. A model provides a taxonomy of key organizational dimensions that guide data collection and diagnosis without which the latter becomes confusing and difficult. There is an abundance of available organizational models from which to choose one which appears most applicable to the type of diagnosis attempted. For example, social systems models which include such major elements as people, structure, behavior and processes, culture, and human outputs are extremely effective in organization development interventions but are best applied to centralized organizations. Considering the complexity and decentralized nature of the Forest Service, a simpler, more manageable model was adopted. Figure 1 depicts the model used to facilitate data collection and diagnosis for this particular project. This model represents a modified version of the Leavitt-Diamond model [Ref. 5: p. 56]

The major element labeled Structure refers to the formal aspects of an organization. They are systems which have

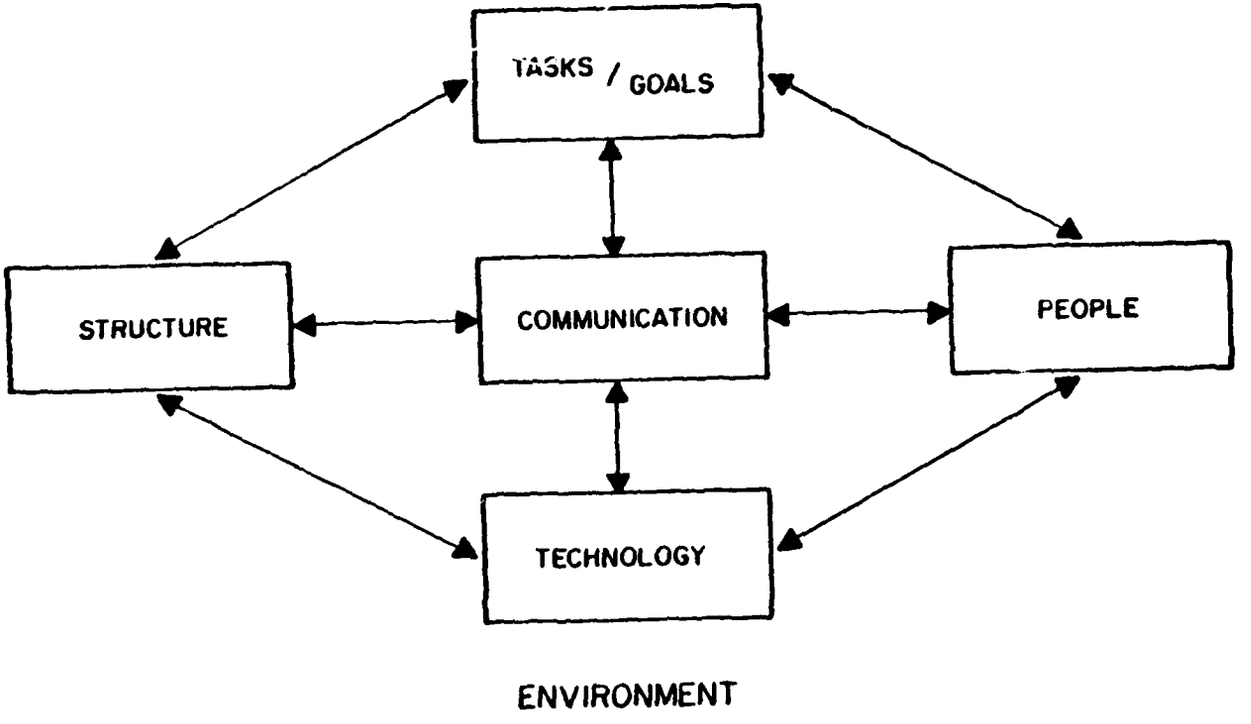


FIGURE 1

CONCEPTUAL MODEL USED FOR DATA COLLECTION AND DIAGNOSIS

basically been designed to regulate the actions of an organization's people and equipment. Subcomponents of this major element include such items as organizational size, span of control, levels of management, job structures, line and staff relationships, centralized versus decentralized management, rewards and compensation systems, evaluation and development systems, and the like. The structures of organizations are often determined by long-held values, personal experience of success, and beliefs of managers about the "right way to organize" rather than more flexible and contingent viewpoints. Also, organizational structures are frequently constrained by budgetary considerations including limits placed upon human as well as material resources. In essence, the structure of an organization dictates the responsibilities of its members by telling them what to do, how to do it, and to whom they are responsible.

The Tasks/Goals element is treated together although each function connotes separate and distinct implications.

Tasking is generally thought of as the assignment of work to one person by another or to one organization or agency by another. Tasking can take the form of being informal (i.e., verbal) or formal (i.e., charters, assignments, position descriptions, etc.). Similarly, tasking functions can constitute a major portion of a specified duty or responsibility or can involve functions over and above specified job design

elements such as are thought of in collateral duty or job assignments.

Relative to the previously discussed elements of an organizational change process, goals can be viewed as written or stated definitions describing the state of the organization in a future period of time. The description of the desired state should be detailed and specific. Goals are the targets toward which organizations aim which reflect the overall reason for the organization's existence. An analogy can be offered in describing a sailing vessel about to embark on a voyage from California to Hawaii. Clearly, the goal of the captain and crew is to safely arrive at their selected port-of-call. To meet this goal, however, the crew must first be adequately trained in the art of navigation, rig handling, and the like. The crew must be made aware of the desired route and the expected events scheduled to occur along the route. This awareness and training generally constitute the objectives of the captain in preparing his crew to meet their ultimate goal. Similarly, organization objectives are established which serve to act as stepping stones upon which an organization depends to help it cross the river of uncertainty and safely arrive at its desired state.

People constitute the raw material of any organization. Clearly, the one most significant major element in any

organization theory is that which deals with behaviors and attitudes of its workforce. Human beings are very complex in their psychological make-up. When they interact with one another in groups and in large organizations, the complexities are multiplied. Observations and interviews within the workforce structure relative to those subsystem components normally associated with this major category will usually provide an abundance of information regarding the overall effectiveness and efficiency of any organization. Subsystem components associated with this major element include such items as personal needs, abilities, expectations, value systems, rewards, attitudes, levels of skill, morale, motivation, incentive systems, and job security to mention but a few. Indeed, there are innumerable factors which significantly influence how a workforce will perform and subsequently determine the overall mission accomplishment of the organization. Subcultural considerations play an enormous role in attempting to implement change efforts and effective communication links. The existence and recognition of the dominant coalition as well as the critical mass will generally aid in the accomplishment of a given task.

The Technology element of the conceptual model refers not only to the availability and utilization of sophisticated computer systems and the like, but also to the methodologies employed in making available to the organization information

required for it to successfully perform its assigned tasks. Hence, solicitation and fulfillment of the needs of an organization clearly contribute to the effective employment of "required" technology. Emphasis is given to the term "required" to distinguish this technology from technology created for the sake of research.

Tying the model together, and following closely behind people in terms of importance, is the element of Communication. Management literature is replete with theories and models of effective and non-effective communication networks, skills, and practices. Its importance to any organization's survival is unquestioned; and, as such, it will not be pursued ad-nauseam in this writing. It is therefore sufficient to acknowledge that breakdowns in this information transference system will generally account for the bulk of organizational problems.

The element of Environment refers to an organization's interaction with external forces which serve on occasion to dictate the direction in which the organization must travel. The social environment, for example, refers to the values and attitudes of the society in which the organization operates. Disregard by management of these sensitive issues may lead to being sanctioned for management practices which violate the value systems.

Similarly, market as well as technological environment demands of an organization a keen awareness of rapidly

changing external forces. This awareness is essential in keeping up with the state of the art of technological and economic advances to insure a competitive position in the market place. Subsystem components of this major element may include market competitiveness, social values, local and national legislation, and the like.

The remainder of this paper will focus on the application of the established model in pursuing the significant factors associated with technology transfer in the National Forest Service.

III. TASKS/GOALS

"One of the major assumptions underlying organization development efforts and much managerial strategy today is the need to assure that organizations are managing against goals. Healthy organizations tend to have goal-setting at all levels." [Ref. 6: p. 35] "Basically, goals are plans expressed as results to be achieved. In this broad sense, goals include objectives, purposes, missions, deadlines, standards, targets, quotas, etc. Goals represent not only the end point of planning but the end toward which the other managerial activities, such as organizing and controlling, are aimed." [Ref. 7: pp. 439-440]

A. MISSION

"The mission of the Forest Service is to provide national leadership in forest management, protection, and utilization, involving participation in designating national priorities for land use, formulation of programs to meet national objectives, and establishment of federal forestry policies to assure maximum contribution of environmental, social, and economic benefits to present and future generations. Accomplishment of the Forest Service mission includes three major areas of operation: (1) management, protection, and development of the 187-million-acre national forest system;

(2) cooperation with state foresters, private owners of forest lands, wood processors, and private and public agencies; and (3) conducting research activities that directly or indirectly support the Forest Service mission, forestry, and forest-related resources." [Ref. 8] The "three major areas of operation" above equate perfectly to the three branches of the Forest Service: (1) the National Forest System, (2) State and Private Forestry, and (3) Research. Therefore, while the overall mission is the multiple-use management of forest resources for sustained yields of water, forage, wildlife, wood, and recreation; each branch of the Forest Service has its own separate mission.

B. PLANNING

"Plans involve selecting enterprise objectives and department plans and programs, and determining ways of reaching them. Plans thus provide a rational approach to preselected objectives. . . . Planning is deciding in advance what to do, how to do it, when to do it, and who is to do it. . . . Planning is an intellectual process, the conscious determination of courses of action, the basing of decisions on purpose, facts, and considered estimates." [Ref. 9: p. 81]

Planning, a major factor in goal-formulation and goal-accomplishment, is in the Forest Service a multi-dimensional procedure. The participants in the planning process include

Congress, various government agencies, lobby or special interest groups such as business and ecology-oriented organizations, representatives of the general public, and administrators in the Forest Service hierarchy. The Chief and Deputy levels normally offer only overall policy plans. Functional planning at the regional level in the National Forest System entails providing broad planning guidelines in the form of multiple-use or land-use guides and priorities and approving particular management plans. "The primary administrative level for planning in the National Forest System is the forest, and it is the forest supervisor who has responsibility for most functional management planning." [Ref. 10: p. 40] The district ranger may have some responsibility for preparing multiple-use plans for coordinating the various functional management plans.

This decentralization of planning effort is apparent in the State and Private Forestry branch and the Research branch as well. In all three branches Washington offers only general policy guidelines and little actual control. "Decentralization also enhances the influence of local interests, which often pull in directions that do not serve, and may even frustrate, overall agency objectives." [Ref. 10: p. 37] "The nature of multiple-use objectives necessarily creates differences of opinion among the groups involved in the Forest Service administration and planning. The

opinions and interests of the participants often appear to be so extreme as to preclude compromise. Although their long-range goals may be congruent, near-term conflicts among participants help create many of the intense problems with which Forest Service management must effectively cope. This confused and conflict-ridden environment has resulted in an apparent non-uniformity of policies, procedures, and methods in various Forest Service regions." [Ref. 11] Concerning the effect of groups and individuals outside the Forest Service itself, "the clash of interests can result in something of a standoff, or at most a kind of vague and ambiguous compromise, which permits the Forest Service a broad latitude to pursue its own policy inclinations." [Ref. 10: p. 24].

C. GOAL CONFLICT IN TECHNOLOGY TRANSFER

"Goal incompatibility motivates interdependent groups to engage in conflict, but for overt conflict to occur among the groups, they must have the ability to interfere with the attainment of one another's goals." [Ref. 12: p. 345] The question to be asked at this point is, "Does goal incompatibility exist within the Forest Service and, if so, does it adversely affect the transfer of technology?"

"The overall goal of Forest Service management is to maintain a balanced diversity of plant and animal species and communities in the forest in order to meet the multiple-use objectives. At the regional and district levels there

is a degree of autonomy which will often give rise to objectives which are not entirely congruent with those of the Forest Service as a whole. The regional and district level managers are responsible for day-to-day operations, including the application of new technologies. Differences in objectives at these levels contribute to the non-uniformity of technology transfer results observed among the various regions." [Ref. 11]

In addition to the differences in goals among vertical levels of the Forest Service caused by decentralization, goal differences also exist among the horizontal levels of the three branches. The prime example of horizontal incongruence of technology transfer goals is that disparity which exists between the Research branch of the Forest Service and the users of the research connected with the other two branches. "The Research mission of the Forest Service supports National Forest management and the cooperative forestry programs, plus management of the Nation's forests and rangelands in general." [Ref. 3: p. 48] The key word is supports. ". . . the Research Branch has been, historically, more concerned with reaching other researchers as the primary client for research; but the shift is now on toward applied clients, the natural resource managers." [Ref. 13: p. 38] "A great deal of output from research is knowledge [basic research] rather than technology [applied research]. If the knowledge base for an important problem is solid, an R&D or

RD&A program may generate the appropriate technology. But such programs are too costly for use in all problem areas. Forestry research must continue to develop knowledge which falls short of technology if the natural resource sciences and professions are to continue to develop. New and innovative ways must be used to transfer this information into practice." [Ref. 14: p. 2] However, "the research team will often proceed with a project which it perceives as relevant in furthering the goals of its organization and of society in general, while having neither a preplanned strategy for implementation nor a 'client' for the results. The project will be perceived among the research team as having great utility, although communication with potential end-users has been minimal. Upon completion of the project, it is assumed to be so relevant and useful that potential users will be anxious to implement the latest developments. However, if the results are not perceived as relevant to the potential users, little is likely to happen." [Ref. 11]

Relevance, or applicability, is not the only factor causing goal incongruence. "If a newly developed technology is not perceived at the district level as economically feasible, it is not likely to be implemented. Budgetary constraints are an important factor in the transfer of technologies. The financial considerations may restrict the procurement of equipment and facilities that are necessary to implement a new technology. For example, if a new technology requires

a certain piece of equipment for fighting fires, the district budget may not be able to support the purchase. Still another constraint will exist if the skill levels of current personnel in the implementing organization are not sufficient to accommodate a new technology. . . . The extent of innovation may further affect the choice for successful transfer. If a technological improvement is 'too innovative' compared to current practices, potential users may not want to try it for fear of failure or disruption of organizational patterns." [Ref. 11]

"Over the past 20 years, research has broadened considerably to include needs other than timber and range production. But it is clear that the research community must continuously reexamine its programs to insure that all forestry-related needs receive appropriate attention." [Ref. 15: p. 7]

From the above data it can be judged that goal incompatibility does exist to some extent in the Forest Service at both vertical and horizontal levels. This incompatibility is a function of decentralization in structure, environmental factors such as special interest groups, and the apparent lack of coordination of effort among the three branches of the Forest Service. Goal incompatibility appears to have its most significantly detrimental effect on the process of technology transfer.

D. TECHNOLOGY TRANSFER GOALS

"Certainly, two goals of improved research planning will be to achieve better accounting of the total research effort and better coordination among the many research programs. Additionally, it should be recognized that the ultimate effectiveness of a research program for forests and associated rangelands will depend on the efficient transfer of research results to interested citizens, forest-based industries, resource owners, and land managers. Another planning goal should be the design of information transfer programs based on analysis of the factors that influence information acceptance by specific research user groups." [Ref. 15: p. 3]

In response to the recognized need for more planning and coordination toward the technology transfer effort, the Forest Service held workshops, solicited studies, created projects and staff positions, and developed technology transfer goals and tasks. On the micro level they defined technology transfer as both a marketing and an attainment process. "As a marketing process, technology transfer involves: (1) identifying the technology available for and needing transfer; (2) identifying the target user group(s) to whom the technology or information is to be transferred; (3) developing an objective and formal or informal plan of application; (4) packaging the knowledge or technology for easy understanding; (5) selecting the media for transfer, including seminars, workshops,

technical assistance, etc.; (6) directly involving scientists and/or specialists with users, especially innovators; (7) trouble-shooting and feedback; and (8) evaluating the process and results. As an attainment process, technology transfer involves: (1) practitioner perceiving a problem, need, or opportunity; (2) practitioner inquiring for knowledge source; (3) analyzing available information; (4) checking costs and benefits; and (5) adopting new technology or knowledge." [Ref. 16: p. 1]

The Forest Service had Region 4 and the Intermountain Station begin a two-year regional technology transfer pilot project. "The following goals for the pilot project were developed: (1) develop a comprehensive technology transfer process as demonstration model; (2) build the technology transfer process into the everyday operations at regional, state, and local levels; (3) develop closer working relationships in technology transfer within State and Private Forestry, Research and regions, and among Forest Service cooperators and users of Forest Service research and development; (4) develop guidelines for coordinating activity in technology transfer planning, budgeting, program development, accountability, evaluation, training, etc.; (5) guide and assist in the development of technology transfer plans; and (6) participate in the development and maintenance of a national renewable resource information system." [Ref. 17: p. 9]

On the macro level the Forest Service developed the National Action Plan for Technology Transfer -- March 1979 to September 1981. The plan was instituted to alleviate the following seven problems which the Forest Service considered as primary inhibitors of a successful technology transfer process:

(1) There is little common understanding and thus considerable disagreement about what needs to be done to facilitate successful technology transfer both in-Service and outside. While regions and areas have "research coordinators" and stations have Assistant Directors for Planning and Application, common goals and objectives and coordinated planning and development of a TT process involving field units at all levels have not been achieved. There is little evidence that the full array of guidance and direction issued in recent years has been implemented across program areas at the region/area/station levels and below. TT staff support is needed at the regional level for TT coordination. Some one person must have responsibility for seeing that it happens.

(2) Technology transfer financing is unclear; staffing and funding to do TT are not always considered in the Resource Planning Acts, national and regional direction, and budgets. Best use is not being made of funding authorities, personnel, and TT plans. Policy direction needs to be developed which clarifies the roles of National Forest System, State and

Private Forestry and Research as they may have changed or expanded as a result of recent public laws. Guidelines on the use of funds for TT should be incorporated in the Forest Service Manual.

(3) Technology transfer awareness level training for Forest Service personnel and cooperators is needed.

(4) There is a need to strengthen the processes of evaluation within each accountability system. Current accountability systems should be capable of fostering and measuring TT progress. Forest Service accountability systems include organizational reviews, personal performance reviews, management attainment, etc.

(5) There is concern that adequate rewards are not always given to researchers for assigned TT activities. There are conflicting views on whether the extent and quality of research scientists' efforts in TT are adequately recognized by scientist evaluation panels.

(6) Formal TT planning is not an operational requirement in the Forest Service.

(7) Communications, education, and demonstration in the TT process are erratic at best. Effective TT requires effective communications at all levels of the process, including demonstration, packaging of information, consultation among scientists and users, bibliographic data bases, communication network, etc. Quality varies from unit to unit and project to project, depending largely on individual

initiative rather than policy and procedure. There is no uniform policy guiding development of a forestry technical information system to serve practitioners and users nationwide. [Ref. 16: pp. 1-8]

Table 1 is a summary of proposed actions, responsibilities, and target dates as stated in the National Action Plan.

TABLE 1

SUMMARY

National Action Plan for Technology Transfer, 1979-81
Proposed Actions, Responsibilities and Manpower Requirements

Action	Description	Responsibility/Co-Responsibility		Target Date
1	Establish pilot regional TT Group.	TTC		6/79
	Prior arrangements.	WO-TT		
	Regional Work Conference.	Pilot TT Project	WO-TT	11/79
	Research OI's in TT process.	WO Task Group	Pilot TT Project	11/79
	Build results in coordinated plan.	Pilot TT Project		1/80
	Complete and disseminate coordinated plan.	Pilot TT Project		1/80
	Evaluate TT Group operations.	WO-AM-TT	Pilot TT Project	7/80
2	Explore TT financing.	WO Task Group		1/80
3	TT process for PD&B system.	WO Task Group		6/79
4	Include best technology in RPA.	Deputy, P&L	TTC	7/80

Action	Description	Responsibility/Co-Responsibility		Target Date
5	Complete orientation package.	WO-TT		6/80
	Complete orientation training.	RF&D's		10/80
6	Review and consolidate FSM-TT directives.	WO-TT		4/81
	Amend directives dealing with reviews.	WO-TT		4/81
7	Individual performance ratings -- TT responsibilities.	Deputy, ADMIN	WO-TT	9/79
8	TT capabilities of management systems	WO-TT	DM, PD&B, etc.	5/80
9	Panel evaluation and reward system.	Task Group		7/80
10	TT considerations in RWU description or study plans.			
	Prepare guidelines.	WO-Research	WO-TT	10/79
11	Formal TT action plans.			
	Prepare guidelines.	WO-TT		10/79
	Prepare plans for available technology.	RF&D's		7/80
	Checklist for evaluating technology.	WO-TT	WO Task Group	10/80

Action	Description	Responsibility/Co-Responsibility		Target Date
	Analyze training needs of persons assigned TT roles.			
	Develop RFP.	WO-TT, PM		10/79
	Complete contract.	Contractor	WO-TT, PM	4/81
	Establish national training standards.	WO-TT, PM		7/81
12	Produce national technical information plan.	WO-TT		8/79
13	Organize interagency committee.	WO-TT		10/79
14	Assist selected State forestry planning committees.			
	Select States.	RF&D's	WO-TT	9/79
	Complete development work.	RF&D's	WO-TT	12/80

IV. TECHNOLOGY

From the interviews, several relevant findings were made which by model definition fall under the major element of technology.

A. RESEARCH SOURCES

The research conducted within the National Forest Service is both widespread and somewhat specialized. For example, the Forest Products Laboratory located in Madison, Wisconsin, specializes primarily in research dealing with forest product utilization (wood utilization). Interactions with the Forest Products Laboratory from within the region examined was accomplished through direct contact with a wood specialist. It appeared as though no formal communication link existed between regional components and the Product Laboratory.

Strategically located throughout the country are Forest and Range Experiment Stations. These components are headed by a Station Director who reports directly to the Office of the Chief of the Forest Service in Washington, D.C. These stations perform both basic and applied research. Subcomponents exist within these research stations in the form of research work units or project teams. These facilities allow for the mobilization of research efforts. The project teams are headed by project leaders or managers, who are essentially representatives of the director at the various

field locations, although they have little or no authority over the research work being performed. Line authority to the project leaders is through the Assistant Director for Continuing Research.

Research is additionally performed at various land grant colleges and universities. This research seems to be applied in nature. If short-term expertise is required on a particular issue, the land grant colleges are frequently contacted for assistance and advice as needed. A cooperative effort has been informally established from the planning of research to the actual performance of the work. This cooperative effort is facilitated through the exchange of personnel via Interdepartmental Personnel Assignment (IPA).

B. RESEARCH FINDINGS

Constraints placed upon the quality and type of research performed are not atypical in nature. Federal agencies are consistently plagued by limited fund availability which in essence requires a careful screening of resource allocations as well as obligations placed against available funds. One experiment station expressed a performance of only 10-25% of the research which it felt necessary, attributing the shortage to limited research funds. Thus, the project selection process occasionally takes on an interesting perspective. Considering the shortness of dollars, project selections are often prioritized in terms of the likelihood of their being

successful. This method of prioritizing may not, however, be consistent with user needs. Herein lies an interesting paradox. On the one hand, there are definitive requirements for advanced technology being generated at the field level. Research dollars are understandably constrained requiring the establishment of a priority system to insure success, thereby meeting the needs of researchers relative to requirements established by virtue of the reward system. Pioneering research work units serve as one example. Success from the standpoint of the researcher lies largely in the amount of research publications and discoveries made. Project priority systems, established in such a manner to insure successes, promote the efforts of the researcher but do little to assist the ranger in the field with real needs. Considering these constraints, the user is somewhat expected to solve a variety of problems "on the ground" and develop some of his own technology. Thus, primary emphasis on user need is difficult to envision.

1. User's View

Consistent with many of the identified constraints were problem areas viewed by prospective users of new technology development.

The Forest Service is charged by Congress to be the leader in range research. As such, it is responsible to the Bureau of Land Management, the National Park Service, state agencies, and private landowners. Private landowners pose

some difficulty in terms of identification. A relatively rapid turnover of land ownership renders it difficult to maintain up-to-date information on this rather large user population. Technology transfer efforts aimed at this particular population are largely a hit-or-miss proposition.

Interviews with users within the Forest Service structure at various levels, including members of state departments of forestry, revealed several areas of concern. In a decentralized bureaucracy, the problems of communication are multiplied at each level. [Ref. 10: p. 3-7] The effects of the broad delegated authority given to the regional foresters with subsequent subdelegation to lower levels of the organization can be realized in several comments produced in the data collection process.

The bulk of research development is communicated by means of technical publications. It was estimated by several interviewees that perhaps 80-85% of the technology information they receive is via this medium. The volume of publications received by interviewees did not appear to be minimal. A common theme throughout the interviewing process was that the volume of material was bordering on being excessive. One interviewee exclaimed, "I don't know where a lot of this comes from -- it just appears in my basket." Several people indicated that too much material was being sent out and expressed a desire to attempt to reduce the enormous mailing. The effects of the volume received by many members was reflected

in the publications' ultimate disposition. Interviewees expressed a general inability to review adequately all of the material received. Alternatively, the material was frequently stored or filed in a variety of methods ranging from organized bookshelves to cardboard boxes located in obscure portions of an office until such time as the member realized an opportunity to examine the material more closely. The backlog of reading material thus created frequently turned into a private library and the transfer of information ceased at that point.

The vast amount of job specialization within the Forest Service structure further adds to the problem of a mass publication effort. A majority of interviewees expressed concerns over a lack of time to assimilate properly what they considered to be relevant data. For example, one district ranger interviewed expressed no desire to read it "all" but was indeed interested in those matters which pertained to his particular area of expertise. As such, he relied more heavily on receiving technology information of interest to him via journals published outside of the Forest Service system. These were primarily trade journals in nature. Although external to the system, the transfer of information in this case was being carried on. Similarly, another interviewee expressed a need for a form of clearinghouse to assist in sorting pertinent data.

Comments such as those described sparked concern considering the availability in the Western Region of the Forest Service of the Western Forestry Information Network (WESTFORNET). This system is a library-based regional documentation and information network. The system is referenced via publication of Monthly Alert, a publication containing a detailed subject index to allow for quick identification of topics appealing to its readers' parochial interests. When questioned, interviewees generally regarded the WESTFORNET system as effective. Most had utilized the system on several occasions and expressed satisfaction with the process when seeking data on a specific topic. However, despite the seemingly excellent response time (mailing within three or four days), many members expressed greater success in acquiring urgent data through informal means, mainly through personal contact with recognized experts in a particular area. Informal methods seemed to be a preferred method for dealing with most technology issues. This appears to be largely a function of decentralization. This thought is perhaps best epitomized by the following comment made by an interviewee of respected position: "Technology transfer is basically hit or miss, trial and error. We're not sure what makes it work."

2. Users' Needs

Methodologies employed in the solicitation of users' technological needs were investigated. A common theme which

permeated interviews conducted outside of experimentation locations was an inability to effectively communicate needs with sources of research production. The logistical separation of users and researchers served to establish a sociological barrier which had the effect in one instance of researchers being referred to as "Messiahs." Frequent reference was made to the inability of research personnel to fully understand the problem faced by field representatives largely due to the many variables associated with a research need. Local political attitudes and influences, for example, were related as being an important consideration on many research projects; yet these variables cannot be effectively transmitted to research personnel through formal means.

The methods for formally communicating research needs to research sources were largely not understood by the interviewees at field units; thus, reference was again made to the use of informal communication systems. A member of the California Department of Forestry (CDF) claimed his only method of making research needs known was through a representative of CDF working out of the Pacific Southwest Experiment Station in Berkeley, California. Communication with that station failed to identify any such representative. Further investigation, however, did uncover a system for CDF personnel to submit research discoveries through the state's headquarters in Sacramento. This is a form of incentive plan, and constitutes part of a merit award system.

Most interviewees related a general dissatisfaction over a lack of sufficient solicitation of users' needs. A more effective two-way communication system capable of reaching each level of the organization appeared to be in great demand.

Findings regarding the actual transfer of the technology will be discussed in subsequent chapters. In keeping with the definitions applied to the conceptual model elements, these findings more appropriately fall under other categories.

V. PEOPLE

"In the final analysis, technology transfer will be accomplished through people. All the tools and aids will not do the job unless we have people who are motivated to do technology transfer. The job of the manager is no different in technology than in anything else. He must work through people. He must motivate them to do the technology transfer job. He must convince his people that technology transfer is needed, is a worthwhile task, and it can be personally rewarding." [Ref. 3: p. 51]

In the introduction to this study, it was stated that "technology transfer efforts become exponentially even more complex when the human element is introduced as a variable." Indeed, interviews with Forest Service management revealed some perceived problems in the area of personnel which could adversely impact on technology transfer. These problems can be placed into three broad categories: roles, rewards and incentives, and evaluation. Each category could, of course, of itself, be the subject of a much larger study than this one. Therefore, only the specific problems in each category which were uncovered in the interviews will be examined.

A. ROLES

The Forest Service has gone through three distinct periods of professionalism in its history. When it was a young organization, its field personnel were basically amateur woodsmen with interests in the field of forestry; and its Washington staff was composed of amateur bureaucrats. Forestry Chief Pinchot dedicated himself to improving the professionalism of the total Forest Service in the second period. Although the amateur woodsman and bureaucrat became professionals in their work during this period, they were still generalists. The most recent period of Forest Service history has changed this era of the professional generalist into the era of the specialist. Today, slightly more than half of the full-time employees of the Forest Service are specialists in fields ranging from mathematics to meteorology, from botany to business management analysis. Staff and line, researcher and forester, and all other differentiated areas of the Forest Service are presently represented by specialists. "However, for all the diversity that does exist, the service, especially the National Forest System, is still dominated by the generalist forester whose professional background is broader than it is deep." [Ref. 10: p. 32].

Within the National Forest System the three primary career fields are forestry, engineering, and business administration; and each of these, in turn, is broken down

into further specialties. In the forestry area alone the main specialties have tended toward production functions such as timber or range management; and although there appears to be a shift toward areas such as outdoor recreation and wildlife, a 1970 survey of forest professionals showed that "71 percent believed that making resources available to users was the most important mission of the Forest Service." [Ref. 10: p. 34] So while there appears to be an interest today in a more balanced multiple-use management approach to all forest resources, this approach is still considered to be within the traditional boundaries of a utilitarian ethic of productive use of forest resources.

This idea of tradition in the Forest Service serves as both a strength and a weakness, as it does in most organizations. There are strong ties of sociability and professional kinship that bind individuals together. Even "the specialist within the Forest Service is very likely to have somewhat closer ties to his colleagues in the Forest Service, regardless of occupational specialty, than to his professional counterpart in another organization. . . . The 'school tie' of the agency is at least as important, if not more so, than the color of the academic cowl." [Ref. 10: p. 35] This identification with the organization is one reason for the remarkably low departure rate of personnel from the Forest Service. Another reason is the Forest

Service's propensity to promote from within the ranks rather than to hire individuals from the outside to fill a high position. This promotion policy is another matter rooted in tradition.

The idea of tradition, however, also breeds a will or expectation to conform. This conformity has its beginnings in the forestry schools, which are accredited only by the Society of American Foresters. The training in these schools is highly influenced by the Forest Service since it holds a position of leadership in professional forestry and since it is a major employer of the school's graduates. Following graduation from a forestry school, the individual is further influenced to conform based on the selection process for forestry jobs and by the process of promotion and career assignments. "While the Forest Service can and does tolerate a variety of views on particular issues and on particular subjects, it does attempt through its hiring, assignments, and promotions to develop loyalty to traditional policies of land use and management. While the agency does not consciously attempt to discourage innovation or new ideas, the incentives created by its emphasis on internal promotion and loyalty to institutional values favor a fairly conservative and stable policy of land use management. . . . Whatever incentives are created for reform or innovation, the Forest Service will undoubtedly continue its past insistence that all members of the organization be 'team players.'" [Ref. 10: p. 39]

While tradition on a macro level tends to influence the individual to conform and identify with the Forest Service as a total organization, it also tends to act on a micro level in perhaps a more subtle way. The forester was given a total picture of forestry in school even though he may have specialized in a particular area; but once he is sent to his initial assignment, he tends to become provincial in his outlook and may, to some extent, lose a proper perspective of the big picture. The Paul Bunyan ethic of some of the foresters as well as different examples of esprit de corps show up in the Forest Service almost every place there is a group boundary. These group boundaries are identified by factors such as role specialization, function (line or staff), geography, age, and experience. Each group, of course, has its own norms, values, language, and its own ideas of other groups. This group cohesion is a good motivator for esprit de corps, but it can hurt the organization as a whole when group cooperation is called for. The split between the roles of researcher and forester is a primary example. If the researcher and forester each think of themselves only in terms of their specific group roles and group identities, rather than as a functional part of the total organization, cooperation, communication, and mutual assistance become difficult if not impossible.

Role specialization, influenced by group tradition, appears to be a major problem in successful technology

transfer, especially for members of the line functions. Staff members are affected by role overload in some cases to the extent that a few roles may suffer. A prime example is the State and Private Forestry staff member who has been given a multitude of collateral duties, of which one may be technology transfer coordinator. The success of this individual at coordinating technology transfer will be affected by his own priorities as well as those of his supervisors. If the role of TT coordinator is not his primary role, it is easy to see how he could justifiably allow his secondary role to suffer. State and Private personnel are not the only ones affected by collateral duties, however; and at only a few echelons other than the Washington level does there exist a full-time technology transfer position. The Chief of the Forest Service, R. Max Peterson, has stated, "Regional research coordinators, Station Assistant Directors for Planning and Application, and Station Information Officers cannot personally devote the significant staff time needed to make the technology transfer process a part of the ongoing work of the Forest Service. Therefore, it is essential to assign staff to do this job." [Ref. 16: p. ii] Public Law PL-96-48, the Technology Innovation Act of 1980, may cause the Forest Service to institutionalize its technology transfer effort, especially at the laboratory or experiment station level. [Ref. 18: pp. 15-16] But even if a full-time role to accomplish technology transfer is established, the success

of its efforts will depend greatly upon the amount of coordination with other Forest Service role positions. In order for this to occur, it may be necessary to have technology transfer thoroughly entrenched as a viable part of every role position in every group in the Forest Service.

B. EVALUATION, REWARDS, AND INCENTIVES

"The CRUSK (University of Michigan's Center for Research on the Utilization of Scientific Knowledge) study has confirmed rather than uncovered that the prevailing conditions and climate in the USFS research facilities (as in most other research establishments outside the USFS) are adverse to TT efforts, and by the same token to linker-type activities. Modification of two aspects of the existing condition in particular are requisite for effective linker deployment. The first is the reward structure, both as regards extrinsic rewards (salary, administrative authority, control over resource allocation, status) and intrinsic rewards (opportunities to use skills, gain new knowledge, deal with challenging problems, freedom to follow up own ideas). The second is freedom to flexibly allocate and re-allocate one's own time between research and linker-type activities at one's own discretion -- which does not, of course, preclude accountability." [Ref. 19: p. 9]

The National Action Plan for Technology Transfer, covered in Chapter III, addressed the need to strengthen the processes

of evaluation within each accountability system in order to measure TT progress and to measure the effectiveness of individuals in the TT process. It also established as a primary problem area the concern that adequate rewards are not always given to researchers for assigned TT activities. The problems of evaluation and rewards and incentives, relating to the technology transfer effort, are really inseparable but will be treated here as two aspects of motivation.

The evaluation of research scientists is governed primarily by the United States Civil Service Commission Research Grade-Evaluation Guide. [Ref. 20] The Forest Service Manual [Ref. 21] (FSM: 6151.17) states that GS-11 and above research positions will be evaluated every three years by a panel composed of researchers and research administrators. The researchers are evaluated on four main factors. Factor I is the research assignment comprising the nature, scope, and characteristics of current studies being undertaken by the scientist. Factor II deals with the supervisory guidance and control exercised over the researcher in his current job situation. The third factor deals with creative thinking, analyses, syntheses, evaluation, judgment, resourcefulness, and insight characterizing the work performed. According to the Research Grade-Evaluation Guide [Ref. 20]: "Also to be considered is the required interpretation of findings, translation of findings into a problem solution,

and recording of these findings and interpretations in a form usable by others as well as in application to specific end-products." Factor IV is intended to focus on the total qualifications, professional standing and recognition and scientific contributions of the researchers as they bear on the current research situation and work performance. Under the area of scientific contributions, the Forest Service's Guide for Preparing Research Scientist Position Description [Ref. 21] states that for each research accomplishment the position description (used by the evaluation panel) will list how it was communicated to users and the extent to which findings are being applied, where, and by whom. It further elaborates by stating the necessity of documenting "the dissemination of research results, irrespective of the method. The test of the significance of the research is its acceptance by resource managers, the using public, or use in other research." Although it appears that any TT activities conducted by the researcher would indeed be adequately covered under the above panel evaluation guidelines, the Forest Service is taking steps to insure technology transfer efforts are mentioned by name and that there is an effort on the part of the researcher toward applied as well as basic research.

The CRUSK findings, mentioned earlier, included 70 recommendations stressing "the importance of providing organizational conditions and supports (particularly rewards) which permit researchers to contribute to both science and

application at the same time." [Ref. 13: p. 48] Lingwood has two major ideas concerning rewards for technology transfer in the Forest Service. One is that although the people in charge emphasize efforts to get research applied, they have not "taken the next required step of putting rewards where their verbalizations are." The second idea concerns the foresters who may be required to give time to the researchers in evaluating research or in explaining the problem conditions. "It doesn't say in a Forester's job description: 'One of the things you will do, and get rewarded for, is listening to the researchers.'" [Ref. 13: p. 47] Rewards for technology transfer efforts should not be incentives aimed only at researchers (the only area of rewards covered in the National Action Plan), but they must encompass all levels within the organization where a contribution to technology transfer efforts can be made.

Much of technology transfer coordination is presently centered in the State and Private Forestry branch, the primary link to the mass of independent users. Yet, interviews with personnel responsible for TT in this branch highlighted a lack of credit for TT success. The cooperative extension service or the state foresters would get the credit for joint TT efforts, based on the numbers of personnel attending seminars or workshops. While this concept was not in the form of a complaint from the interviewees, perhaps the TT effort could be enhanced if these positions of TT

coordination (which are not researcher positions) were evaluated and rewarded for their contributions to technology transfer.

Another possible inhibitor to TT brought out in the interviews concerned the possibility of managers' stifling TT attempts on the part of their subordinates due to fears that the subordinates may then know more than the managers. This form of job security, while perhaps extreme, is quite possible. A more common theme, perhaps, is that managers are too busy in their jobs to keep track of all research outputs and new information in the different forestry fields. Some of the material which they may desire to read first and later disseminate to subordinates never gets read or disseminated due to lack of time or other priorities; and, although the item may be eventually stored in a personal or office library, the TT effort has not been served. A final inhibitor is the constraint imposed by lack of funds for travel to TT seminars and workshops. While some foresters appear eager to learn about TT or about a new technology itself, presentations away from their local area which involve travel expenses may have to be paid for out of their own personal funds.

These last two inhibitors of the technology transfer process should pose no real problem if serious effort is taken to deal with them. One incentive for the manager to disseminate TT information is for his superiors to evaluate

his performance regarding TT. Another is to reward that performance so that he may ensure his job security in more productive ways. For the forester who is eager to go to the workshops and seminars, an incentive toward the TT effort is to pay his travel expenses or to bring the demonstration closer to his local area, or even to arrange for a film or videotape of the presentation which could be shown at his local unit.

Evaluation, rewards and incentives are all intermingled concepts of motivation which, when structured correctly, could enhance the success of technology transfer. If the goal of the National Action Plan truly involves building "the TT process into the everyday operations of the Forest Service at Regional, State, and local levels," then this proper structuring of evaluation, rewards and incentives is paramount.

VI. STRUCTURE

As previously defined, structure refers to the formal aspects of an organization. Structures are comprised of systems which are regulatory in nature and serve to place limits on the flexibility of organizations. These limits assist the organization in maintaining control and direction through formal mechanisms such as levels of management, span of control, line and staff relationships, centralization versus decentralization, and similar constraints, which are generally incorporated as part of the organization's formal operating plan.

A. INTERNAL ORGANIZATION

The formal organizational structure of the National Forest Service is shown in the organization charts located in Appendix B. At the apex of the organization is the Chief of the National Forest Service. There are five major subcomponents under the Office of the Chief, each headed by a Deputy Chief. The offices include: (1) Administration, (2) Research, (3) the National Forest System, (4) State and Private Forestry, and (5) Programs and Legislation. The offices of the Chief and his deputies are located in Washington, D.C.

"While the Washington Office is responsible for general policy directives, most Forest Service operations -- including

a broad policy-making authority -- are delegated to the field offices. For Research, field organization consists of eight experimental stations, a separate Forest Products Laboratory, and an Institute of Tropical Forestry (in Puerto Rico), each headed by a director reporting directly to the Chief. State and Private Forestry currently has two area offices in the East, each headed by a director reporting directly to the Chief. In the western states, state and private forestry work is organized as a division within the regional offices. With the exception of Research and the two eastern field offices of State and Private Forestry, the regional offices of the Forest Service administer all the affairs of their respective regions." [Ref. 10: p. 28]

The Forest Service thus presents a picture or profile of an organization with a diversity of areas of involvement as well as one which, because of its logistical boundaries, is extremely decentralized. Each field organization thus possesses a high degree of individual control and autonomy. It is within this complex structural formation that technology transfer efforts are designed to exist and survive.

Decentralization in and of itself can be a very effective managerial tool; however, it comes with a price tag. "Authority, like energy, dissipates over space. The decentralized character of the organization adds a special dimension to the problem. For one thing, the diffusion of field-level discretion and responsibility adds to the distance,

geographic and personal, over which control and direction must be exercised; with each level of bureaucracy the problems of communication and accurate reporting are multiplied." [Ref. 10: p. 37]

The formal structure of the Forest Service exhibits a vertical reporting authority from field activities directly to the Office of the Chief. There does not appear to be a formal mechanism established allowing for a horizontal transfer of information particularly between the sources of technology development and those units identified as users of the data or as staff specialists capable of effecting information dissemination. As such, the establishment of informal communication networks is promoted.

B. TECHNOLOGY TRANSFER WITHIN THE INTERNAL ORGANIZATION

Not atypical of bureaucratic organizations is an innate propensity to avoid the rigors and frustrations associated with structural reorganizations. Recent literature emphasis, however, has focused on the need for organizations to move toward a more organic state. This state has been characterized by joint problem solving efforts, open communication channels, interdependence among various components of the organization, and a matrix structure. Countering movements in organizations toward more organic states are such familiar problems as a general resistance to change, largely associated with past conditioning, and emerging research by

structural-contingency theorists. These theorists conclude that "a prime determinant of organizational effectiveness is an organization's fit between its structure and the demands of its environment and technology. Most significant here is the finding that mechanistic, bureaucratic structures are not only appropriate for relatively stable environments and routine technologies but that some structures are more conducive to high performance than organic-adaptive structures in similar environments." [Ref. 22: p. 49]

Regardless of the reasons for resistance to structural change, one method employed as a compensatory measure in lieu of restructuring is to supplement the existing structure with units or positions whose function it is to absorb these new responsibilities or tasks. This augmenting force is intuitively supplied within the existing constraints of money and personnel. These augmentation units are frequently established within the headquarters area primarily to insure the necessary visibility important in any new undertaking. Responsibilities for these new tasks at the lower levels of the organization are frequently established in the form of collateral or extra-job assignments.

A similar situation appears to be present within the Forest Service structure. At the headquarters level, there are two units which have been established for the purpose of enhancing technology transfer efforts. A Technology Transfer Council (TTC) has been created and tasked with the broad

mission of encouraging technological innovations. This council is comprised of the various Deputy Chiefs. Within the Office of the Deputy Chief for State and Private Forestry is a Central Technology Transfer (CTT) Office which is not depicted on the organization charts included as Appendix B. The broad scope of this particular unit is to enhance the promotion of technology transfer which it attempts to accomplish largely through the publication and distribution of technology-related literature.

As the technology transfer responsibilities flow downward through the organization, however, these responsibility assignments become more vague. Reference has been made in previous chapters to the establishment within the Research branch of the position of Assistant Director (AD) for Program Planning and Application. These positions are located at the various experiment stations. The incumbents have the responsibility for research implementation. Despite a seemingly innate correlation between research implementation and technology transfer responsibilities assumed at the headquarters level, it is extremely difficult to find any formal organizational link between these two important elements. In fact, they are structured in separate branches of the Forest Service system. The assignments of technology transfer responsibilities within the State and Private Forestry branch at the regional level, as shown through the

data collection process, are primarily made as collateral duties. Regional State and Private Forestry personnel assigned the responsibilities of promoting technology transfer efforts generally exhibited great enthusiasm over the potential for significant advances in this endeavor; however, they related significant constraints placed upon available time by virtue of their primary duty responsibilities. As is the case with the Research Branch representative (AD), there is no formal link between the State and Private Forestry technology transfer regional representative and the CTT Office in Washington, D.C. Again, informal communication networks are relied upon to get the job done.

Technology transfer responsibilities of a formal nature at field levels beneath the regional offices are essentially nonexistent. The term "technology transfer" was, in fact, undefinable by several personnel occupying positions at various levels beneath the regional office headquarters. This is not to say, however, that the process of information transfer is not taking place. Conversely, informal communication networks at these levels are often quite effective and the exchange of information is carried out as efficiently as this form of process will allow. It does indicate, however, that the technology transfer effort at these levels of the organization is occasionally a hit-or-miss effort.

As mentioned in Chapter III, attempts to establish a technology transfer position which would more actively pursue

these efforts was begun in 1979 as a pilot project. The Intermountain Station and Region 4 volunteered to pioneer the project. The thrust of the endeavor focused on the ability of the position coordinator to freely move across organizational lines in the absence of any formal restructuring of the agency. Since that time, the incumbent has developed formal action plans which provide recommendations for the sequential implementation of technology transfer improvement steps. The plan was to be evaluated in May 1981 at the headquarters level and further recommendations made at that time. At the time of this writing, no final disposition has been made regarding the future direction of this project. The action plan reflects a comprehensive technology transfer package, the nature of which suggests improvements to the present process requiring little to no structural change.

C. DECENTRALIZATION

The term "decentralization" can be interpreted in many different ways. It can be used to denote the physical separation of production or sales, for example, from the head office. Another type of decentralization refers to the type of management under which an organization operates. Specifically, it prescribes the assignment of responsibilities and authority down through the organizational chain. In

relation to technology transfer, the latter form of decentralization is of primary concern.

The high degree of autonomy associated with each level of the Forest Service organization has been alluded to in previous sections. "Because of the broad delegated authority given to regional foresters and the broad discretion given to them to redelegate authority to lower levels, the degree of responsibility in authority of line officers varies considerably throughout the system. . . . Occasionally, the Executive will direct a particular policy emphasis, but usually these provide only occasional direction and are of such a general nature as to be more hortatory than compelling. As for departmental regulations, these too are very general typically adding little beyond that provided by statute or what is already prescribed by the Forest Service itself." [Ref. 10: p. 37]

A system of decentralization, while functioning well in the face of usual business, often manifests problems when faced with external or environmental influences such as governmental intervention. Meyer [Ref. 23: pp. 56-57] illustrates this point by presenting an analogy involving the automobile industry. He refers to the strict anti-pollution laws and safety regulations imposed by the federal government and points to the need for corporate efforts versus single operating division efforts to efficiently address

the change implementation. Meyers points out that one of the major constraints in the assumption of this responsibility by operating division management personnel was that the effort did not add to profitability; and, hence, it was not in the interest of product division managers to encourage or perfect the required control or safety devices. "In general, environmental adversity that cannot be handled through the normal marketing mechanism of a firm usually requires recentralization." [Ref. 23: p. 57]

The principles inferred in this example can be likened to the situation encountered within the Forest Service. The requirement placed upon federal agencies in 1972 by the General Accounting Office survey represented an external requirement to modify existing policies and procedures with regard to the movement of information. The decentralized nature of the Forest Service thus makes commitment-building a difficult task to achieve. Organizational subcomponents removed from the source of the requirements have difficulty identifying with the nature and severity of the problem.

"The highest-priced and best talent of many companies is often assembled at headquarters. When decentralization is introduced, men in the field may feel that they no longer need to utilize headquarters advice. They may be glad to escape such counsel as they consider unwarranted and time-consuming. The result may be that headquarters staff is

only partially utilized and its effectiveness is thus impaired. It is essential, therefore, that management carefully define relationships between headquarters and the field so as to strike an optimum balance between the advantages of waiting for superior advice and of action on the spot." [Ref. 24: p. 113]

Decentralization within the Forest Service appears to be a necessary structural form in view of its logistical constraints. However, the effects of attempting to instill a program such as increased technology transfer emphasis must be realized as a difficult process requiring a high degree of commitment-building measures. This is particularly true in light of the non-quantifiable nature of the desired end-state. Top-level support in insuring that the endeavor penetrates each level of the organization, by the assignment of specific responsibilities with appropriate feedback mechanisms, is essential in assuring relative success.

VII. COMMUNICATIONS

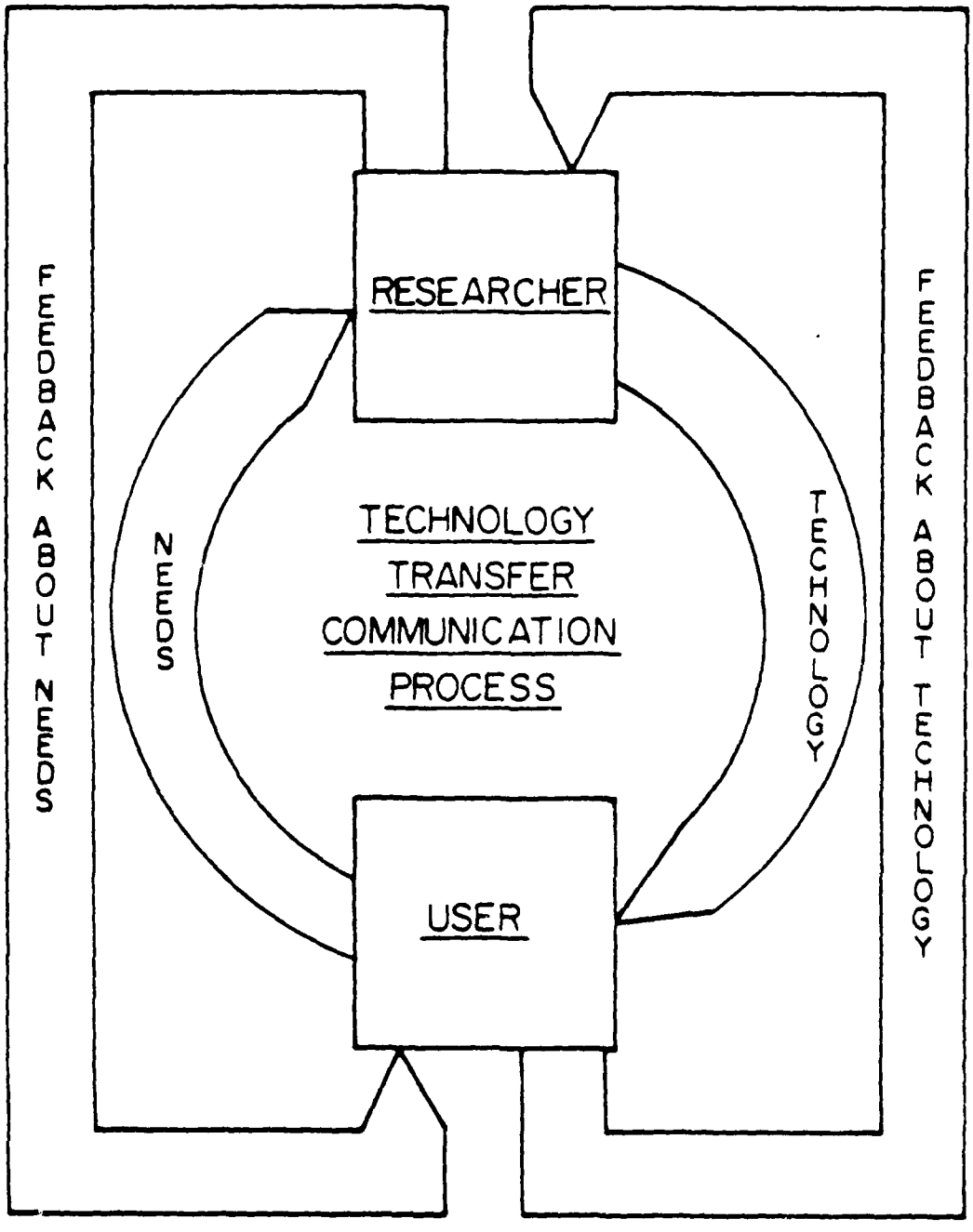
"Whether you are a scientist, innovator, or someone else with responsibility for getting technology applied, there is a need to communicate, in a systematic way, the technical information to assure its transfer. The standard way of publishing in a journal or technical publication may not be the best way to communicate results to intended users, nor to stimulate implementation of technology." [Ref. 25: p. 8]

The normative model on the following page (Figure 2) represents a technology transfer view of the communications process. As can be seen, the process is a cycle in which technology needs are communicated from the user to the researcher, and technology is communicated from the researcher to the user. There is an outer cycle of feedback which is used by the researcher to comment on or ask questions about the needs of the user. The user takes his feedback route to the researcher as a means of commenting on or recommending improvements to the technology. As this is a normative model, it represents the way things are supposed to work -- the ideal situation.

Technology transfer can also be described as a push/pull situation. Speaking ideally again, the researcher uses communications to pull out the needs of the users, and he

FIGURE 2

TECHNOLOGY TRANSFER COMMUNICATION PROCESS MODEL



communicates to push down the results of the technology. The user, on the other hand, pushes up his technology needs and pulls down the technology. The pull phase involves questions such as: "What are your needs?" and "What technology is available to solve my problem?" The push phase uses statements such as: "Here is my technology," or "Here are my needs." Once again, the push/pull model is a normative approach describing the ideal situation.

The Forest Service, however, does not operate in an ideal world. Descriptive models, which show how communications actually operate in the Forest Service, describe a situation which is somewhat less than ideal. If the Forest Service were divided into its top, middle, and lower echelons, one could say that communication at the top level is accomplished horizontally, or across deputy lines. Vertical communication up and down the levels and horizontal communication among the agencies and personnel in the middle level and horizontal communication at the lower level appears to be lacking. Part of this communications gap is caused by the nature of decentralization in the Forest Service. In some cases there are no formal channels of communications. People may or may not communicate informally. In other cases the formal channels of communication are not used as intended, but informal methods may fill the gap somewhat. Interviews with management personnel at various levels in the Forest Service confirmed the above findings.

Comparing communication normative models of what theorists think "ought to be" with descriptive models of what "actually is" serves to illuminate discrepancies between the two models which may possibly be causing problems in an organization's communication system. Previous chapters have identified the technology transfer process as one in which communications certainly play a major role. Barriers to effective communications, and thus to effective technology transfer, have been touched upon and explained as being partially caused by inherent problems in people, roles, structure, goals, the planning process, tradition, the reward system, and internal and external pressures from various sources. This chapter will elaborate on some of those problems, especially as they affect the three aspects of the cyclic technology transfer communications process, depicted in Figure 2. It will also offer some alternative methods for dealing with the problems that are presently being tried in different locations in the Forest Service.

A. COMMUNICATION OF NEEDS

"Ideally, the information push by the developer should be matched by the information pull from the user. Realistically, the activities of developer and user communities are often mutually exclusive. Research is often generated without adequate knowledge of the user's need, and the user continues to struggle with the inadequate information

because research results scratch where he doesn't itch, are too hard to find, are too difficult to understand, or are so site specific that they appear unusable." [Ref. 26: p. 2]

Results of the interviews pointed out that there are both formal and informal methods for making user needs known to research facilities. The informal means, such as telephone conversations with the experiment station or expressing needs to researchers at conferences, were used most often. Many users, even those in the state forestry system, felt frustrated that no one ever solicited their needs and that there was no really effective method to make their needs known. Different regions in the Forest Service have tried to actively solicit needs, and some of these efforts have been relatively successful.

The Research-Needs-Response Program was designed by the Forest Service to find out what the problems or needs of the users are. Region 9, the Northeastern Area State and Private Forestry system, the Northeastern and North Central Forest Experiment Station, and the Forest Products Laboratory all worked together in developing the program. "Each year on November 1, the State and Private Forestry organization asks all State Foresters in the Northeastern Area, and other research user groups outside the Forest Service to submit Research-Need-Statements by January 15. In addition, all

Region 9 National Forest System and Northeastern Area line and staff specialists are asked to submit Research-Need-Statements." [Ref. 27: p. 1] The need statement requires the problem to be written as a specific question. The impact, extent, or importance of the problem must be stated, and the problem must be such that the solution has broad application. The anticipated benefits from the application of research results are filled in as are the timing requirements (What are the consequences of deferring the research on this problem?). Northeastern Area specialists and Region 9 staff review the statements and forward them to the experiment stations where individual research work units are selected to prepare formal responses to the originator of the need statement. The responses are reviewed by line and staff administrators in the station, the area, and the region to evaluate potential program changes and to identify appropriate follow-up action. If research has already been conducted on the problem, the response tells where the results may be found. Otherwise, the response states whether or not research will be conducted on the problem. The area or region conducts a follow-up by telephone, letter, or personal contact to determine if the originator of the need received the response and if additional information is needed. The research agencies inform the originator of any action taken in response to his need. "The program gives forest-land

managers and forest-resource users a direct means for suggesting problems that need research. This close communication between scientists and research users at the planning stage should lead to more rapid and widespread implementation of research results. Since available research results can often provide at least a partial answer to identified problems, the Research-Needs-Response Program also serves as an immediate means of communicating available technology from scientists to research users." [Ref. 27: p. 1]

The Rocky Mountain Station and Region 2 made an agreement for research assistance designed as a formal mechanism to expand the availability of research expertise and to provide in-depth answers to problems. "In order to handle requests for assistance in an orderly manner, Forests forward their needs to the Regional Forester for initial screening and follow-up action. These requests state the nature of the problem, the scope of answers needed, whether the assistance is needed within a specific time frame, and the contact person on the Forest. The agreement provides scientists to the Regional Forester as 'consultants.' They are available for up to 20% of their time to provide currently available information, comprehensively and soundly reasoned, written answers and recommendations to questions and problems encountered by the Region. This agreement led to close

working arrangements between Region and Station specialists and resulted in numerous accomplishments." [Ref. 28: p. 1]

Specialists have been used in other areas to determine needs through observations made through field trips, examination of field reviews, discussions with foresters, and through TV talk show appearances, through solicitation of needs via radio station announcements, and through symposia, conferences, professional meetings, and other group activities. [Ref. 29: pp. 1-9] Almost all of the above need-discovering processes involve an active interaction between the specialist and the user which serves to knock down barriers to communication and understanding of the need or problem.

The Surface Environment and Mining Program (SEAM), attached to the Intermountain Forest and Range Experiment Station, established Technology Transfer Specialist positions in Regions 1 through 4 to act as liaison between research scientists and users. "The Specialists are housed in the user community and are responsible not only for representing the users' research needs, but also for keeping current on what information is available in the research community." [Ref. 26: p. 3] "With regard to SEAM research, the need may surface from the scientist, or any member of the user community including Forest Service manager or staff specialist, industry representative, other governmental agencies, or the general public. Each may see the problem from a

specific point of view based on a particular interest. Getting an accurate and objective analysis of the research need is critical. The Technology Transfer Specialist can play an important role in facilitating the interaction between research and user during this phase. Many times information already exists to answer specific problems. If not, the scientist can provide the most current knowledge to give the user some help until more information can be generated. This immediate feedback of current knowledge to the user community should be a mandatory requirement before permitting new research starts." [Ref. 26: p. 5]

The Northern California Section of the Society of American Foresters (NCS SAF) and the University of California Cooperative Extension Service jointly sponsor an effective on-going educational program for foresters and forest land-owners. The program is an annual series of six to ten short courses (one to three days each) which are classroom or field oriented as appropriate. The program is a grass roots approach focusing on educational needs defined by users. The approach starts with an Education Committee composed of Education Committee chairmen from each of the 14 chapters of the NCS SAF, plus designated representatives from the four main sectors of forestry in Northern California (public agencies, industrial landowners, consultants, and academia). This committee meets every April to plan the following season's

program. The members of the committee provide inputs based on the needs of their respective communities. Priorities for the upcoming courses are by consensus. Courses are designed by the Cooperative Extension Forester and a team of three or four specialists in the subject matter field. Inadequacies in the program include the following: (1) it does not provide a formal survey of educational or training needs of Forest Service personnel, (2) it does not necessarily extend research results as they become available in any given subject area, nor does it assure extension to the appropriate user, and (3) it does not necessarily provide for specific problem solving with the Forest Service. However, as an informal method, it does serve to indicate educational needs, extend research results, identify expertise outside the Forest Service, provide an excellent forum for interchange with professionals in other sectors of forestry, and cultivate cross communication between scientists and practitioners. [Ref. 30: pp. 1-5]

The Missoula Equipment Development Center (MEDC) identifies user needs in a number of ways including conducting surveys, maintaining servicewide contact with field specialists, meeting with advisory boards, monitoring national direction, evaluating employee suggestions, organizing ad hoc committees, and listening carefully to inquiries. "All involve field people directly or indirectly." [Ref. 31: p. 1]

Another method of need identification, now being tried in Region 5 and the Pacific Southwest Experiment Station, is to put together a technology transfer/knowledge utilization (TT/KU) team. "Team members should be at the policy making level and have a broad perspective on real-world problems. Research, NFS, and S&PF should each provide a team member. Other agencies and industry should provide policy level members, where appropriate." [Ref. 14: p. 3] A sub-team of users categorizes the problems by priorities, each rated urgent, necessary, or important. Then there is a technical group which rates the problems by technical priority. A problem with a combined scale showing a top technical rating for a user-classified urgent problem would get the highest priority for research work. This method allows users and researchers to get together on problem identification.

The above methods, while presented here as being successful in drawing out user needs, are not truly ideal because they have their drawbacks. The Research-Needs-Response Program was referred to as "a disaster -- just reams of paper" by one of our interviewees. It also can prove very time-consuming for those research personnel who have to answer the queries and the management personnel who must check the responses and conduct the follow-up activities. This problem is akin to that posed by the use of the researchers as consultants. "Researchers feel compelled to

help 'hot spot.' They are called upon as consultants and as potential expert witnesses. Their pursuit of studies that will yield badly needed definitive results becomes delayed; future technological gains are impeded. Operational personnel, on the other hand, will become frustrated if research documentation and pursuit of the scientific method delay their ability to deliver. New priorities must be frequently set and new understandings established among all concerned. The R&D manager becomes a juggler at this point; he 'fronts' for his scientists, goes out on limbs to maintain program support, and reconfigures his resources to shelter as much as possible of the slow and tedious behind-the-scenes pursuit of science." [Ref. 32: p. 4] Another reason for the problems associated with the "consultant" approach is that there are so few researchers who could be used as consultants. "There are about 1,000 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." [Ref. 13: p. 47] Difficulties with other approaches; such as the NCS SAF/University of California Cooperative Extension joint education program, the MEDC surveys, and the TT/KU utilization team; center around the relatively small number of users who are actually exposed to the solicitation-of-needs opportunities. The TT/KU teams, in fact, are composed primarily of policy-making level managers. These personnel, while perhaps familiar with

many needs, do not typify and cannot effectively represent the mass of users. SEAM's approach using Technology Transfer Specialists provides a middle-man between the user and the researcher to allow coordination, communication, priority resolution, representation of the need, and transfer of the research information. This approach does, however, add another layer to the bureaucracy, and the cost-effectiveness of establishing permanent TT specialist positions has yet to be determined.

No matter what approach has been chosen, one matter is paramount: "By establishing solid communications between developers of new technologies and the potential implementors, research efforts will have a user-oriented direction. This is essential for the implementation of results. Channels of communications are important links to the research organizations. The end-user is most likely to perceive the need to implement a new technology if he has had the opportunity to provide input to the research." [Ref. 11] "By keeping the user involved from the start, awareness, commitment, and ownership are established, thereby eliminating some of the barriers to efficient transfer." [Ref. 26: p. 5]

B. COMMUNICATION OF TECHNOLOGY

"The communication of research results between the research organization and the end-user is also likely to have an impact on technology transfer. The degree of

understanding of the results at the user level may significantly affect the chances for successful implementation. A complex technical thesis concerning the development of a herbicide is less likely to create a demand for the herbicide than simple proof that its application will indeed do what is desired of it." [Ref. 11]

"There is a buffer zone between research and user communities where a great deal of valuable information and technology stacks up and remains unused. Information that does get into the user community often does not flow smoothly within an organization or across regional or state boundaries. In addition, often no responsibility is assigned for monitoring the application of research information to insure that refinements are documented and passed along to the user audience." [Ref. 26: p. 2]

Effective transfer of research technology thus involves a three-phase process: (1) packaging, (2) transfer, and (3) application, monitoring, and follow-up. If close attention and a lot of care are not paid to each of these phases, the transfer of technology will, more than likely, be unsuccessful.

"Effective packaging covers a spectrum of skills and techniques including writing, editing, design, advertising, audiovisual, training, consultation, symposia, and workshops. Whatever medium or skills are involved, the information must

be stratified to meet the specific needs of the targeted audience. There are significant differences in the needs of the high-level administrators, mid-level staff specialists, and on-the-ground operators. Rarely does one publication meet all needs." [Ref. 26: p.8] The SEAM program conducts most of its packaging work through contract. Missoula Equipment Development Center (MEDC) hired information specialists to study their target audiences and design the packaging using various media including a wide range of publications, audiovisual materials, and other techniques. "The specialist must be aware of client capabilities to use given technology. . . . The solution technology should always be packaged to fit the environment of the client. . . . Considerable thought and planning must be given to the method and forum for transferring the technology in question. Particular attention should be given to the diversity of user groups and to the specific problem or need being addressed." [Ref. 29: p. 4] MEDC often uses field personnel to help determine the proper medium for transfer. Media which could be used as "packages" involve the following: project reports, equipment tips, user's guides, catalogs, operating manuals, flyers, brochures, handbooks, slide tapes, films, talks, demonstrations, videotapes, symposia, specifications, standards, drawings, prototypes and models, information retrieval systems, journal articles, conference proceedings, news releases, television, radio, mobile

training units, poster displays, and local on-call experts. "Often it is necessary to attract your audience first, and then move them slowly into the message. If people are 'hit' with all messages or too much message too fast, they stop and never go on. . . . Too often the concern to save a few dollars in packaging ends with a no-response attitude from the potential user. The wider the audience that you are trying to reach, the greater the amount of introductory attractive material." [Ref. 33: p. 4]

The transfer process involves selecting the right users for the material and passing the information to them. Many of the complaints which came out of the interviews relate to problems in the transfer process itself. Examples include the following: "There's too much stuff being sent out. There'd be a lot more trees out there if they'd cut some of it out," "Improvements? If you didn't have to read it all," "The supply is short -- sometimes just one copy," "I'm not sure if the info gets to the landowners," and "The problem is how do we know what's available that's important to us so we can do our job."

To insure the right people get the information, MEDC has ma[illegible]g lists of specialist-users. They also include information in retrieval systems such as WESTFORNET, Firebase, the National Technical Information Service, and the National Agricultural Library. The SEAM Program uses its Technology Transfer Specialists, who are familiar with the needs and

capabilities of the users, to facilitate the transfer of packages to users. "If the user has been brought along throughout the process, research results do not have to be force fed into the user community. The interaction between the Transfer Specialists, the scientists, and the users throughout the technology transfer process pays dividends during the transfer phase. If this interaction has been effective, the push by research will be matched by the pull from the user." [Ref. 26: p. 10]

Herbert F. Lionberger, in his book Adoption of New Ideas and Practices, identified five stages a user goes through in accepting new information and in adopting it: (1) awareness, learning about a new idea or practice; (2) interest, getting more information about the idea; (3) evaluation, trying the new concept out mentally; (4) trial, using the new idea a little; and (5) adoption, accepting the new idea in full and continuing to use it. Lionberger specifies that research has shown that information sources vary in their success of presenting the new idea depending on what stage the user is in. The most successful information sources per stage are as follows: (1) awareness -- mass media such as radio, television, poster displays, brochures, newspapers, and magazines; (2) interest -- mass media; (3) evaluation -- friends and neighbors, linking agents such as extension agents and other peer contacts; (4) trial -- friends and neighbors and other personal

contacts; and (5) adoption -- personal experience is the most important factor in continued use of an idea; but interpersonal contacts with friends and neighbors, colleagues, extension agents, or consultants help to add reinforcement. [Ref. 34: pp. 21-32] Muth and Hendee re-emphasize the importance of Lionberger's concept of interpersonal communications in technology transfer. "The need for personal contact after awareness and interest in an innovation have been generated is a well-established principle. It allows people to reassure themselves of the appropriateness, or applicability, of an innovation by providing them with needed details for implementation, previous experience with the innovation, pitfalls to be avoided, and so on. . . . It is from opinion leaders (those people most often sought out for information, opinions, or suggestions about innovations) that innovations are most effectively diffused to the rest of the social system. A key concept here is that this information flow is often a lateral one spreading across the system from opinion leaders to peers rather than vertically down through some formal hierarchy of the system." [Ref. 35: pp. 6-9] Some District Rangers may perform this role of the opinion leader, which is very similar to the role officially played by the formal position of Technology Transfer Specialist in the SEAM Program.

The diffusion or transfer of information can place a large burden on the Research branch of the Forest Service

if, as in some cases, they are held largely responsible for the transfer process from researcher to user. Large and accurate mailing lists may be very difficult to maintain. The State and Private Forestry branch, as in other cases, could be held responsible for the transfer to their constituents. Breaking the problem down still further, some state agencies such as the California Department of Forestry (CDF) receive information from the experiment stations; and coordinators in the state office are responsible for dissemination of the information further down the state forestry hierarchy. Whatever method is chosen, one thing is clear: transfer of technology is an inter/intra-agency problem which cuts across and down through all layers of bureaucracy, including the private sector. In order for any program to be successful, there must be communication, understanding of methods used and responsibilities, and a great bit of cooperation among all levels.

The final stage of the transfer process, application and monitoring and follow-up, is nearly self-explanatory; but it is not always practiced. "If research knowledge is passed along to the user with no method for monitoring its progress, a valuable opportunity is lost. Many times information is refined as it is applied by the user. However, this refinement doesn't always get passed along to other users, or if it does, the user's time is captured by explaining it to others. . . . By assigning specific responsibility for

documenting any refinements and alterations, information can be kept up-to-date and key users can share the benefits." [Ref. 26: p. 10] Technology Transfer Specialists, agency opinion leaders, extension agents, or Foresters can serve both the research and the user communities by insuring not only that the transfer of information takes place but also that the information is accepted and effectively used by the practitioner and that he is kept up-to-date and supported in his efforts toward improvement.

"Improved technology transfer in forestry will require a strategy that takes into account established principles of diffusion; such things as the characteristics of forestry innovations, characteristics of practitioners and the social systems in which they operate, and the effectiveness of various communication channels depending on the stage of acceptance. These behavioral considerations must be built into a technology transfer program which provides policy direction, identifies objectives and targets, assigns responsibility and accountability, coordinates activities, identifies staffing and funding requirements, and sets forth evaluation criteria." [Ref. 35: p. 17]

C. FEEDBACK

The final aspect of the technology transfer communication cycle involves feedback from the researcher to the user

concerning user needs and feedback from the user to the researcher concerning the technology.

Feedback to the user is accomplished most easily if the user and researcher are directly communicating about the need involved. This action may occur at symposia, conferences, etc.; or more informally during a telephone conversation. Indirect feedback can be accomplished via a third party, as through the Technology Transfer Specialist (who may offer immediate feedback as well, if he is knowledgeable about the subject matter). It can also occur through the Needs-Response system by means of a letter from the specialist assigned to answer the query or from the person calling to inform the user of the latest status of the research on his need. Feedback to the user, at the very minimum, is an acknowledgement that his need has been received by someone competent to handle it or to forward it to the proper person. Proper feedback would entail statements of the need in the user's own words and as the researcher understands it. Further feedback to the user could come in the form of instant available data to answer the need, as a report on the status of the query, directions to query another agency, or a listing of available publications to answer the need. If the need is not accepted for a research proposal, although no information presently exists to answer the need, the user should be informed of this decision. But

if research is to be conducted, then the user should be given status reports as feasible. Personal, direct feedback in the form of letters or calls may be desired; but if the user is a member of a club/society/agency, or if he is a subscriber to a forestry journal, then less personal methods could be agreed upon. The user's primary concern is that someone is listening to him.

As for feedback from the user to the researcher: "The technology transfer process should not end with its application. Once practitioners or user groups have applied the technology, they will evaluate its success in addressing a particular problem or need. A feedback mechanism responds to those who were responsible for development of the technology. This feedback may consist of simply acknowledging its usefulness, or it could indicate certain shortcomings in either the transfer methods used or any phase of application or development. In this case, the technology is continuously being improved." [Ref. 29: p. 6] The means of feedback should, for the most part, be instituted by the agency responsible for the research. It has been said that people complain loudly and praise softly. If the technology is a failure in answering a need, more than likely the researcher will hear about it from the user, whether or not an evaluation has been solicited. But if the technology is "good enough" to answer a need, then feedback will be sparse at best. In this case a survey of users by the

research unit or Technology Transfer Specialist or extension agent, etc., could serve to produce valuable feedback. Telephone calls to users or letter requests for feedback (with SASE enclosed, of course) may be effective survey methods. Other methods would include communication with users at conferences, workshops, and the like. A particularly beneficial aspect of this feedback process is that once the user feels his evaluation is desired and important, he will be more likely to offer objective and, perhaps, unsolicited feedback in the future. At any rate, the communication barrier existing between user and researcher will diminish as a result of this process.

Whatever the methods chosen, to respond with feedback to the user or to solicit his feedback about technology, they should serve to break through any previous communication barriers, to offer channels of communication which are easy to use and which do not get clogged up with red tape, to offer honest and objective feedback in a timely manner to those who can most benefit from it, and to suggest and cultivate a spirit of cooperation between user and researcher which will result in improved technology and an improved technology transfer process.

D. ADDITIONAL COMMENTS

Several aspects of communications were not heavily covered in this chapter due to emphasis on other matters

or because of exposure in previous chapters. The concept of informal versus formal communications is one such aspect. The advantages and disadvantages of both methods are familiar to most people. While the informal may be quick and easy, the formal may provide a better record for future use and may cause less misunderstanding in the long run. Interviewees stressed that proximity to local "experts" prompted the informal means, but some felt frustrated due to a lack of more formal methods to express needs or feedback. Some users were more comfortable calling specialists directly through the informal approach to talk over problems rather than using the formal information retrieval systems, while others felt the experiment stations should be putting out more research data. One interviewee suggested a national clearing house for information which would store all research results as well as user names and their needs and interests. The clearing house (computer system) would then disseminate research results to those whose needs and interests matched the information available. The choice between an informal and a formal system should be contingent on factors such as the following: identity of the users, proximity of user to researcher or Transfer Specialist, cost of method, flexibility, ease of use, desirability of records, desires of those communicating, which system works best, importance of time, and communication barriers resulting from the choice.

Obviously, the decision is no easy matter; but either method, if used properly and if constructed with the possibility of improvements in mind, can produce nearly similar results.

Appendix C is an example of a successful technology transfer effort which took into account nearly all factors of the technology transfer communications cycle presented in this chapter. It is presented separately and in toto due to its brevity and because it requires no elucidation.

VIII. CONCLUSIONS AND RECOMMENDATIONS

Attempts to effectively implement a viable technology transfer program in any organization system require the utmost emphasis in the areas of planning and coordination. Organizational structures will largely dictate the level of ease or difficulty with which these endeavors will be realized. Considering the scope of the National Forest Service's mission and the complexity of the organization's structure, the Forest Service has indeed made significant advances in promoting its technology transfer effort.

A first step in any problem-solving attempt is to define and understand the nature of the problem to be solved. Many problem areas associated with technology transfer efforts have been accurately described in the Forest Service's National Action Plan for Technology Transfer of July 1979. Areas of concern, together with proposed action plans, have been referenced in previous chapters and thus will not be reiterated here. Suffice it to say that the Action Plan appears to represent an accurate assessment of many of the technology transfer problems.

The diagnostic model referred to in Chapter II provides an excellent basis from which an examination of the measure of "fit" between organizational components can be made. As mentioned, this model represents only one of many potential

designs available. Selection of the chosen model was based primarily upon its potential to provide a system-wide view of the National Forest Service and its technology transfer effort. Application of the model and the resultant findings have been described in detail in Chapters III through VII.

An analysis of the data presented in these chapters has led to the conclusion that, of the model elements applied, Structure and Communication appear to be those which provide the greatest deterrent against maximizing technology transfer returns. Although these elements were spoken to as separate but overlapping factors in the body of the report, they will be treated together with reference to a potential recommendation, for it largely appears that structural implications directly affect the process of establishing meaningful communication networks and the two elements are thus not mutually exclusive.

In attempting to arrive at a meaningful recommendation, great consideration was given to the problems associated with organizational restructuring. This consideration largely stemmed from comments, recorded during the interview process, which supported a tendency on the part of middle management to avoid establishing additional structural elements solely for the purpose of promoting technology transfer. In fact, the prevalent attitude appeared to indicate that, at other than headquarters level, redesign efforts must be produced

which utilize existing resources. Whether this attitude is reflective of the consequences of ineffective commitment-building toward the technology transfer endeavor or representative of a keen awareness of budgetary constraints will not be speculated upon. Regardless of its source, the message rang clear that local or regional "undirected" efforts would not include additions to the existing bureaucracy.

Considering the structural organization of the Forest Service, and further considering the structure in terms of its supporting action proposals identified in the National Action Plan, there seems to be a significant gap between policy establishment plans and effective implementation. Specifically, under the present structure, it does not appear that there has been sufficient technology transfer responsibility assigned throughout the "entire" Forest Service system to insure with any reasonable accuracy that action plan implementation could take place. For example, the headquarters level houses the policy establishment managerial talent to effectively and efficiently produce the necessary guidelines for a viable technology transfer program. However, direct technology transfer responsibilities at the regional level are restricted in scope such as responsibilities associated with the (AD) positions and/or restricted in available time such as is the case with many State and Private

representatives whose technology transfer responsibilities come in the form of added assignments to primary duties. Additionally, lines of authority, to include technology transfer guidance, between headquarters and the regions are vague and represent an informal communication process. Specific technology transfer responsibilities below the regional level are, for the most part, non-existent. Thus, it would appear difficult at best to conceive of technology transfer implementation in any form which would guarantee penetration throughout the entire Forest Service system. It would therefore appear necessary, as a first step, to insure that a network exists through which policy formulation and guidance would flow and would, at the same time, provide a network for feedback and evaluation processes. Assuming acceptance of this theory, the following paragraphs will attempt to describe one potential network source, placing emphasis on avoiding the need to add to the existing structural design.

The headquarters level possesses a ready-made design from which policy formulation and goal setting can emanate. This policy-making body exists in the Technology Transfer Council (TTC) which, by virtue of its composition, possesses expertise in all areas considered essential in promoting an effective technology transfer program. These areas include and require the involvement of the National Forest System,

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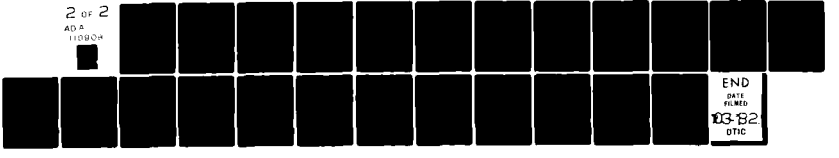

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State and Private Forestry, Administration, Research, Programs and Legislation and Controller functions (which could provide the budgetary data deemed essential in providing financial support of a workable technology transfer program). Providing assistance and support to this policy-making body is another pre-structured group known as the Central Technology Transfer Office (CTT) whose resources can be utilized to act as the policy implementation unit responsible for administering the policies formulated by the TTC and similarly serving as the direct line of authority between regional headquarters and the TTC. This structural relationship between the CTT and the TTC would be analogous to the relationship between the Chief Executive Officer (CEO) and the Board of Directors of a private sector organization.

The present composition of the TTC provides the distinct advantage of establishing a horizontal communication network which, in turn, provides a forum in which a variety of professional perspectives can be identified and evaluated on any given issue.

This structural design is viewed as essential in terms of establishing commitment toward the technology transfer effort "across" the various organizational subcomponents. The advantages of awareness, involvement, and participation which this system affords are thought to contain particular application within the lower levels of the Forest Service.

Envisioned at the regional levels of the organization would be the establishment of a similar council/committee whose composition would include essentially the same membership as that of the headquarters office. Involvement of National Forest members, State and Private representatives, research personnel and, equally important, members of the respective state forest organizations is deemed necessary. This multi-department involvement would perhaps tend to "pull together" available resources toward a common interest and render the regional council a mirror image of the headquarters organization.

In an effort to formalize the communication network, this regional council would report directly to the CTT on technology transfer matters on a predetermined schedule. Considering the logistical separation of these members in many regions, a quarterly or semi-annual reporting requirement would appear to be appropriate. Various "informal" communication links between members representing similar branches could then be established on an ad hoc basis to discuss common technology transfer related issues. More importantly, responsibilities and reporting authority would have been established.

This concept can further be applied at the forest supervisor level, again, including membership representation by components of each Forest Service branch as well as state forest and private sector representatives. Clearly, this

council would have reporting obligations to the regional council on an as-required basis. Membership on this committee would perhaps best be served on a staggered rotational basis. This would serve to insure that maximum technology transfer exposure is achieved at this critical user level.

The advantages of such a system in support of the technology transfer efforts are more far-reaching than simply the avoidance of having to establish additional positions or ceiling points. The system would further serve to provide a mechanism through which a technology transfer professional evaluation system could be formulated. The need for such a system had been discussed at various levels of the organization during the interview process. More importantly, it provides a pipeline through which information can freely flow and through which a feedback mechanism is available. This quasi-centralization of the technology transfer function should not otherwise hinder the decentralized structure of the Forest Service system in that the major or primary missions performed by council members will retain the existing structural format. It is felt that a relative degree of centralization is essential particularly in the early development stages of a new program. As the technology transfer program becomes more institutionalized and becomes an integral part of daily operations, the need for less formal intervention should

become apparent although a reliable communication/feedback mechanism should be perpetually retained.

This project offered an interesting study in both the workings of the National Forest Service as well as problems associated with the establishment of a viable technology transfer program. As with any undertaking, a need exists for frequent and continuous evaluation. It is therefore proposed that objective functional evaluations be conducted at some time in the future to determine the extent of progress being made in these endeavors.

This report would not be complete without acknowledging the members of the Forest Service without whose cooperation this report would not have been possible. Exhibiting a genuine desire to improve technology transfer in the Forest Service, their cooperation with and attitudes towards the efforts of the authors of this report are deserving of particular mention.

The authors' sincere thanks is extended to each of them.

APPENDIX A

SELECTED QUOTATIONS FROM INTERVIEWS

There's too much stuff being sent out. There'd be a lot more trees out there if they'd cut some of it out.

We get a lot of TT information from the Society of American Foresters.

Our foresters rathole 9/10 of what comes down because no one asks them for that kind of information.

The problem is how do we know what's available that's important to us so we can do our job.

The mail -- it just turns up in my basket.

We [State and Private Forestry] disseminate tons of printed literature.

WESTFORNET is acceptable, but the rest is just a papermill.

How do we communicate our research outputs? Prime method is scientific pubs, but they're not a good communicator.

We've been doing TT for 75 years or so. But it's been a hit or miss operation, trial and error. We don't know what makes it work for sure. It's monitored by seeing if the job got done; by looking at the effect on the job.

Our role [State and Private Forestry] is to take existing information and pass it on. It may require translation or repackaging. It has to be compatible with the guy who manages a sawmill.

The forester comes out of forest school and then is sent to Timbuktu. They get provincial and do not stick to their profession.

It's [TT responsibility] just one of half a dozen hats I wear.

There's a formal two-way link between region and station. But there's always a problem of getting the specialist to talk to the specialist. Need to do something at that level. Has to be a policy decision. Need top-level commitment. This has to happen at the technical level -- what must be done, what problems are most heavy.

The Deputy Regional Forester does not want to build a hierarchy for TT. We don't need a layer for this. We can use our existing structure. We're trying to put TT in a systematic way so it can fit in what we already have.

We need to develop the informal organization. . . can't do much with the formal.

The line and staff are separate for State and Private, National Forests, and Research.

The Forest Service is decentralized.

The regional foresters and directors have lots of authority.

I see the district ranger role as a linker role. Others see the link with the staff on down.

We don't have leverage in pushing TT. We sell ideas. We try to convince state foresters they need to take technology on board.

The research response system allows 30 days to respond to a question. By mail. This is a disaster -- just reams of paper. We will not do this.

I'd say 75% [of research] is done for the National Forest Service usually.

TT is a cliqueish word in the Forest Service. But they're saying we have to have a formal system. I get excited about what can be accomplished through a more formal system. We have a lot of support to improve the format. Others develop it and they use us to carry it down to the people. We have a lot who can't do this and some who've figured out by trial and error how to do it.

The expertise doesn't lie in the TT group in Washington.

The major function of CTT and TTC? I don't know. For us they perform an advisory role.

If we need tech help, we can turn to them [CTT]. We are not in contact with them. It's politics. Washington and [the region] each set up their own forts.

We are funded only up to 10-25% for the research that we feel is necessary. Hard to communicate this at the forest level to a scientist who is in the middle of his research. Hard decisions have to be made about what to fund due to lack of funds and people, also politics. We also look at what is the likelihood of success.

We get asked to do studies and the studies get filed; and five years later, they ask us to do it again.

I have the need to know what's going on. I don't have time to read it all.

The questions are how do we get the TT information and how do we assimilate it.

The Sacramento program coordinator makes sure we get the information that he feels pertains to us.

Lots of technology is sitting on the shelves with dust on it.

If the scientist knows his findings are being applied, he generally tracks it. Usually there's an informal communication line between the scientist and the first two users.

The Washington State and Private is all staff, all advisors. Our role is input to them. We don't take orders from them. We get on the phone and chew the fat. They have no control over us.

We have a job, to transfer technology. . . . All the knowledge in the world is not in Mecca. We turn to wherever the sources of knowledge happen to be. Proximity plays a big role in this.

If the product or research doesn't work, someone complains. It's generally easier to get feedback up than ideas down.

The grapevine in the Forest Service is good.

Paul Bunyan and the esprit de corps of the foresters hurts us.

Failures get better feedback.

I refer people to some of the experts.

We put on work shops, seminars, or short courses. We overlap with the extension service. This is mass communications for them, where ours [State and Private Forestry] is more one to one. But this is a gray area.

We need a clearing house for all levels of government for all the information.

But the supply is short -- sometimes just one copy. If it's marginally useful, I stick it away on my shelf. I'm not sure if the info gets to the landowners. Among the

pressures of business, I may not get around to ordering more even if I think some of our foresters need them.

The staff supervisor office in the Regional office comes up with stuff that may be important to us and sends us a memo. This is an informal mechanism. We are trying to stop the enormous mailing.

The state of California has a coordinator for [seminars and workshops]. He searches out needs from the Society of American Foresters and the U.S. Forest Service, and he finds experts in the areas to talk. The beauty part of these conferences is the open discussion. But we get down to the real nut-cutting in the bar.

We [State and Private Forestry] seldom get credit for things that are done. The state forester and cooperative extension get all the credit. Our measure is that the tech gets transferred. Theirs is the number of people at workshops or the number of sessions held.

The key word is cooperation.

I don't buy the idea that we must answer each problem of each forester. They expect us to act like scientists, professional. It is the foresters' job to solve their problems on the ground. I demand the ultimate user produce some of his own technology.

If it's a unique opportunity, then we [State and Private Forestry] consider it a challenge; and we try to figure out how to do it. But it is the state forester who comes up with the need or the idea. This is our method. If they have a need, we look for a cure; we may already have it on the shelf. If not, we look for a new cure.

Because of the opportunities for TT and utilization of resources, I feel I can't be bogged down by politics.

Washington doesn't worry about "need." If we have the tech, then they say we ought to sell it. We go on the basis of need. They market it.

In some cases we produce technology which is ready as a package to solve problems. But most is basic knowledge that must be blended to solve real world problems.

Researchers don't often know the foresters' problems.

We are exposed to "pull" [in Research] almost constantly.

One prerequisite [for prioritizing research] is that we already know a lot about it.

We need to coordinate the Washington office. One is push, and the other is pull.

Researchers in the expert role get the "Messiah effect."

Research in all cases does not develop technology, and shouldn't.

They [CTT] set up as a staff group which was supposed to give management leadership. The influence of this office on all else is limited.

Need to encourage development of technology from knowledge. Private firms pay people to take knowledge and develop technology. Federal government doesn't do this. We can't do this in Research.

Some scientists like to follow their own hobby horses, whether it answers a need or not.

We try to make it application-oriented, but we do research that is innovative in science as well.

We have a good system to get things transferred and a hell of a good market approach. My role is to keep this up and not let the system get too formalized as long as it is still working and not let the guys butt heads.

I'm satisfied with it [WESTFORNET]. 50% of the staff officers review it and 50% of these get stuff out of there monthly.

We find it better to go to the source than to use WESTFORNET. It's a little cumbersome.

There's a need on the part of the Forest Service admin and the experiment station to do two-way communications. We meet some of them at the conferences and this is real beneficial.

We keep trying to get landowner lists. There's a contract to get this.

I feel PSW should be getting more out than they are. They should get more out than what they're doing. A lot of research is basic, and this doesn't get it to the ground at all. It's not applied enough.

What's important to the experiment station may not be important to us.

If they closed PSW or the whole experiment station, things wouldn't change much, and it'd be years before I noticed.

The expert people are more important than the pubs. I've used the experts and send people up to them. This is a form of TT, but it's not the printed form. I get a lot out of just having an available expert.

Basic research may not be meant to come to ground level.

If I can remember the stuff I've got, then when a problem comes up, I use it.

I don't have any input to this process [need identification]. They never ask me, so I feel frustrated. The Service Foresters feel the same. They may have a problem, but nobody ever asks them from the board.

Have the researchers work out of the district office. The researchers don't know the sociological constraints coming down on the district. And it gives our people a chance to meet the researchers and see that they are human.

[The most significant problem regarding the TT effort] Communications. We do a good job in state-of-the-art and scientific pubs. But getting across to management is tough. They don't want those below them to know more than them.

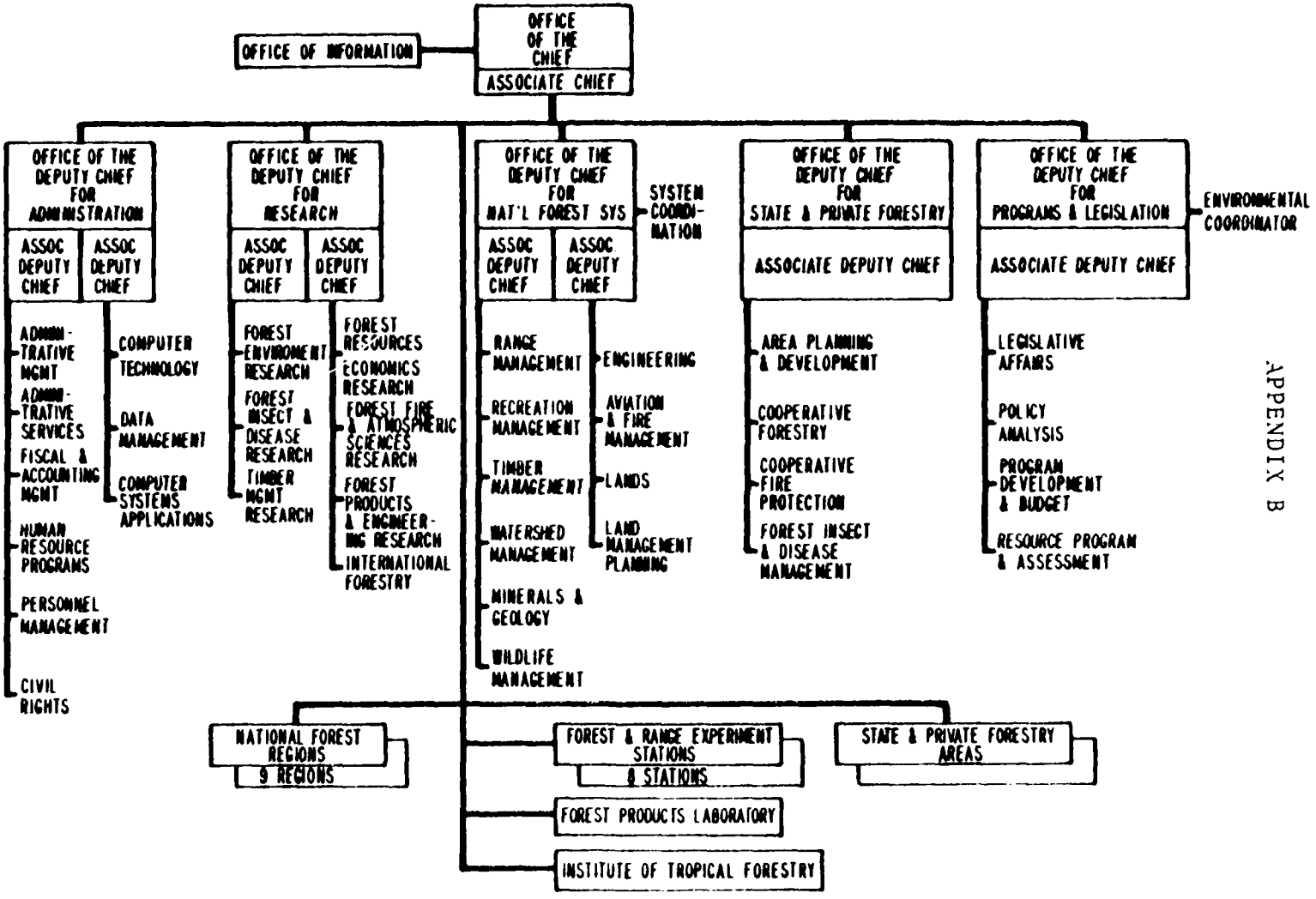
[Improvements] If you didn't have to read it all.

[Improvements] Be able to attend more seminars and workshops. The younger professionals want to go but can't spend their own money and their own time. Our travel limitations make it tough.

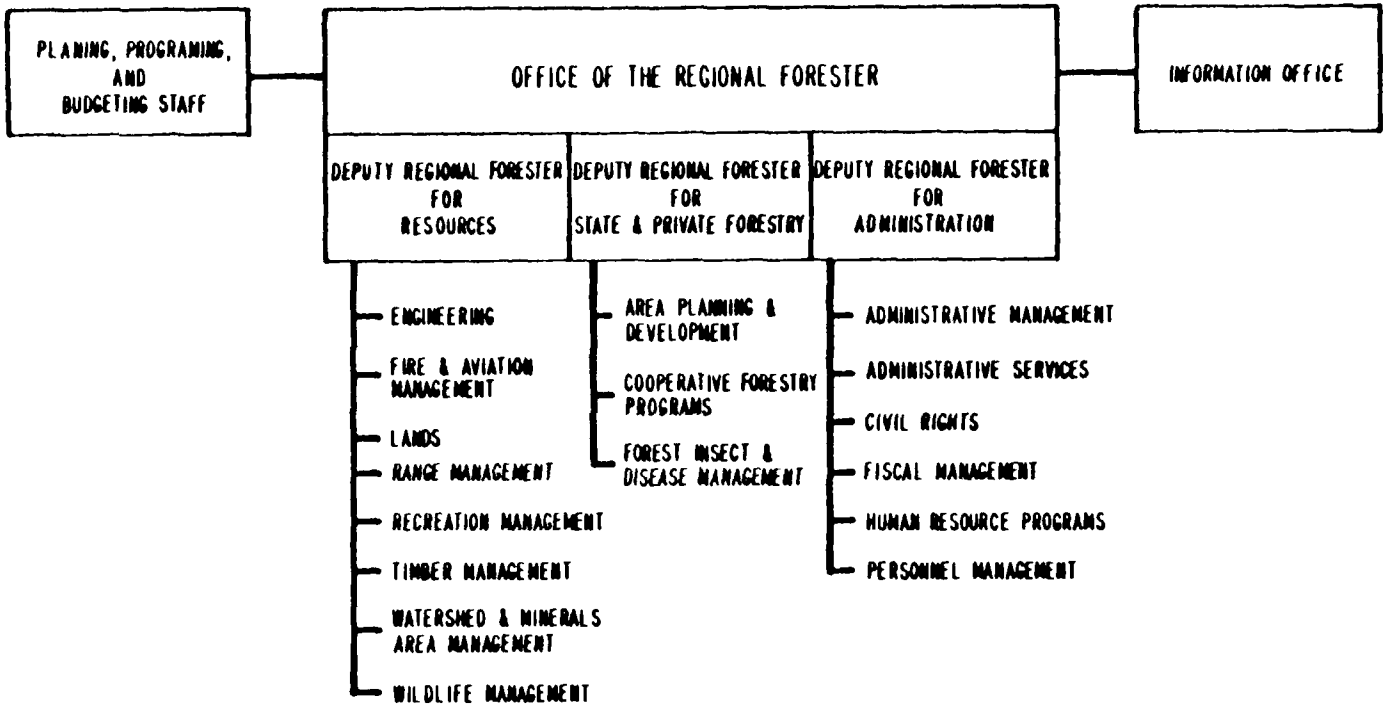
[Problems in Research] Don't have people who know the problem well enough to solve it. This is close to the communication problem.

The TT is there, but you can't shove it at them. They have to want it.

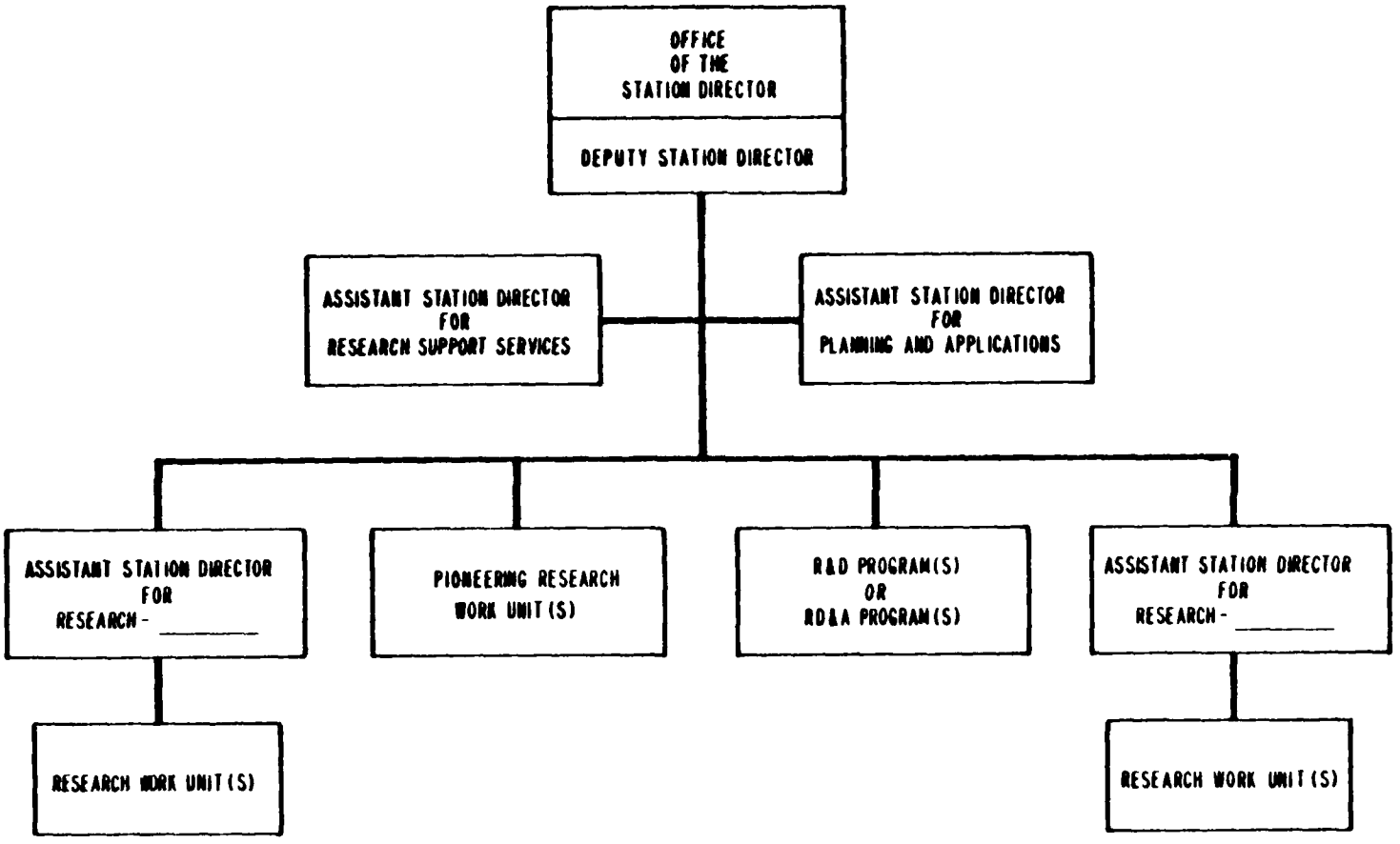
FOREST SERVICE (Overall) ORGANIZATION CHART



TYPICAL REGIONAL CHART



TYPICAL STATION CHART



APPENDIX C

INCENTIVE SYSTEM FOR LITTER CONTROL -- LATERAL DIFFUSION AMONG NATIONAL FOREST PERSONNEL

Pacific Northwest Station recreation researchers developed an incentive system for litter control in campgrounds and wilderness backcountry. The system was developed with and for Forest Service land managers, and it has received wide acceptance and use in-Service and outside.

The technology transfer process working in this research and implementation effort can be properly characterized as "integrated." Integration of technology transfer mechanisms into this project from its inception is considered a key element in bringing about the successful conclusion of the research and widespread implementation of the litter control system. A basic premise in this is that integrated technology transfer assures relevance of the research to the user's (manager's) needs and makes the user a partner in the effort. Built-in commitment becomes a powerful ally in achieving successful implementation.

Research Phase -- Interaction with the user group had been an ongoing activity and somewhat naturally brought about the managers' initial involvement in this project -- identifying the research need. Problem identification resulted from research-manager consultations, formal and informal meeting exchanges, and review of the draft problem analysis. This input was important in establishing priorities and predicting time frames for actions and expected accomplishments.

On-the-ground land managers were deliberately involved in designing and conducting the research to get their understanding, cooperation, and feedback. Their involvement helped the researchers' understanding of both the real problem and any policy or procedural limitations that would affect the design or conduct of the study. Managers' participation in the research ranged from passive support, e.g., protecting the study site, to very active support, e.g., collecting data -- acting as research assistants.

Prepared by Eldon M. Estep, Assistant Director for Planning and Applications, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon, to accompany poster presentation at National Technology Transfer Workshop, Tucson, Arizona, February 12-15, 1979.

The research results were reported in the usual formal means, journals and Station publications. In addition, a concerted reporting program was carried out to directly inform land managers of the results. Briefings to reach several levels of NFS land managers were initiated by both researchers and managers. There were staff meeting presentations, workshops, and field demonstrations, which were supplemented by a quick-and-dirty slide-tape and an 8 mm movie. In these reporting sessions, the managers' interest helped identify potential early adopters.

Development Phase -- Procedural guidelines on how to make the system work were formulated. These were cooperatively tested in administrative studies, evaluated, and revised in an iterative process. Early adopters tried the litter control procedure with researchers' help and on their own, providing direct and indirect opportunities for researchers to find out how the research product was being used and how it was working. Feedback on problems and successes was indispensable in adjusting the litter control procedure until it worked.

Implementation Phase -- Implementation results more easily from a "pull" than a "push." At the completion of the R&D, the integrated technology transfer approach meant the researchers were in a "responding" rather than a "selling" role. This both directed and eased the researchers' approaches to communicating, demonstrating, and consulting about the results of their research.

Publication of a "how to" brochure and development of an improved slide-tape were key steps toward getting widespread use of the litter control system without direct interaction of a researcher with every user. So, too, were workshops held to train those who would use the system and also train others to use it. The brochure was given wide distribution from PNW. Placement of the slide-tape at Oregon State University's Forestry Media Center has assured its continued availability for purchase or rental. Standard public information releases of the Station and OSU advertised these items.

While some consultation service concerning his work benefits the researcher, responding to too many consultation requests generated by a success can be deadly. A ready-made cadre of informed substitute consultants resulted from the close researcher-user interaction prevalent throughout the project. Referral to early adopters and other cooperators of requests for consultation significantly lessened impacts on the researchers. Perhaps more important, potential

users heard the litter control message from their peers who could speak convincingly from personal experience.

With slight differences, researchers in this PNW Station group have used the integrated technology transfer approach to successfully develop and implement CODINVOLVE and CODE-A-SITE, respectively, systems for handling public output to resource decisions and inventory of dispersed recreational sites.

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