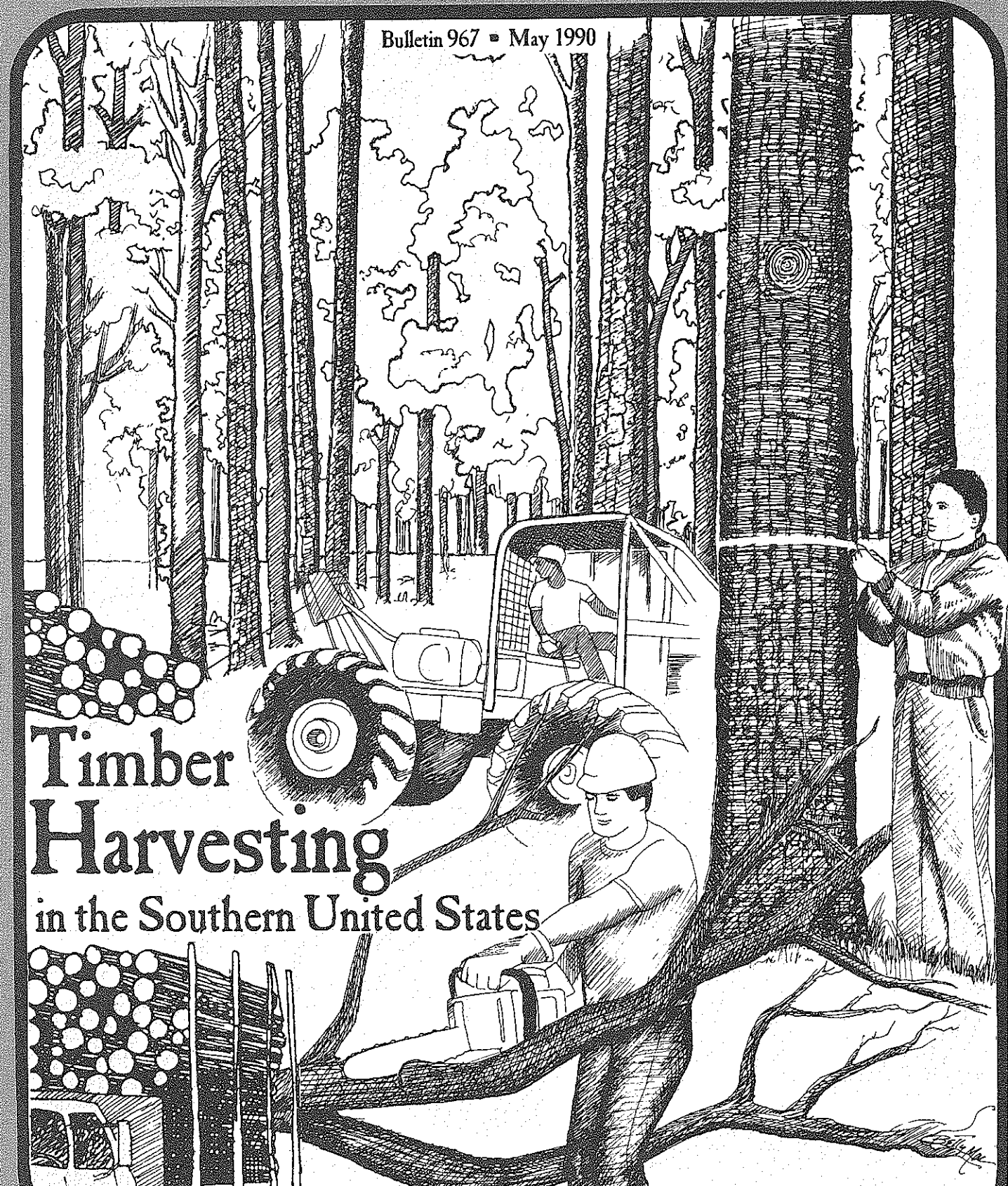


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Timber Harvesting

in the Southern United States

A Sociological Analysis and Research Proposal

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Preface

Until recently, sociology and forestry were considered to be the academic equivalents of oil and water. It is only within the last two or three decades that genuine interdisciplinary research, teaching, and extension endeavors have become institutionalized in universities, research centers, and government agencies. Still, as documented in this bulletin, there is much room for expansion of such endeavors.

Mississippi State University is one of the pioneers in the melding of sociology and forestry. Cooperative research between the Social Science Research Center and the U.S. Department of Agriculture Forest Service has continued uninterrupted since its beginnings in the early 1960's. Faculty from the Departments of Forestry and Sociology have worked together on several research projects and shared the podium in numerous classes.

The assessment of social science research needs in the southern timber harvesting industry reported in this bulletin was conceived and funded by the Forest Products Utilization Laboratory at Mississippi State University under the directorship of Dr. Warren S. Thompson. The Department of Forestry, through its affiliation with the Mississippi Agricultural and Forestry Experiment Station, administered the project and provided general direction. Dr. Douglas P. Richards, Department Head, and Professor William F. Watson

participated throughout the assessment by offering their expertise and ideas and acting as sounding boards as the project progressed.

While it is impractical to name all the people in the harvesting industry who contributed to this assessment, three who made significant contributions of their time, experience, and knowledge must be acknowledged: Kenneth S. Rolston, Jr., James A. Altman, and Douglas W. Domenech, all with the American Pulpwood Association. Without their help, this assessment would have been significantly more difficult if not impossible. Dr. Arthur G. Cosby, Director of the Social Science Research Center, and Professor A. W. Baird provided valuable support and consultation from the social science perspective.

This publication is the report of an effort to critically examine timber harvesting in the South from a social science perspective. From the outset, the intent was to provide the industry with information that could be used to help solve some of its problems. Hopefully, the report will be the impetus for a renewed research, development, and application effort in the industry and not simply a dust-gathering curiosity on a few bookshelves.

Larry Doolittle

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Executive Summary

The pivotal position of harvesting in the timber management-marketing-manufacturing process is not matched by the effort devoted to timber harvesting research and development. A group of timber industry consultants recently recommended a 10-year, \$13,950,000 research program for the southern harvesting industry alone. (Silversides et al., 1988). One high priority problem area identified by this group was the sociological aspects of harvesting labor. In an effort to more sharply define social science research needs and recommend a research program, an analysis of the southern timber harvesting industry was performed from a sociological perspective. The analysis had four objectives:

- (1) document the current state of knowledge about the human behavior aspects of timber harvesting;
- (2) identify the nature and relative importance of harvesting problems that are amenable to social science based solutions;
- (3) identify the specific specializations within the social science disciplines that should be applied to the various harvesting problems; and
- (4) develop a plan for a social science based research program to solve the problems.

Review of the timber harvesting research literature produced little evidence of social science research activity, particularly in the United States. After a promising start by the Battelle Institute and the American Pulpwood Association Harvesting Research Project in the 1960's, social scientists have been almost totally inactive in this subject area. A few investigations of woods worker selection, training, and motivation have been conducted, but the knowledge base pertaining to these aspects of harvesting behavior remains very small.

More progress has been reported outside the United States, especially in Sweden and Finland. Among the accomplishments in those countries are studies of job satisfaction, psychological responses to the work environment, the effects of crew organization on productivity, and work system designs. Whether or not results of these studies are applicable in the U.S. South could be determined only by their replication.

Perusal of the general timber harvesting literature and personal contacts with industry representatives led to the identification of five problem areas that should be the subject of social science research over a 10-year period:

- (1) **Individual Workers** — Most behavioral research has focused upon individual woods workers, but the effect of selection, training, and motivation efforts upon individual responses, such as productivity, absenteeism,

efficiency, and accidents, has not been systematically evaluated. Also, studies of worker satisfaction, psychological stress, psychological profiles, and leadership traits are needed. Estimated manpower and funding for research in this area are 3 scientist years and \$450,000.

- (2) **Harvesting Crews** — Group-level variables like norms, values, goals, and interaction patterns should be included as independent variables in evaluation studies. Case studies of the effects of crew organization and operations upon output also are needed. Estimated manpower and funding for this research are 2 scientist years and \$300,000.

- (3) **The Harvesting Labor Force** — The biggest need in this area is for documentation of labor force characteristics. Periodic surveys can help answer questions about labor sources, qualifications, mobility, turnover, accidents, and other issues as well as provide a basis for trend analysis and projections. Estimated manpower and funding requirements are 1 scientist year and \$150,000.

- (4) **Structure and Organization of the Harvesting Industry** — Case studies of producer-buyer relationships are needed to determine if there are system variables in the harvesting industry that influence various outcomes. Also, major changes in the structure of the industry, such as the formation of cooperatives or associations, should be documented and evaluated. Estimated manpower and funding are 3 scientist years and \$450,000.

- (5) **Societal Influences** — Many of the issues facing the southern harvesting industry originate from concerns within the social environment. Macro-level analyses are needed to determine the impact of laws, politics, economic conditions, ecological concerns, and other societal influences upon the harvesting industry. Manpower and funding requirements are estimated to be 1 scientist year and \$150,000.

The conceptual framework that seems best suited for providing general direction for the proposed research program is that of the open organizational social system. A wide array of social scientists have participated in organizational research and contributed to an interdisciplinary theory of organizations. Consequently, the literature contains numerous examples of studies focused upon units of analysis from individuals to interorganizational relations. Viewing the harvesting industry as an open system is compatible with the interaction with other social systems and with its general social environment that characterizes the industry. Approached from the open system perspective, the proposed

research program has the potential for making significant contributions to the solution of many of the industry's human behavior related problems.

Implementing the recommended research program will require 10 scientist years and \$1.5 million over a 10-year period. Since timber harvesting research efforts in this country have been hampered by a lack of coordination and direction, it is recommended that an appropriately trained social scientist be placed in a university or government research organiza-

tion to direct and coordinate the program. Among this scientist's responsibilities would be interpretation and application of social science research results for timber harvesting problems; identification of specific research needs and referral of those needs to appropriate specialists for study; consultation to the industry on matters such as training development and evaluation, motivation efforts, crew organization, and accident prevention; and working with technology transfer agencies to assure that research results are disseminated.



Very little data about the logging labor force is systematically collected. Other areas needing attention by social scientists include individual workers, harvesting crews, structure and organization of the industry, and societal influences.

Timber Harvesting in the Southern United States

A Sociological Analysis and Research Proposal

Larry Doolittle

Introduction

Timber harvesting occupies a pivotal position in the conversion of standing timber into consumable wood products. In the southern United States,¹ the focal region for this analysis, an estimated 7.5 billion cubic feet of timber valued at \$6.1 billion were harvested in 1984 (USDA Forest Service, 1988). In 1987, there were more than 5,600 business establishments engaged in logging; these firms employed nearly 38,000 people and had an annual payroll of almost \$522 million (U.S. Department of Commerce Bureau of the Census, 1989).

In spite of the essential nature of timber harvesting, some observers have noted that it is not accorded equal status with either forest production (timber management) or wood processing (Knight, 1985; Shell, 1988b). The impetus for the analysis reported in this document emerged from concern about the disparity in the research resources committed to timber harvesting compared to other forestry subject areas concerned with growing, protecting, and inventorying trees. In 1985, \$973,900 and 8.95 scientist years were expended for forest equipment and engineering research in the southern United States (Southern Industrial Forestry Research Council, 1986). These figures were 2.4 percent and 2.9 percent of total expenditures of dollars and scientist years, respectively — the smallest proportions of any of the five subject areas under which research was classified. As an initial step toward rectifying the research inequity, the School of Forest Resources at Mississippi State University sponsored the development of a plan for timber harvesting research in the southern United States. The resulting document (Silversides et al., 1988) identifies research needs in six problem areas and prescribes the manpower and funding requirements for implementing the research program. Under the general problem area of "Labor," a need for sociological research is

specified and assigned a high priority. Since there has been virtually no involvement by sociologists in timber harvesting research, and since this is an academic discipline not usually associated with forestry or forest operations, further assessment of the need for sociological (or, more broadly, social science) research was deemed appropriate. Consequently, this paper reports the results of an analysis of the southern timber harvesting industry from a social science perspective.

Objectives and Procedures

The objectives of this analysis were to:

- (1) Document the current state of knowledge about the human behavior aspects of timber harvesting.
- (2) Identify the nature and relative importance of harvesting problems that are amenable to social science based solutions.
- (3) Identify the specific specializations within the social science disciplines that should be applied to the various harvesting problems.
- (4) Develop a plan for a social science based research program to solve the problems.

The general procedures that were employed to meet these objectives were:

- (1) Conduct an extensive search and review of the literature pertaining to the behavioral aspects of timber harvesting.
- (2) Contact representatives of the harvesting and wood procuring industries and scientists studying other, non-behavioral dimensions of harvesting in an effort to construct a composite account of the problems in harvesting that are behavioral in nature.
- (3) Consult social scientists representing the range of specializations that may be appropriate for addressing the problems.
- (4) Document the analysis and propose a program of research.

¹Includes the states of Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia.

Current State of Knowledge

At the 39th Industrial Forestry Seminar at Yale University in 1974, one of the participants began his presentation as follows: "The study of human factors in logging productivity is still in its infancy. There is almost no published research on this topic in North American logging literature. European work is somewhat farther advanced, but we do not know whether their results are directly applicable here" (Cottell, 1975). Even though research needs were specified and a research program proposed at this same conference (Bond, 1975), a search of the timber harvesting research literature revealed that little progress has been made in the ensuing years. Contributions to the understanding of human behavior as it relates to timber harvesting have been fragmentary, uncoordinated, and widely dispersed, both geographically and conceptually. The resultant literature is elusive; it does not emerge as an entity from either electronic or manual searches. A great many of the titles are in hard-to-locate proceedings, unpublished reports, and foreign journals that often are considered too specialized to be purchased by libraries. A significant volume of the information that does emerge turns out to be empirically based, not scientifically derived, and there is no discernible social science theory or conceptual framework that has guided the scientific undertaking.

In the review that follows, explicit rules for inclusion/exclusion of materials were not set. As near as possible, the included material reported results of systematic inquiry, not isolated incidents, opinion, or "experience," and the inquiry (study, experiment, survey, etc.) was conducted in a timber harvesting setting. Since the ultimate objective of this review is to contribute to the identification of researchable problems, emphasis was placed upon American literature, scant as it is. Literature from other countries is presented primarily as a basis for comparison to help answer the question of what kind of social science investigations should be considered for initiation in the South.

Research in the United States

Studies of human behavior in the U.S. timber harvesting industry have concentrated upon the issue of how to increase productivity. In a harvesting operation, production is a function of two sets of factors — physical and nonphysical (Warren and Raburn, 1975). Physical factors include the machines used, the timber being harvested, the terrain, and the weather. The nonphysical factors are the people who work in the industry. Therefore, raising productivity can be accomplished by introducing new and larger machines or by improving work methods. However, "...perhaps the cheapest and most effective [way to increase production]... involves motivating each man to his highest potential" (Warren and Raburn, 1975). This conceptualization of the production function was evident from the beginning of social science activity in the timber harvesting arena and has continued to play the lead role in

the design and conduct of "human factors" research that has been conducted in this country. Early examples are the Battelle Memorial Institute study from 1960 to 1963 and the American Pulpwood Association Harvesting Research Project from 1967 to 1973.

The Battelle Study — Wood shortages in 1955 and 1959 prompted the southern pulp and paper industry to try to determine why the shortages occurred and how to avoid them in the future. An interdisciplinary research team that included psychologists conducted a comprehensive investigation of the entire pulpwood procurement system, focusing upon the factors affecting production. They found that while production was indeed influenced by site conditions, a factor labeled "crew aggressiveness" was the most important determinant of variations in production (Hamilton, 1963). Crew aggressiveness was defined in terms of a number of factors relating to the producer, the crew, and the work environment (Hamilton and Stock, 1962). Results of these studies led the American Pulpwood Association to initiate a research project with the central purpose of identifying human traits associated with high pulpwood production (Warren and Raburn, 1975).

The Harvesting Research Project — Funded by grants from six wood products companies (later expanded to 15) the Harvesting Research Project (HRP) was initiated in 1967 and headquartered in Atlanta, Georgia (Walbridge, 1972). Though HRP had objectives other than finding ways to increase productivity,² it is best remembered for those activities and products. While collecting data about pulpwood crew production, it became obvious that production levels between crews fluctuated even when variables like crew size, equipment, logging site conditions, etc. were identical (Kinne, 1989). Industrial psychologists from the Georgia Institute of Technology were enlisted to investigate this discovery; one, Gary P. Latham, eventually was employed by HRP.

The ultimate purpose of the research conducted by Latham and other psychologists was to develop job performance criteria for the evaluation of independent pulpwood producers in the southern United States (Latham, 1971a). In an effort to determine how successful and unsuccessful producers differed, the researchers first operationally defined "success" in terms of productivity, turnover, absenteeism, and injuries. Then they sorted through a wide array of independent variables, such as the producer's attitude toward his employees, managerial ability, supervisory methods, age, education, experience, marital status, terrain, and equipment (Ronan and Latham, 1969 and 1970). The only important factor to emerge from this analysis was the "producer-worker relationship"; *viz.*, effective producers stayed on the job site, set production goals, gave instructions and explanations, kept tools and equipment in good condition, provided training,

²According to one of the company advisors to HRP, original objectives were to develop production tables for pulpwood crews and to develop a new harvesting machine (Kinne, 1989).

and "treated their employees as human beings as opposed to objects" (Latham, 1971a). Building upon this finding, the HRP scientists developed an inventory of producer behaviors that were correlated with productivity, turnover, absenteeism, and injuries; ultimately these behaviors were collected into a performance assessment device that pulpwood dealers and company foresters could use in the field to evaluate a producer (Latham, 1971b and 1971c).

In a related but separate analysis, Latham and Kinne investigated the motivations of pulpwood harvesters. After concluding that existing theories of motivation were "inadequate, inapplicable, and/or infeasible" for pulpwood harvesting, the researchers hit upon goal setting as the key to increased production (Latham and Kinne, 1971). However, setting production goals for individual crew members increased productivity only in those crews already found to be "effective"; and, while production goals seemed to lower absenteeism, they had no measurable effect upon turnover or injuries (Latham and Kinne, 1971).

Other social scientists, including a sociologist and an anthropologist, were involved in studies for HRP (Ronan et al., 1970; Bailey and Kim, 1971). These investigations dealt with other aspects of the pulpwood harvesting industry's "labor problem," like sources, qualifications, selection processes, and occupational prestige. In 1973, the HRP was terminated. However, its influence can be detected in subsequent investigations of human behavior factors affecting wood production. Since the days of HRP, behavioral research has focused upon selection, training, and motivation of loggers.

Selection, Training, and Motivation Research — Since cessation of the Battelle and HRP activities, research in the human behavior aspects of timber harvesting has been concentrated more in the Pacific Northwest than in the South (where it originated) and it has been carried out primarily by engineers rather than social scientists.

The screening and selection of loggers has received little attention by research in this country even though there is a pronounced absence of objectivity in these processes (Garland, 1986; Schuh and Kellogg, 1988; Stevenson, 1988). According to Garland (1984), some selection procedures have been validated, but most are either unpublished or proprietary. There is no indication that objective screening procedures, where they do exist, have been subjected to rigorous evaluation.

Training has received more attention by the harvesting industry than either selection or motivation. Most of the formal training activity originates in either academic institutions or trade associations, like the American Pulpwood Association (APA). Perusal of the literature indicates that the most popular subjects for formal training are safety and business management; there are very few references to *formal* training for equipment operation or maintenance or for personnel management and supervision (Garland, 1984; Schuh and Kellogg, 1988; Stevenson, 1988; Garland, 1979). A recent survey of training needs in the Northeast revealed that 81 percent of the respondents felt that employees should have for-

mal training prior to employment but only 34 percent had even an introductory orientation program for new hires (APA, 1986a). Chain saw operators and skidder operators were the jobs with the greatest need for training according to this survey; however, the *area* of greatest training need was safety.

One account of an attempt to experimentally evaluate a training program was found in the literature, and a second evaluation effort is currently being made. Garland examined the short-term and long-term effects of training for chokersetters in Oregon (Garland, 1982). Evaluative criteria in this experiment included time saved (and, in turn, cost reduction), job leaving, and training cost. Initially there was little difference between the experimental and control groups in performance. During the middle of the experiment, which ran for 6 weeks, the experimental group's performance improved significantly. At the end of the experiment, the control group's performance nearly matched that of the experimental group. The researcher concluded that "the value of training is in the improved learning of the trained group over the group learning on the job."

A second attempt to evaluate a training activity has been conducted in the Southeast (Garland, 1989). This effort employed a before-after case study design, but did not include the experimental controls utilized in the chokersetter study. Published results of this evaluation are not available, but one of the participants described the outcome as "disappointing" (Rolston, 1989).

The high accident rate in logging is a well-documented fact that has received attention in the popular press (Phillips, 1988; Ubell, 1989). In spite of the concern about logging safety in the industry and the emphasis it receives as a subject for training, studies of logging accidents and safety measures are rare. In preparing a background paper for a recent workshop on logging safety, Garland (1988) found only two recent studies of logging accidents "...worthy of mention." An early exploratory study of risk assessment by chain saw operators found little correlation between operators' estimates of risk and actual risk as reflected by accident rates (Dunn, 1972). Later, Mason (1977), in a British Columbia study, found a low correlation between method of payment and accident frequency; however, pieceworkers suffered more severe accidents than salaried workers.

No discussion of logging accidents and safety training is complete without some reference to the subject of insurance, particularly workers' compensation where rates in the timber harvesting industry reach 50-60 percent of payroll in some southern states (Silversides et al., 1988; APA, 1987). The workers' compensation issue receives a lot of attention in the industry (Stevenson 1989), but very little from research. A project is currently underway at Virginia Polytechnic Institute's (VPI) Industrial Forestry Operations Research Center, where investigators are examining the workers' compensation issue in an effort to develop workable solutions to the problems of "slippage,"³ insurance rate determination bases, and the absence of physical screening programs for new employees (Wilson, 1988). According to the principal in-

investigator, this effort is greatly hampered by the lack of reliable data on accidents in the harvesting industry (Stuart, 1989).

Interest in improving the managerial and supervisory skills of wood producers goes back at least to the results of the HRP research. Most extension harvesting specialists in the South include management and/or supervision in their training activities (Brinker, 1989; Deal, 1989; Shaffer, 1989). However, once research established that supervision was an important variable in the production equation, there is no evidence of any subsequent activity directed at training development or evaluation.

The timber harvesting industry has been asking social scientists how to motivate loggers to produce more wood for nearly 30 years (Mayo, 1962; Santopolo, 1962). Incentives ranging from paying bonuses in trading stamps (Altman, 1989) to providing alcohol on the job (Latham, 1989) have been proposed. The landmark research on this subject performed by the HRP has already been reviewed in this report, and there is little work to cite since the producer behavior inventories were developed. Olsen (1988) recently analyzed the performance of five incentive systems for loggers by applying them to a hypothetical yarding operation. He found that each system had its advantages and disadvantages and concluded that if workers are production oriented and the incentive system is well managed, the effects are mostly positive. Even though production gains as high as 39 percent have been documented (Michie, 1983), Garland (1986) concluded that a lack of reliable information about incentive systems hampers their widespread adoption and use in the industry.

Ergonomic and "Human Factors" Research — "Ergonomics is concerned with assuring that machines, task operations, and work environments are designed so that they match human capacities and limitations" (Smith and Sirois, 1982a). In their review of the ergonomic literature as it relates to southern timber harvesting, Smith and Sirois placed the research in this area under five general topics: (1) equipment design and maintenance, (2) work physiology, (3) heat stress, (4) vibration and noise stress, and (5) safety. The authors, both engineers, did not review research on "... other areas of human performance... in forest harvesting," such as operator selection and training and psychological stress. Even with those stated restrictions, Smith and Sirois point out that while considerable work in ergonomics has been done in other countries only very limited work has been published by American researchers.

There is evidence that operator safety is a matter of concern to equipment design engineers, as the topic is often discussed at meetings of the American Society of Agricultural

Engineers, which has a forest engineering section. Two members of this society recently examined psychological theories concerning the development, analysis, and modification of human behavior and attempted to relate these explanations to an understanding of the effectiveness of safety training (Aherin and Murphy, 1987). These authors concluded that "... normal human behavior is often unsafe and to be expected." Consequently, "... training humans to practice safe behaviors for the purpose of reducing accidents is the most difficult of any accident prevention measure." No research or development effort was proposed.

The timber harvesting literature contains several references to "human factors" in harvesting (Duncan, 1987). In a presentation to the Human Factors Society, Smith and Sirois (1982b) also reviewed this area of research as it might apply to forest harvesting. As in the case of ergonomic research, there is very little social science based work in this general area, particularly in the United States. Smith and Sirois cited only two studies (Dunn, 1972; Mason, 1977), both of which were described in the section on worker safety in this paper.

Research Outside the United States

In their review of human factors and ergonomics research in forest harvesting, Smith and Sirois (1982a and 1982b) observed that "the countries in which human factors specialists have been most active in forest harvesting research include Sweden, Finland, Norway, Germany, Czechoslovakia, Canada, England, and Japan." The reasons for this disparity between the United States and other developed, forested countries is not at issue here. Neither is it important, for purposes of this paper, to review the specific content of relevant research from around the world — results may or may not be applicable in the U.S. harvesting industry, particularly in the South. Instead, this review will focus upon what scientists from other countries have done in this area that has not been done in the United States. This information will be used later as input for a recommended social science research program in the southern harvesting industry.

At an International Union of Forestry Research Organizations (IUFRO) Congress in 1976, a seminar about psychological and social aspects of forest work was proposed. Organized by the Work Environment Group at the Department of Operational Efficiency, Swedish University of Agricultural Sciences, the seminar was held at Garpenberg, Sweden, in September, 1980. All of the countries (except Japan) mentioned by Smith and Sirois (1982a) were represented by the 27 attendees; no one from the United States attended. The 20 papers presented at the seminar were representative of research on human behavior as it relates to timber harvesting; they were organized into nine "problem areas" (Ager, 1980a)⁴:

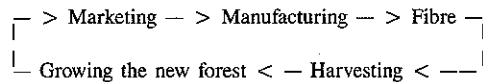
- (1) Mental workload (3 papers).
- (2) Psychological and social qualities of forest work (4 papers).

³Slippage is the term applied to the failure of some loggers to fully report wood production, which is used as a basis for setting insurance rates for pulpwood producers (industrial category 2705); consequently the cost of insurance is spread over a smaller base than it should be with the result of higher rates per producer (Wilson, 1988).

- (3) Work organization (4 papers).
- (4) Work supervision (1 paper).
- (5) Work system design (5 papers).
- (6) Selection of individuals for work (1 paper).
- (7) Reward systems (1 paper).
- (8) Workers participation in planning and control (1 paper).
- (9) Research methods (separate workshop).

By way of comparison, the U.S. Forest Products Research Society and the Canadian Pulp and Paper Association co-sponsored a conference at about the same time entitled *“People and Productivity: Keys to a Successful Harvesting Operation”* (Robertson and White, 1984). The 19 papers presented at that conference were organized into four sessions:

- (1) Organizing people and machines to optimize productivity in harvesting.
- (2) Training and development: people make the system work.
- (3) Emerging technologies in harvesting, transportation, and merchandizing.
- (4) Closing the circle:



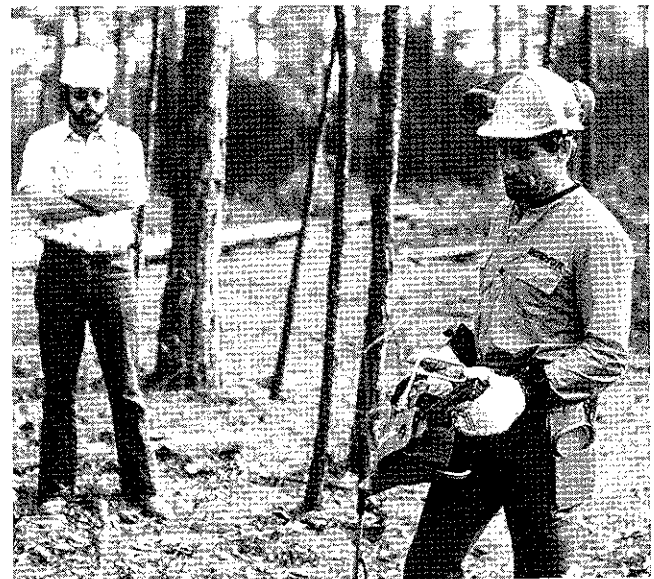
Although the comparison may not be entirely valid, the contents of the two conferences are illustrative of the different directions taken by researchers in the United States and other countries in the past 25 years.

First, researchers outside the U.S. simply have been much more active in the behavioral dimension of harvesting. Any bibliography or reference list pertaining to harvesting will contain more human behavior related work by foreign authors than by Americans. The Scandinavians, in particular, have been much more productive in this field than have the Americans, Canadians, or any other single nationality.⁵

Second, even though foreign scientists continue to look for ways to increase worker productivity, their research is much more likely to include what has been called “job satisfaction” (Bostrand, 1980a; Teikari, 1980; Wilson et al., 1988). From the perspective of the worker, American effort appears to be directed more toward doing something *to* him while foreign effort at least includes doing something *for* him. The fact that there are psychologists involved in the research outside the U.S. may partly account for this shift in research emphasis (Johansson, 1980).

⁴A very similar classification of research activities was made earlier by Bostrand and Frykman (1975) who noted that research in the behavioral aspects of forest work started in Scandinavia in the 1960's — about the same time as the Battelle and HRP research in this country.

⁵Apparently, the propensity of the Nordic countries to conduct social science research in “nontraditional” areas like forestry extends beyond any particular operational area such as harvesting. For an example of “Sociology in Finnish Forest Research,” see Young (1980).



Selection, motivation, and training of loggers has received most of the attention by harvesting researchers over their past several years.

A third comparative observation has to do with the units of analysis employed by the various scientists investigating human behavior in harvesting operations. While American researchers continue to focus upon the individual logger, by the late 1970's scientists from other countries had begun to conduct studies in which the analytical units were work organizations (Frykman, 1980; Kytala, 1980), work systems (Ager, 1980b; Aminoff and Lindstrom, 1980; Henderson, 1980), and the work environment (Kjellstrand, 1980). Also, more evidence of recognition of the social nature of man can be found in foreign literature than in American literature. That is, while most investigators in this country examine the individual worker only in his or her role as logger (or machine operator, foreman, truck driver, etc.), scientists in other countries are more likely to include other roles or social activities in their analyses of workers; family life and leisure activities (Bostrand, 1980b) and commuting (Bendz, 1967) are examples. Furthermore, the Scandinavians, in particular, are more likely to include personal characteristics, like age, education, and marital status, as independent variables (Hansson, 1965; Makinen, 1988).

Finally, as one might expect, scientists from other countries are more advanced in social science research methods employed in harvesting research. The Swedes and Finns have used questionnaires and personal interviews for a number of years (Gustafsson et al., 1971; Klen, 1977; Lindstrom and Sundstrom-Frisk, 1975; Makinen, 1988), and at the IUFRO workshop were calling for international standardization of research instruments (Ager, 1980b). How much the United States could contribute to such an effort is questionable; since cessation of the HRP research, little has been done in the way of design, application, and improvement of social science research methods.

Evaluation

The most striking feature of the body of literature pertaining to human behavior in timber harvesting is its sparseness. Even the Scandinavians, acknowledged leaders in the field, have not amassed a great store of knowledge on the subject in their 30 years of activity. In the United States, the situation can only be described as dismal. The frontier of knowledge established by the HRP has been advanced only slightly if at all in the past 15 years. Selection, motivation, and training of loggers and supervisors have received most of the attention of harvesting researchers over the past several years. While the evaluation of chokertraining by Garland (1982) and the incentive system analysis by Olsen (1988) may be prototypical studies of training and motivation, respectively, repetition will be required to prove their value. The absence of a coherent, theory-based research effort to date is only too evident.

Identification of Problems

There is no shortage of opinions about problems in the harvesting industry. More problems are identified than solved in the research literature; the technical literature is replete with implicit and explicit references to gaps in knowledge; trade journals and the popular press contain numerous appeals for problem solving. Moreover, nearly 50 active participants in some aspect of harvesting were personally contacted and quizzed about problems during the conduct of this analysis.

An old adage states that how you stand depends on where you sit. The problems identified by a logger, a procurement officer, an extension specialist, or a scientist reflect his or her particular perspective. The challenge for the analyst is to distinguish between problems that are researchable and problems that are not, to conceptualize the problems at a level of abstraction that lends itself to systematic inquiry, and, finally, to offer a theoretical perspective from which empirical investigations can be deduced and to which findings can be related. The problems in the southern timber harvesting industry that emerged from this analysis and which are behavioral in nature can be placed into five broad areas:

- (1) individual workers,
- (2) harvesting crews,
- (3) the labor force,
- (4) structure and organization, and
- (5) society.

Individual Workers

Silversides and his colleagues (1988) noted several woodworker problems in their analysis of research needs. Not surprisingly, most dealt with issues that have been addressed by research over the past 30 years: selecting, training, and

motivating individual workers. Specific research needs identified by these analysts are training in efficient, safe, and environmentally sound harvesting methods; increasing the capacity of logging contractors to manage people; and studies and trials of various methods of employee selection. They also noted that training programs for workers should be carefully evaluated and that more effective ways are needed to transfer new knowledge.

Active researchers in the individual worker area are very explicit in their appeal for additional work. Garland, for example, has listed five "appropriate research questions" pertaining to logger training (Garland, 1979) and 14 "potential research areas" in logging safety alone (Garland, 1988). He also feels strongly about the need for "Sound, scientific measures . . . to confirm (or deny) the gains due to selection, training, and incentive programs" (Garland, 1984). Harvesting equipment design engineers are most concerned about the safety ramifications of "human factors" (Hull and Berry, 1987; Smith and Sorios, 1982a). However, in his overview of human factors concepts, Duncan (1987) lists six examples of equipment design problems whose solutions require knowledge about humans; most require input by physiologists, but some, such as human response to vibration and noise, have psychological aspects as well.

Based upon results of a recent "wants and needs" survey, APA members ranked "10 subject areas which have concerned the pulpwood industry in the past" as follows: workers' compensation, liability insurance, harvesting regulation, stumpage availability, trucking regulation, economy/interest, accidents/injuries, wood demand, independent contractor status, and manpower availability (APA, 1988). The reporters conclude that, "Concerns about insurance do not appear to come hand-in-hand with concerns about accidents/injuries, and the perception that they are not linked appears particularly strong among loggers." The fact appears to be that accident rates and insurance premiums indeed are directly correlated, even though there is a time lag between the two. In a series of articles in a major trade journal, the author reports that reducing accidents is the single best option the logger has for lowering insurance costs (Stevenson, 1989). One major wood supplier in the South saw workers' compensation premiums drop 33 percent over a 9-year period following implementation of an intensive safety program for its producers (Stevenson, 1989).

Assuming that accident prevention through safety training is a major need in the industry, the question of how to deliver the training remains unanswered. The APA survey (1988) showed that 46 percent of the loggers who responded liked the idea of paying \$500 to \$1,000 to have a trainer spend a day with their employees teaching safe and efficient logging techniques. Among the 54 percent who did not like the idea, approximately equal numbers reported that lack of funds and existing levels of safety and efficiency were reasons for their opposition (APA, 1988). Among nonloggers (wood suppliers, procurement officers, etc.), 67 percent opposed the training idea; nearly one-third of those felt it would be inappropriate

for them to become involved in their contractors' operating methods without jeopardizing the "... appropriate arms-length relationship..." with their contractors (APA, 1988).

This analysis discovered little concern about other aspects of employee selection, motivation, or training from within the industry. Anecdotes exist, to be sure, (like the contractor who hired the only guy that showed up in tennis shoes — the other applicants wore sandals) (Garland, 1984) but they make a shaky foundation for a research program. An informal reader survey conducted by *Timber Harvesting* led to the conclusion that more solid approaches to hiring, training, and motivating employees are needed. However, there was little consensus among respondents about what works and what doesn't (Stevenson, 1988). There is a great deal of training activity in the industry with safety (for woods workers and truck drivers) and business management (for contractors) being prevalent topics. Research plays a very minor role in the development, delivery, or evaluation of this training.

Conclusion: The greatest social science research need in the general problem area of individual workers is the systematic evaluation of selection, training, and motivation (incentive) efforts. Unless programs are evaluated, there can be no objective basis for their continuation, alteration, replacement, or termination. Social scientists have the research tools to conduct scientific evaluation of programs that aim to alter human behavior. Failure to employ those tools to evaluate programs like truck driver training (Rolston,

1986) and tailgate logging safety (APA, undated) means continuing the current practice of appraising programs upon the basis of appearances, opinions, and isolated observations.

Other opportunities for social science research are in the areas of job satisfaction, psychological responses to the work environment (including harvesting machines), worker profile development, and leadership studies. A good foundation for research in these areas has been laid, particularly in the Scandinavian countries and, in worker profiles, in Canada (Sarna, 1977). Furthermore, the general industrial psychology literature is a rich source of pertinent information (see, for example, Locke, 1986; Cooper and Robertson, 1986; Landy, 1986).

Harvesting Crews

Timber harvesting work crews are more than an aggregation of individuals: they are small social groups which, consequently, possess the defining characteristics of similar norms, values, and expectations and regular, conscious interaction (Schafer, 1989). Groups have structure (statuses and roles), and they are goal oriented. The relationship between an individual and groups to which he or she belongs is reciprocal; that is, each influences the other.

Although economists have treated the timber harvesting crew as the basic unit of production, it has been almost totally ignored as a unit of analysis by other harvesting researchers. In perhaps the only direct reference to a crew-level



Logging crews are more than an aggregation of individuals; they are small social groups as well.

characteristic in the American research literature, the Battelle group identified "crew aggressiveness" as an important factor in pulpwood production (Hamilton and Stock, 1962). Aggressiveness was further defined in terms of several more specific variables: planning and job flexibility, performance standards, crew responsibility for safety and equipment maintenance, leadership, production goals, and production incentives. Although later studies, including those conducted by HRP, have identified some of these same variables as production factors, all have treated them as characteristics of individual workers. The role that social (group) influences may play in productivity, safety, efficiency, and other crew "outputs" simply has never been explored in the timber harvesting industry although the importance of such influences in an industrial setting was discovered by social scientists 50 years ago (Roethlisberger and Dickson, 1939).

The Swedes and Finns have been somewhat more active in the area of work organization, including crew-level studies (see Frykman, 1980, and Kytala, 1978, as examples.) The work environment research group in the Department of Operational Efficiency, College of Forestry, Swedish University of Agricultural Sciences, has been following and evaluating logging crews with different work organization forms since 1975. The composition of the work team and the role of supervisors have emerged as critical factors in crew production and efficiency (Frykman, 1980).

The technical literature and trade and popular media are nearly as mute as the research literature on the subject of logging crew organization and operations. A technical paper from the northeastern United States describes results of a survey of seven logging crews to identify the characteristics of a "safe and efficient" crew (APA, 1985). Two key elements were identified: worker attitude and knowledge of planning and work procedures. This report also includes brief descriptions of two of the crews that were surveyed; other than "teamwork," no group phenomena were included in the description.

The only specific appeal for research in this problem area that could be found in the American literature was made 15 years ago. In his comprehensive assessment of research needs in timber harvesting labor, Bond (1975) included "interpersonal relations" among his eight problem areas and specified worker-worker, worker-supervisor, and worker-machine as examples. The very ambitious research program outlined by Bond has not become reality.

Harvesting industry representatives contacted during the course of this analysis did not specify any problems related directly to logging crew organization and/or operations; traditional worker issues (selection, training, motivation) are perceived as individual, not crew level, problems.

Conclusion: The independent nature and variability of the logging force in the United States, and the fact that nearly all of the social science involvement has been by psychologists, have combined to discourage behavioral research at the group (crew) level. Consequently, a potentially important source of variation in productivity, accident rates, turnover, absenteeism, etc. has not been analyzed.

Future studies of these "output" phenomena should include norms, values, goals, and interaction patterns at the crew level as independent variables. Furthermore, evaluation studies, described under the "individual worker" problem area, should examine group phenomena as possible explanations for why the same program produces different results in separate but similar crews.

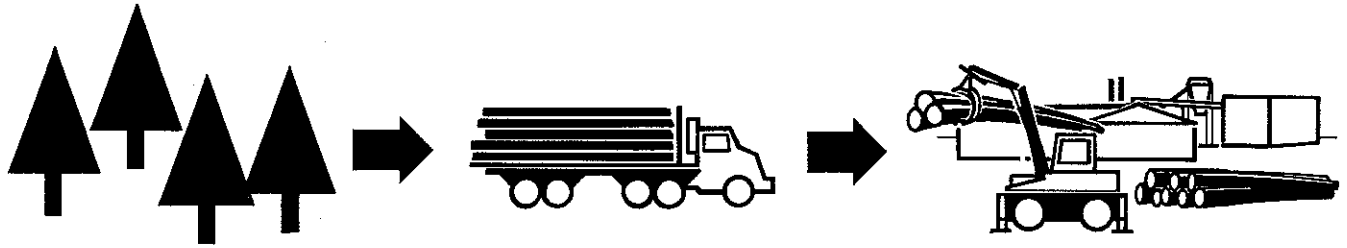
Experimental manipulation of crew organization, work assignment, work schedules, etc. could produce significant results, as it has in Scandinavia (Bostrand, 1980b; Frykman, 1980). However, the nature of the harvesting industry in the South makes the conduct of such studies highly unlikely. An alternative approach would be to identify existing logging crews that collectively possess variations in organizational and operational features and conduct comparative case studies in an effort to identify both individual and group variables that influence outcomes.

The Labor Force

In his assessment of research needs in forest labor, Bond (1975) noted several problems related to the harvesting labor force: competition from alternative job opportunities; how to attract workers; the desired character of future laborers; the image of woods labor. Apparently, there has been very little response to Bond's appeal for research in this area. The timber harvesting research literature is nearly devoid of studies of labor force issues or even documentations of labor force characteristics. Most labor force issues are addressed from the individual worker perspective; that is, problems like employee selection, motivation, and training are defined as labor force problems but analyzed at the individual worker level (Garland, 1984 and 1986). This approach ignores the possibility that some issues, such as manpower availability, occupational prestige or image, turnover rates, age structure, educational attainment, and geographic distribution, should be (or, in some cases, can *only* be) examined at the labor force level.

Within the industry itself, the labor problem most often mentioned is that of manpower availability, or, "How to find forest workers and keep them on the job" (Bryan, 1981). Results of APA's "wants and needs" survey showed 77 percent of the respondents agreeing that "availability of harvesting manpower will be more of a problem in 5 years than it is now" (APA, 1988). While mechanization has shifted the industry away from its once near total reliance upon labor, there is now a sense of uneasiness about the availability of *qualified* labor: 53 percent of APA's respondents agreed that "mechanization will make qualified harvesting workers harder to find over the coming 5 years" (APA, 1988). As machines become more and more sophisticated and complex to operate and maintain, loggers and wood procurement foresters worry about where the operators will come from (Manz, 1988; Griffin, 1988).

Conclusion: The biggest single need in this problem area is for documentation of labor force characteristics. Other than



The timber harvesting industry can be viewed as a social system that regularly interacts with other systems, particularly tree growers and wood buyers/processors.

general data from Bureau of Labor Statistics and Bureau of Census reports, there is no source of systematic, detailed information about the logging labor force. In the South, the periodic "producer surveys"⁶ sponsored by the APA provide a modest amount of information about pulpwood contractors, like age, education, and number of employees (Watson et al., 1989). APA should give serious consideration to including provision for collecting more detailed data about all workers in the harvesting industry in subsequent surveys of this type. Periodic descriptions of worker characteristics would either substantiate or refute some of the fears concerning skilled labor shortages and provide a basis for projecting trends into the future.⁷

Labor force studies also have the potential for producing answers to questions about worker sources, turnover, mobility (within the industry and between harvesting and other industries), job satisfaction, occupational prestige, accidents and near accidents, and a host of others that concern the industry from time to time. Modern survey techniques allow results to be produced in a matter of days or even hours, depending upon the size of the sample. There is simply no good reason for the harvesting industry to remain in the dark about its own manpower.

Structure and Organization of the Harvesting Industry

Just as harvesting crews can be viewed as social groups, the timber harvesting industry can be analyzed as a social system. The defining characteristic of a social system is the interdependence of its parts; that is, a system is composed of a complex of elements in interaction. When applied to large organizations or industries, the focus of systems analysis is

⁶These surveys were conducted in 1976, 1979, 1980, and 1987 (Watson et al., 1977; Weaver et al., 1981; Weaver et al., 1982; Watson et al., 1989).

⁷For an example of the use of a single survey in dispelling myths about the labor force, see Stevens' (1979) article appropriately titled, "Six Views About A Wood Products Labor Force, Most of Which May be Wrong."

upon the relations among the interacting elements (Haas and Drabek, 1973). An "open-system" perspective recognizes that a social system cannot survive in isolation; instead, it must interact with other systems within its environment (Cook, 1977). This perspective seems especially appropriate for the timber harvesting industry. Not only is it composed of a complex of interacting elements (logging contractors, transportation contractors, wood dealers), it also regularly interacts with other social systems, particularly with timberland owners and wood buyers/processors upon which its very survival depends.

The structure and organization of the timber harvesting industry has received very little attention in harvesting research or literature. References to "systems" usually mean silvicultural (Blomquist, 1985), operational (Mattson, 1985), technological (Sturos, 1985), or managerial (Burton, 1985). However, in his opening presentation to the IUFRO seminar cited earlier, Ager (1980b) reviewed a few of the many different conceptualizations of "work design systems," and Kytala (1980) discussed the organization of logging in Finland at the same seminar. Also, Bond (1975) again must be cited for his insight as he included "the organization of the timber harvesting industry" among the problems potentially affecting the supply of forest labor. He went on to raise the question which remains unanswered: "[Is] the dealer-producer-contractor system . . . at fault," and suggested that ". . . alternatives need to be investigated."

The relationship (or interaction) between timber harvesters (loggers, truckers, wood dealers) and wood buyers/processors (sawmills, paper mills, etc.) is frequently discussed, but it has not been the object of systematic study. It is a complex phenomenon; there are legal considerations (Granskog and Siegel, 1978), economic aspects (Black, 1984), and an underlying cultural tradition (Barnes, 1972; Flick, 1985). Also, it has been the subject of debate (Black, 1984; Holli, 1984) and an issue about which feeling sometimes runs very strong (Shell, 1988a and 1989). At APA's 1988 national meeting, a six-man industry panel concluded "the major barrier to forest worker professionalism is industry's fear of jeopardizing its independent contractor relationship with individual wood suppliers" (Griffin, 1988).

Results of three surveys indicated a modest degree of concern about the relationship between loggers and buyers. In

a 1985 opinion survey of pulpwood dealers and mill procurement managers, APA found "maintaining a union-free environment" and "arms length relationship" perceived as potential problems (APA, 1986b). However, the 35 respondents were much more concerned about cost and timber availability issues. The 1988 wants and needs survey gave respondents the opportunity to rank several subject areas that concern the pulpwood industry from time to time. Maintaining the independent status of loggers ranked next to bottom nationally; however, it ranked third in the APA Southwest Technical Division (Kansas, Oklahoma, Texas, Missouri, Arkansas, Louisiana, Mississippi, and Alabama), and pulp and paper company employees ranked it higher than logging contractors (APA, 1988). Finally, Wilson and Shaffer (1986) surveyed Virginia loggers "... to determine how they perceived their business relationship with the forest products companies they supply." The 111 loggers who responded felt that while the relationship was good, there was room for improvement. Perhaps more revealing was the perception by the loggers that the companies were unconcerned about the loggers' success and the finding that nearly one-fourth of the loggers would have liked to get out of the business altogether.

The contractual relationship between wood producers (loggers and dealers) and wood buyers/processors recently received a great deal of attention in a Southern trade publication. Shell (1989) described the relationship as follows:

[M]ills dictat[e] when loggers can haul, where loggers can haul, how much they can haul per load, how loggers should harvest, where loggers can harvest, what woods workers can wear, how much insurance loggers must have, and how much they will be paid.

Mill procurement managers, on the other hand, complain that most of the loggers' problems could be solved if they were better business managers (Shell, 1989).

In their assessment of research needs, Silversides et al. (1988) identified the "impact of quotas" as a problem of medium priority under their "economics" problem area and recommended investigations of benefits, costs, and alternatives. Among those contacted during the course of this analysis, opinions about quotas depended upon one's perspective. Mill procurement managers generally viewed quotas as an essential control mechanism for regulating the flow of wood into the mill, although a few acknowledged that quotas prohibited some loggers from making a decent living. Loggers and wood dealers tended to express a more negative view of quotas as being unnecessarily restrictive. One former logger placed a great deal of blame upon the quota system for his getting out of the business.

Conclusion: The cogent question for purposes of this analysis is, what effect does the structure and organization of the harvesting industry have upon various aspects of harvesting operations, like productivity, worker turnover, accident rates, and skill levels of employees? In other words, does the control exerted by the wood buyers—in the form of quotas, prices, logging site selection, equipment use, etc.—

contribute to many of the problems that exist in the harvesting industry? All dimensions of the wood procurement system should be systemically investigated: economic, legal-political, cultural, and social. Variations in logger-buyer relationships, such as the formation of logger associations,⁸ should be studied for their impact upon the operational aspects of harvesting. While it is not the role of research to pass judgment upon matters like quota systems, arms length relationships, independence of loggers, or unionization, the effect of these phenomena upon other features or actions of the industry is a legitimate area of study.

Societal Influences: The Organizational Environment

An organization's (or industry's) environment includes "all phenomena that are external to and potentially or actually influence the population under study" (Hawley, 1968). Hall (1987) identified seven conditions within an organization's environment that should be analyzed: technological, legal, political, economic, demographic, ecological, and cultural. Examples of environmental influences upon the harvesting industry in each of these categories are readily available.

Technological Influences — The impact of the technological environment upon the logging industry over the past several years is common knowledge, and the trend toward more and more sophisticated equipment, although slowed, is continuing. The question of whether or not individual workers can keep pace with this sophistication already has been raised (Griffin, 1988), but technology impacts more than individuals who must operate new machines; it potentially affects the entire harvesting system. In describing new harvest equipment and systems at a recent technical conference, Sturos (1985) ended his presentation by stating, "The equipment alternatives presented in this paper should be evaluated in complete stump-to-mill system analyses... Only in this way can the merits of the equipment be realistically judged." Any such evaluations should include provision for assessing impacts upon the individuals, the crews, and the organizational system within which the technology is introduced.

Legal Influences — Like most other organizations, timber harvesting must live with federal, state, and local laws as constants in their environment, and there is concern within the industry about the restrictions imposed by law.⁹ For example, deregulation of the railway industry resulted in increased

⁸It was announced recently that pulpwood loggers in Mississippi will get a 15 percent reduction in workers' comp rates if they are fully mechanized; the Mississippi Loggers Association is given credit for proposing the rate adjustment to the state insurance commission (McPhail, 1989).

⁹Respondents to APA's wants and needs survey ranked "harvesting regulations" third among 10 areas of concern to the harvesting industry (APA, 1988).

reliance upon trucks with an attendant increase in their numbers, capacity, length, and weight (Stephenson, 1988; Rolston, 1986). States reacted with a myriad of trucking regulations that left loggers in a state of confusion about what was legal and what was illegal (APA, 1981). Several industry representatives contacted during this analysis flatly stated that strict enforcement of weight and length restrictions would severely alter current trucking practices. The impact of these laws, and others currently or potentially affecting the harvesting industry, should be the subject of systematic analysis.

Political Influences — Laws often result from pressure for their enactment, and once legislation is passed, political pressures can be brought to bear in their implementation. McCaffrey (1982) has documented the strong political pressures that were placed upon the Occupational Safety and Health Administration (OSHA) during its early history. Sherar (1987) and Stuart (1988) have noted the importance of considering the political environment when making harvesting decisions. Sherar emphasized the potential for special interest groups to apply pressures that could affect logging (or already do); Stuart mentioned several areas where political pressures can complicate harvesting operations — land use debates, labor legislation, direct economic incentives, water and air quality standards, road construction and maintenance budgets, and public image (of harvesting). As Bond (1975) pointed out, "An understanding of the effect of public policy requires research rather than subjective speculation. . ."

Economic Influences — In most businesses, the state of the economy in which the organization is operating is the crucial variable. Loggers and wood products manufacturers suffered along with other sectors of American society during the general economic recession of 1980-81 (Knight, 1985). During the last few years, demand for paper has been very strong and pulp and paper companies have reported record profits.¹⁰ Sherar and Sloan (1985) identified several economic conditions that may affect timber sales, and, consequently harvesting, in the eastern United States: timber stand quality/value, timber access costs, timber management costs, and higher valued uses of forest land, such as tourism and development. How the harvesting industry responds to these and other economic conditions is a legitimate research question.

Demographic Influences — Most businesses are concerned about the demographic composition of the buying public, and timber harvesters ultimately are affected by the characteristics of users of wood products. However, of greater interest to the harvesting industry is its *internal* demographic makeup. Research ". . . has shown that demographic distribution within an organization have important ramifications for

a wide variety of organizationally important issues, such as performance, innovation and adaptability, turnover, and interorganizational linkages" (Hall, 1987). Some of the major research issues in this area — labor force characterization, availability, qualification, turnover — were discussed earlier in this paper. In sum, the demographic makeup of the logging industry should be examined closely as a possible contributor to some of the ills that plague the industry.

Ecological Influences — The physical environment affects the harvesting industry in two important ways. First, climatic and physiographic factors set limits on when, where, and how logging can occur. The industry has made significant progress in pushing back these limits through the development and use of new logging equipment and systems (Sherar, 1987). Second, and more troublesome, is concern about the physical environment by the American public. Environmental concern can manifest itself in the landowners who refuse to allow their timber to be cut (Broadway, 1989), motorists who successfully petition for a law prohibiting log trucks on the highway unless the mud is first removed (Rolston, 1986), or various special interest groups who want to prohibit harvesting in an area for as many different reasons as there are groups (Currie, 1989).¹¹ Sherar and Sloan (1985) identified visual quality, water quality, and wetlands as the major environmental concerns affecting harvesting in the East. Social scientists can play a role in helping the industry respond to these pressures.

Cultural Influences — At a 1988 conference on harvesting machines and systems evaluation Stuart (1988) reported results of an effort to find ways to alleviate the problems of translating harvesting research findings across regional and national boundaries. His general conclusion was ". . . that even among a selected set of highly developed countries producing similar products, the working and business environments differed greatly. These differences, not the mechanical, productivity or cost characteristics of the machine or a system were the final determinants of successful adaptation or evolution." Without using the term, Stuart presented a dramatic example of how culture impacts the harvesting industry's response to change in different countries or regions. In a sense, culture overrides all other factors in determining how an industry is shaped and operates (Hall, 1987). The cultural traditions underlying logging in the South have been noted already (Flick, 1985), and the gap between the sophistication of logging equipment and the sophistication of workers is a classic example of "cultural lag," a phenomenon described by a sociologist nearly 70 years ago (Ogburn, 1922). Other instances of cultural influences upon harvesting are regional differences in public perceptions of loggers, or the "image problem" (Kluender, 1976); the reluctance of workers to wear

¹⁰This economic turnaround in the paper industry has contributed to the current hostility being expressed by some loggers toward the companies they log for. The loggers claim that they are not sharing in the economic bonanza (Shell, 1988a and 1989; Dunaway, 1989).

¹¹In one of the most extreme proposals to date, the Wilderness Society has recommended that the allowable cut on national forests be reduced by one-half over the next 8 years (Anon. 1989).

safety equipment;¹² and the lack of importance attached to formal training for loggers (Griffin, 1988). Social scientists should be involved in efforts to assess the impact of culture upon the harvesting industry and to try to forecast change which may influence the industry in the near future.

Conclusion: Many of the issues that face the southern harvesting industry emanate from one or more conditions within the social environment. While some industry observers, like Bond, Sherar, and Stuart, recognize the importance of societal influences, the capability to trace conditions in the industry to their sources and, thus, be in a better position to instigate change, has not been demonstrated. This capability is far from perfect in the social sciences, but there is a research tradition for the analysis of interorganizational and organization-environment interactions. The timber harvesting industry provides both a challenge and an opportunity for scientists interested in pursuing that tradition.

A Social Science Research Program

The third objective of this analysis of the southern timber harvesting industry was to identify specific specializations within the social science disciplines that should be applied to various harvesting problems. However, the discovery that social scientists of any persuasion have been inactive in timber harvesting research and the consequent paucity of social science based material in the knowledge base suggest that a proposed research program needs first to be pointed in a general direction else it goes flying off in several directions at once. Therefore, before a research program is proposed, a general orientation for social science study of timber harvesting will be briefly described.

Research Program Perspective

The theoretical perspective that has guided this analysis is that of the large-scale organization as an open social system. Although it is obvious that timber harvesting is not performed by a single, large-scale organization, the wood harvesting/transporting industry certainly meets the criteria of "a relatively permanent and relatively complex discernible interaction system" (Haas and Drabek, 1973). The alternative interaction systems — groups, communities, and societies — are either too transitory (groups) or too complex (communities, societies) to characterize the industry.

Perceiving timber harvesting as an organizational social

¹²In a survey of 509 loggers in 10 southern states, 60 percent reported wearing hard hats, 56 percent wore safety boots, 21 percent used eye protection, 26 percent hearing protection, and 19 percent leg protection, even though OSHA regulations have required 100 percent use of all this equipment except leg protectors for over 10 years (Griffin, 1988).

system offers the advantage of familiarity to a wide array of social science disciplines. The pervasiveness of organizations in modern societies has attracted sociologists, psychologists, social psychologists, anthropologists, political scientists, and economists, and each discipline has made significant contributions to the "science of organizations" (Roberts et al., 1978). The interdisciplinary interest in organizations has resulted in research focused upon individual members, groups and individuals as group members, tasks performed, and the organization itself (Roberts et al., 1978). The potential relevance of each of these units of analysis for the study of timber harvesting has been specified or implied throughout this paper.

The open-system conceptualization of organizations seems most appropriate for guiding the analysis of the timber harvesting industry, primarily because of its emphasis upon a social system's interaction with other systems in its environment. That is, organizations are viewed as systems within systems. "The image is something akin to the layers one sees upon peeling an onion" (Haas and Drabek, 1973). The interdependency of the timber growing, harvesting, and wood processing social systems suggests that none can be analyzed in isolation from the others. The importance of the environment within which the timber harvesting industry exists has been stressed throughout this paper.

Research Program Description

Silversides and his colleagues (1988) recommended a 10-year program of research in timber harvesting and transportation with an estimated expenditure of 93 scientist years and \$13,950,000. The "sociological aspects" of harvesting labor was allocated 3 scientist years and \$450,000 of these totals. However, their "labor" problem area also included training programs, methods of payments, selection and retention of workers, and ergonomics, which have a combined total of 15 scientist years and \$2,250,000 allocated. Furthermore, incentive programs, techniques of technology transfer, wood procurement strategies, and the impact of quotas are listed under different problem areas; all have been mentioned in this paper as needing attention by social scientists. Altogether, 25 scientist years and \$3.3 million is the estimated requirement for a 10-year research program in these areas. Taking into account the need for involvement by physical and biological scientists in many of the areas, it is estimated that 10 social scientist years and \$1.5 million would provide modest support for the research program proposed here. Allocation of these resources among the five problem areas and research subjects is shown in Table 1. Although the research subjects were deliberately left unranked in priority of initiation, the best opportunities for quick results probably are in the evaluation of selection, training, and motivation efforts, and labor force surveys. However, over the long run research in the structure and organization problem area would be expected to produce the most dramatic results in terms of bringing about needed changes in the industry.

Program Implementation

The greatest deterrent to the implementation and continuation of timber harvesting research in the United States has been recognized for at least a dozen years: there is no national focal point "for stimulating, sponsoring, and coordinating research to meet current and future needs in forest harvesting" such as exist in Sweden, Finland, Australia, New Zealand, and Canada (Boyd et al., 1977). The only national forestry research organization in this country is the USDA Forest Service, and the meagerness of that agency's timber harvesting research effort already has been noted (Silversides

Table 1. Recommended 10-year social science research program in timber harvesting

Problem area scientist and subjects	Estimated scientist year	Funding
INDIVIDUAL WORKERS		
— Evaluation of existing and new selection, training, and motivation efforts	2.0	\$300,000
— Studies of other worker characteristics and issues	1.0	\$150,000
	<u>3.0</u>	<u>\$450,000</u>
HARVESTING CREWS		
— Case studies of crew organization & operations	2.0	\$300,000
— Studies of effects of crew characteristics on selection, training & motivation	*	*
	<u>2.0</u>	<u>\$300,000</u>
THE LABOR FORCE		
— Labor force characteristics surveys	0.5	\$ 75,000
— Labor force issues studies	0.5	\$ 75,000
	<u>1.0</u>	<u>\$150,000</u>
STRUCTURE AND ORGANIZATION		
— Case studies of producer-buyer relationships	2.0	\$300,000
— Evaluative case studies of logger cooperatives/associations	1.0	\$150,000
	<u>3.0</u>	<u>\$450,000</u>
SOCIETAL INFLUENCES		
— Macro analysis of impacts of environmental conditions	1.0	150,000
	<u>1.0</u>	<u>\$150,000</u>

Recommended Program 10-Year Totals

Individual Workers	3.0	\$450,000
Harvesting Crews	2.0	\$300,000
The Labor Force	1.0	\$150,000
Structure & Organization	3.0	450,000
Societal Influences	1.0	\$150,000
TOTAL	<u>10.0</u>	<u>\$1,500,000</u>

*Included in evaluation studies under individual workers problem area.

et al., 1988). The dispersed nature of research activities was vividly illustrated by the results of a 1984 survey of "all known public sector forest engineering research and development institutions in the United States and Canada" (Mann, 1984). In the United States, Mann identified 13 universities, six Forest Service research work units (in five experiment stations), and two other U.S. government research organizations, or a total of 21 semi-autonomous forest engineering research entities. In Canada, on the other hand, he identified only two universities and one government organization — the Forest Engineering Research Institute of Canada (FERIC).

The structural barriers to implementing and sustaining timber harvesting research could be partially overcome, in the case of social science research in the South, by placing a key scientist in a research and development position in a university or a government agency. The role for this person should include the following:

- (1) Interpret social science research literature for application to timber harvesting and identify specific research needs.¹³
- (2) Refer specific research needs to appropriate specialists in the social sciences.
- (3) Obtain sponsorship for research from government sources, industry sources, foundations, and private donations.
- (4) Serve as a consultant to the industry on matters pertaining to human behavior.
- (5) Work with technology transfer agencies to assure that research results are disseminated.
- (6) Serve as the social scientist on interdisciplinary research teams that normally are made up only of physical and/or biological scientists.

The individual occupying this position ideally would have academic training in some combination of psychology, sociology, social psychology, industrial psychology, industrial sociology, business administration, or management.¹⁴ The resources allocated to the proposed 10-year research program will support this position, and the position will provide the opportunity for significant progress toward solving some of the problems that have plagued the timber harvesting industry for nearly 50 years.

¹³Gary Latham, now chairman of the Department of Management and Organization, School of Business Administration, University of Washington, stated in a personal interview (1989) that there are several areas of knowledge in industrial psychology alone that have immediate application to harvesting problems; examples are goal setting as a means of increasing productivity (Locke and Latham, 1984), identification of supervisory potential and training for supervisors (Latham and Saari, 1979), the use of incentives (Yukl, Latham, and Pursell, 1976), and performance appraisal (Latham and Wexley, 1977). (Latham also helped develop the "Key Scientist" idea.)

¹⁴Latham related that it now is quite common for a Ph.D. industrial psychologist to have an MBA, for example.

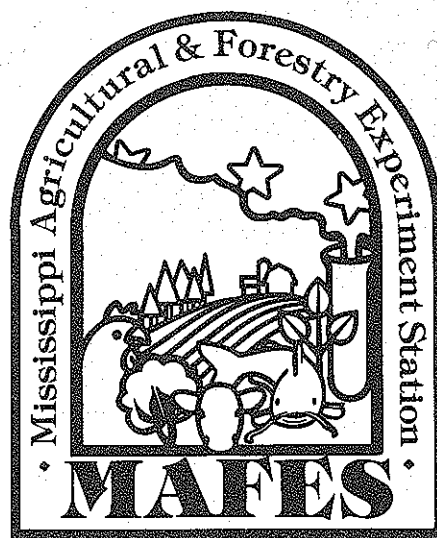
Literature Cited

- Ager, Bengt (ed.). 1980a. Design of Work Systems in Forestry. Proceedings of a I.U.F.R.O. Seminar, Garpenberg, Sweden, Sept. 21-26, 1980.
- Ager, Bengt. 1980b. Design of work systems — a review. In Ager, B. (ed.), Design of Work Systems in Forestry. Proceedings of a I.U.F.R.O. Seminar, Garpenberg, Sweden, Sept. 21-26, 1980, 1-16.
- Aherin, Robert A., and Dennis J. Murphy. 1987. Impact of operator training on reducing losses. Unpublished paper no. 87-5528 presented at the 1987 International Meeting of the American Society of Agricultural Engineers, Chicago, IL, Dec. 15-18, 1987.
- Altman, James A. 1989. Personal communication.
- American Pulpwood Association. 1981. Southern Guide to Federal and State Trucking Regulations. Special Project Report 81-A-5. American Pulpwood Association, Inc., Washington, DC.
- American Pulpwood Association. 1985. Safe and Efficient Logging Crew Study. Publication 85-A-5, American Pulpwood Association, Inc., Northeastern Technical Division Safety Committee, Augusta, ME.
- American Pulpwood Association. 1986a. Logging Industry Training Needs Survey Report. Publication 86-A-6, American Pulpwood Association, Inc., Northeastern Technical Division Training Sub-committee and VTI Craft Committee, Washington, DC.
- American Pulpwood Association. 1986b. Opinions about Southern Pulpwood Procurement. Publication 86-A-2, American Pulpwood Association, Inc., Washington, DC.
- American Pulpwood Association. 1987. Workers' Compensation Insurance Rates by States for Logging. Technical Release 87-R-24, American Pulpwood Association, Inc., Washington, DC.
- American Pulpwood Association. 1988. The 1988 American Pulpwood Association Wants and Needs Survey: A Final Report. Publication 89-A-1, American Pulpwood Association, Inc., Washington, DC.
- American Pulpwood Association. undated. Tailgate Logging Safety. Unnumbered Safety Booklet, American Pulpwood Association, Inc., Washington, DC.
- Aminoff, Staffan, and Klas-Goran Lindstrom. 1980. On the decision process in the choice of highly mechanized logging systems. In Ager, B. (ed.), Design of Work Systems in Forestry. Proceedings of a I.U.F.R.O. Seminar, Garpenberg, Sweden, Sept. 21-26, 1980, 132-140.
- Anonymous. 1989. Society wants harvesting cut in half. *Timber Harvesting* 37(4):5.
- Bailey, Wilfred C., and Choong S. Kim. 1971. Community Factors in the Productivity of Pulpwood Harvesting Operations. University of Georgia, Department of Sociology and Anthropology, Athens, GA, in cooperation with the American Pulpwood Association Harvesting Research Project, Atlanta, GA.
- Barnes, Peter. 1972. Pulpwood peonage: unionizing the rural South. *The New Republic*, March 18, 1972, 15-16.
- Bendz, M. 1967. Community and service travelling of forest workers in Sweden. *Studia Forestalia Seucica* Nr. 38, Royal College of Forestry, Stockholm, Sweden.
- Black, Richard L. 1984. Reasons for a large corporation moving toward or adopting an "armslength" independent contract for harvesting. In Robertson, Doris, and Julia White (ed.), People and Productivity: Keys to a Successful Harvesting Operation. Proceedings 7305 of a Conference sponsored by the Forest Products Research Society in cooperation with the Canadian Pulp and Paper Association, Thunder Bay, Ontario, Canada, Sept. 17-18, 1984, 34-36.
- Blomquist, C.R. 1985. Silvicultural system alternatives: the forester's tool box. In Martin, A. Jeff (ed.), Timber Harvesting: the Link between Management and Utilization. SAF Publication 85-09, Proceedings of the Third Society of American Foresters Region V Technical Conference, Madison, WI, Sept. 25-27, 1985, 117-121.
- Bond, Robert S. 1975. Labor research needs in the forestry economy of the United States. In Irland, Lloyd C. (ed.), Manpower — Forest Industry's Key Resource. Bulletin No. 86, Yale University School of Forestry and Environmental Studies, New Haven, CT, 178-183.
- Bostrand, Lisbet. 1980a. Job satisfaction of logging machine operators in Sweden. In Ager, B. (ed.), Design of Work Systems in Forestry. Proceedings of a I.U.F.R.O. Seminar, Garpenberg, Sweden, Sept. 21-26, 1980, 17-25.
- Bostrand, Lisbet. 1980b. Social effects of shift work in forestry. In Ager, B. (ed.), Design of Work Systems in Forestry. Proceedings of a I.U.F.R.O. Seminar, Garpenberg, Sweden, Sept. 21-26, 1980, 78-84.
- Bostrand, Lisbet, and Bengt Fykman. 1975. Forest Work in the Nordic Countries from the Viewpoints of the Behavioral Sciences. Research Note Nr. 82, *Skogshogskolan*, Royal College of Forestry, Garpenberg, Sweden, 259-288.
- Boyd, Coner W., Ward W. Carson, and Jens E. Jorgensen. 1977. Harvesting the forest resource — are we prepared? *Journal of Forestry* 75(7): 401-403.
- Brinker, Richard. 1989. Personal communication.
- Brinker, Richard. 1989. Personal communication.
- Broadway, Regina. 1989. Timber harvesting practices studied. *MAFES Research Highlights* 52(1): 7-8.
- Bryan, Richard W. 1981. How to find forest workers and keep them on the job. *Forest Industries* 108(9) 38-39.
- Burton, Bruce. 1985. Improved operational and business management practices. In Martin, A. Jeff (ed.), Timber Harvesting: the Link between Management and Utilization. SAF Publication 85-90, Proceedings of the Third Society of American Foresters Region V Technical Conference, Madison, WI, Sept. 25-27, 1985, 122-127.
- Cook, Karen S. 1977. Exchange and power in networks of inter-organizational relations. *The Sociological Quarterly* 18(1): 62-82.
- Cooper, C., and I. Robertson (eds.). 1986. Review of Industrial and Organizational Psychology. Chichester, England: Wiley.
- Cottell, Phillip L. 1975. Human factors in logging productivity. In Ireland, Lloyd C. (ed.), Manpower-Forest Industry's Key Resource. Bulletin No. 86, Yale University School of Forestry and Environmental Studies, New Haven, CT, 48-72.
- Currie, Bob. 1989. Preservationists move South. *Timber Harvesting* 37(4): 37.
- Deal, Earl. 1989. Personal communication.
- Dunaway, H.L. 1989. Personal communication.
- Duncan J.R. 1987. Human factors concepts: an overview. Unpublished paper No. 87-1595 presented at the 1987 International Meeting of the American Society of Agricultural Engineers, Chicago, IL, Dec. 15-18, 1987.
- Dunn, J.G. 1972. Subjective and objective risk distribution: a comparison and its implications for accident prevention. *Occupational Psychology* 46: 183-187.
- Flick, Warren A. 1985. The wood dealer system in Mississippi: an essay on regional economics and culture. *Journal of Forest History* 29(3): 131-138.

- Frykman, Bengt. 1980. Studies on autonomy and work organization of logging crews in Sweden. In Ager, B. (ed.), Design of Work Systems in Forestry, Proceedings of an I.U.F.R.O. Seminar, Garpenberg, Sweden, Sept. 21-26, 1980, 53-77.
- Garland, John J. 1979. A look at logger training. *Loggers Handbook XXXIX*: 14-17; 96, 98.
- Garland, John J. 1982. Assessing gains from choker setter training on skyline systems. In Burke, Doyle, Charles Mann, and Peter Schiess (eds.), Proceeding of the fifth Northwest Skyline Logging Symposium, University of Washington College of Forest Resources, Seattle, WA, Jan. 27 and 28, 1981, 97-105.
- Garland, John J. 1984. Perspectives on the logging labor force: selection, training, and motivation. In Robertson, Doris, and Julia White (eds.), People and Productivity: Keys to a Successful Harvesting Operation. Proceedings 7305 of a Conference Sponsored by the Forest Products Research Society in cooperation with the Canadian Pulp and Paper Association, Thunder Bay, Ontario, Canada, Sept. 17-18, 1984, 7-29.
- Garland, John J. 1986. Selection, training and motivation of the logging labor force. Unpublished paper presented at the 9th Annual Council of Forest Engineering meeting, Mobile, AL, Sept. 29 — Oct. 2, 1986.
- Garland, John J. 1988. Perspectives on logging safety in Oregon. Unpublished background paper for a workshop on Strategies to Improve Logger Safety, Salem, OR, May 13-14, 1988.
- Garland, John J. 1989. Personal communication.
- Granskog, James E., and William C. Siegel. 1978. Legal distinctions between employee and independent contractor as applied to collective bargaining activities in timber harvesting. *Forest Products Industries* 28(9): 16-20.
- Griffin, Griff. 1988. As machines get smarter, can workers keep pace? *Forest Industries* 115(7): 7,9.
- Gustafsson, L., E. Layerlof, and B. Pettersson. 1971. An analysis of near accidents in cutting work. Report No. 4E, Logging Research Foundation, Stockholm, Sweden.
- Haas, J. Eugene, and Thomas E. Drabek. 1973. Complex Organizations: A Sociological Perspective. New York: Macmillan.
- Hall, Richard H. 1987. Organizations: Structures, Processes and Outcomes. Englewood Cliffs, NJ: Prentice-Hall.
- Hamilton, Henry R. 1963. A Summary of the Southern Pulpwood Production Research Project to the American Pulpwood Association. Columbus, OH: Battelle Memorial Institute.
- Hamilton, H.R., and J.R. Stock. 1962. Special Report on the Aggressiveness of Pulpwood Crews to the American Pulpwood Association. Columbus, OH: Battelle Memorial Institute.
- Hansson, Jan-Erik. 1965. The relationship between individual characteristics of the worker and output of work in logging operations. *Studia Forestalia Suecica* Nr. 29, Royal College of Forestry, Stockholm, Sweden.
- Hawley, Amos H. 1968. Human ecology. In Sils, David L. (ed.), International Encyclopedia of the Social Sciences, New York: Macmillan. 4: 328-337.
- Henderson, Mel. 1980. The future for research based work design in Australian logging. In Ager, B. (ed.), Design of Work Systems in Forestry. Proceedings of a I.U.F.R.O. Seminar, Garpenberg, Sweden, Sept. 21-26, 1980, 149-167.
- Holli, David V. 1984. The independent contract experience from the logger's viewpoint. In Robertson, Doris, and Julia White (eds.), People and Productivity: Keys to a Successful Harvesting Operation. Proceedings 7305 of a Conference Sponsored by the Forest Products Research Society and the Canadian Pulp and Paper Association. Thunder Bay, Ontario, Canada, Sept. 17-18, 1984, 34-37.
- Hull, R. Lewis, and Thomas A. Berry. 1987. Recommendations for an ASAE human factors safety design manual. Unpublished paper No. 87-1106 presented at the 1987 Summer Meeting of the American Society of Agricultural Engineers, Baltimore, MD, June 28-July 1, 1987.
- Johansson, Gunn. 1980. Stress-strain at work: general knowledge and aspects. In Ager, B. (ed.), Design of Work Systems in Forestry. Proceedings of a I.U.F.R.O. Seminar, Garpenberg, Sweden, Sept. 21-26, 1980, 17-25.
- Kinne, S.B., III. 1989. Personal communication.
- Kjellstrand, Gunnar. 1980. Why did you quit? In Ager, B. (ed.), Design of Work Systems in Forestry. Proceeding of a I.U.F.R.O. Seminar, Garpenberg, Sweden, Sept. 21-26, 1980, 47-52.
- Klen, T. 1977. Use of personal protectors and their influence on accidental head injuries of lumberjacks. Report No. TTI — 131, Institute of Occupational Health, Helsinki, Finland.
- Kluender, Richard A. 1976. Improving the image of the pulpwood producer. Technical Paper 76-P-15, American Pulpwood Association, Washington, DC.
- Knight, David. 1985. Wood tick trail. *Timber Harvesting* 33(12): 6-7.
- Kyttala, Timo. 1978. Aspects of work organization in logging. *Folia Forestalia*, The Finnish Forest Research Institute, Helsinki, Finland.
- Kyttala, Timo. 1980. Organizing logging work in Finland. In Ager, B. (ed.), Design of Work Systems in Forestry. Proceedings of a I.U.F.R.O. Seminar, Garpenberg, Sweden, Sept. 21-26, 1980, 85-89.
- Landy, F. (ed.), 1986. Readings in Industrial-Organizational Psychology. Chicago: Dorsey Press.
- Latham, Gary P. 1971a. Indicators of Productivity, Turnover, Absenteeism, and Injuries of Independent Pulpwood Producers: the Development of the APA-HRP Producer Behavior Inventory. American Pulpwood Association, Harvesting Research Project, Atlanta, GA.
- Latham, Gary P. 1971b. The APA-HRP Producer Behavior Inventory (Pulpwood Dealers). American Pulpwood Association, Harvesting Research Project, Atlanta, GA.
- Latham, Gary P. 1971c. The APA-HRP Producer Behavior Inventory (Company Foresters). American Pulpwood Association, Harvesting Research Project, Atlanta, GA.
- Latham, Gary P. 1989. Personal communication.
- Latham, Gary P., and Sydney B. Kinne, III. 1971. Goal Setting as a Means of Increasing the Performance of the Pulpwood Harvester. American Pulpwood Association, Harvesting Research Project, Atlanta, GA.
- Latham, Gary P., and L.M. Saari. 1979. Application of social learning to training supervisors through behavior modeling. *Journal of Applied Psychology* 64: 239-246.
- Latham, Gary P. and K.N. Wexley. 1977. Behavior observation scales for performance appraisal purposes. *Personnel Psychology* 30: 255-268.
- Lindstrom, K.G., and C. Sundstrom-Frisk. 1975. Determining Factors in Incentive to Wear Personal Protective Equipment — Survey in the Logging Industry. Arbetarskyddsstyrelsen, Stockholm, Sweden, Undersokningsrapport AMP 103(75).
- Locke, E.A. (ed.). 1986. Generalizing from Laboratory to Field Settings: Research Findings from Industrial - Organizational Psychology, Organizational Behavior, and Human Resource Management. Lexington, MA: Heath Lexington.
- Locke, Edwin A. and Gary P. Latham. 1984. Goal Setting: A Motivational Technique that Works! Englewood Cliffs, NJ: Prentice-Hall.
- Makinen, Pekka. 1988. Forest machine operator as entrepreneur (English summary), *Folia Forestalia* 717, The Finnish Forest Research Institute, Helsinki, Finland.

- Mann, John W. 1984. A summary of current forest engineering research and development in the United States and Canada. Unpublished paper presented at the joint meeting of the International Union of Forest Research Organizations (Division 3) and the Council on Forest Engineering, Orono, ME, Aug. 12-14, 1984.
- Manz, John. 1988. Personal communication.
- Mason, K. 1977. The effect of piecework on accident rates in the logging industry. *Journal of Occupational Accidents* 1: 281-294.
- Mattson, James A. 1985. Harvest system alternatives: the logger's toolbox. In Martin, A. Jeff (ed.), *Timber Harvesting: the Link between Management and Utilization*. SAF Publication 85-09, Proceedings of the Third Society of American Foresters Region V Technical Conference, Madison, WI, Sept. 25-27, 1985, 122-127.
- Mayo, S.C. 1962. A sociological approach to pulpwood procurement in the Appalachians. Technical Paper 62-P-73, American Pulpwood Association, Washington, DC.
- McCaffrey, David P. 1982. *OSHA and the Politics of Health Regulations*. New York: Plenum.
- McPhail, Carol B. 1989. Mechanized loggers get a break on workers' comp rates. *Clarion-Ledger, Jackson Daily News*, Jackson, MS, April 15, 1989, 4B.
- Michie, Rob. 1983. An incentive for small tree harvesting. In Robertson, Doris (ed.), *The Small Tree Resource: a Material Handling Challenge*, Proceedings 7306 of a Conference sponsored by the Forest Products Research Society and the Canadian Pulp and Paper Association, Portland, OR, April 19-21, 1982, 91-94.
- Ogburn, William F. 1922. *Social Change with Respect to Culture and Original Nature*. New York: Huebsch (Reprinted 1966, New York: Dell).
- Olsen, Eldon D. 1988. Logging Incentive Systems. Research Bulletin 62, Oregon State University College of Forest Resources, Corvallis, OR.
- Phillips, Rob. 1988. Death in the woods. *Sunday Oregonian Magazine*, Portland, OR, Nov. 13, 1988, 7-11.
- Roberts, Karlene H., Charles L. Hulin, and Denise M. Rosseau. 1978. *Developing an Interdisciplinary Science of Organizations*. San Francisco: Jossey - Bass.
- Robertson, Doris, and Julia White (eds.). 1984. *People and Productivity: Keys to a Successful Harvesting Operation*. Proceedings 7305 of a Conference Sponsored by the Forest Products Research Society and the Canadian Pulp and Paper Association, Thunder Bay, Ontario, Canada, Sept. 17-18, 1984.
- Roethlisberger, F.J., and W.J. Dickson. 1939. *Management and the Worker*. Cambridge, MA: Harvard University Press.
- Rolston, Kenneth S. 1986. Log hauling in the South. *Forest Farmer* 45(9): 28-30.
- Rolston, Kenneth S. 1988. Personal communication.
- Rolston, Kenneth S. 1989. Personal communication.
- Ronan, W.W., and G.P. Latham. 1969. The Job Performance of Pulpwood Producers. American Pulpwood Association, Harvesting Research Project, Atlanta, GA.
- Ronan, W.W., and G.P. Latham. 1970. Effective producer performance. Technical Release 70-R-1, American Pulpwood Association, New York, NY.
- Ronan, W.W., G.P. Latham, C.R. Tatro, and S. Aral. 1970. Community Variables Affecting the Pulpwood Harvesting Labor Force. American Pulpwood Association, Harvesting Research Project, Atlanta, GA.
- Santopolo, F.A. 1962. Some insights to the problems of pulpwood procurement in the southern Appalachians. Technical Paper 62-P-72, American Pulpwood Association, New York, NY.
- Sarna, R.P. 1977. A Quebec training improvement project: *The Psychological Profile of Forestry Workers* by Claude Forest and Rene Boulard. Technical Paper 77-P-25 (book review), American Pulpwood Association, Washington, DC.
- Schaefer, Richard T. 1989. *Sociology*. New York: Macgraw-Hill.
- Schuh, Donald D., and Loren D. Kellogg. 1988. Timber harvesting mechanization in the western United States: an industry survey. *Western Journal of Applied Forestry* 3(2): 33-36.
- Shaffer, Robert M. 1989. Personal communication.
- Shell, Dan. 1988a. Loggers deserve better. *Southern Loggin' Times* 17(10): 4.
- Shell, Dan. 1988b. Open mouth, insert foot. *Southern Loggin' Times* 17(11): 5.
- Shell, Dan. 1989. Exploring the procurement process. *Southern Loggin' Times* 18(1): 4.
- Sherar, James R. 1987. Environmental influences affecting machine performance and selection in the southeastern United States. In Stuart, William B. (ed.), *Proceedings of Harvesting Machines and Systems Evaluation Workshop*, Charleston, SC, Nov. 18-19, 197-201.
- Sherar, James R., and William H. Sloan. 1985. Meeting the Eastern challenge: planning and producing. Unpublished paper presented at the 8th Annual Council on Forest Engineering Meeting. Tahoe City, CA, Aug. 18-22, 1985.
- Silversides, C. Ross, Donald M. Tufts, Thomas A. Walbridge, and Steven H. Bullard. 1988. Planning and Priorities for Timber Harvesting Research in the Southern United States. Bulletin 952, Mississippi Agricultural and Forestry Experiment Station, Mississippi State, MS.
- Smith, Leo A., and Donald L. Sirois. 1982a. Ergonomic research: review and needs in southern forest harvesting. *Forest Products Journal* 32(4): 44-49.
- Smith, Leo A., and Donald L. Sirois. 1982b. Review of human factors applications in forest harvesting. In *Human Factors: A World of Human Potential*, proceedings of the 26th Annual Meeting of the Human Factors Society, Santa Monica, CA, Oct. 25-29, 1982, 271-275.
- Southern Industrial Forestry Research Council. 1986. *Priority Research Needs from a Forest Industry View*. Report No. 4, Southern Industrial Forestry Research Council/American Forest Council, Atlanta, GA.
- Stephenson, E. 1988. Unpublished and untitled paper presented at a C and S Railroad—Union Camp Corporation meeting, Baltimore, MD, October 6-7, 1988.
- Stevens, Joe B. 1979. Six views about a wood products labor force, most of which may be wrong. *Journal of Forestry* 77(11): 717-720.
- Stevenson, John. 1988. Labor. *Timber Harvesting* 36(4): 18-20.
- Stevenson, John. 1989. Start with safety: reducing workers' comp premiums. *Timber Harvesting* 37(3): 18-20.
- Stuart, W.B. 1988. Harvesting machines and systems evaluation. In Stuart, William B. (ed.), *Proceedings, Harvesting Machines and Systems Evaluation Workshop*, Blacksburg, VA, June 21-22, 1988, 100-111.
- Stuart, W.B. 1989. Personal communication.
- Sturos, John A. 1985. New harvest equipment and systems. In Martin, A. Jeff (ed.), *Timber Harvesting: the Link between Management and Utilization*. SAF Publication 85-09, Proceedings of the Third Society of American Foresters Region V Technical Conference, Madison, WI, Sept. 25-27, 1985, 155-165.
- Teikari, Eira. 1980. Methods for measuring job satisfaction. In Ager, B. (ed.), *Design of Work Systems in Forestry*. Proceedings of a I.U.F.R.O. Seminar, Garpenberg, Sweden, Sept. 21-26, 1980, 220-228.
- Ubell, Earl. 1989. Is your job killing you? *Parade Magazine*, Jan. 8, 1989, 4.

- U.S.D.A. Forest Service. 1988. The South's Fourth Forest: Alternatives for the Future. Forest Resource Report No. 24, USDA Forest Service, Washington, DC.
- U.S.D.C. Bureau of the Census. 1989. County Business Patterns 1987, Washington, DC., U.S. Government Printing Office.
- Walbridge, T.A. 1972. A Resume of the APA-HRP. American Pulpwood Association, Harvesting Research Project, Atlanta, GA.
- Warren, B. Jack, and Julian A. Raburn. 1975. Effective Management of Pulpwood Logging Crews. Timber Harvesting Report No. 1, LSU/MSU Logging and Forestry Operations Center, MSU NSTL Research Center, Bay St. Louis, MS.
- Watson, W.F., G.A. Day, Jim Altman, T.J. Straka, D.W. Domenech, and R.K. Matthes. 1989. 1987 Pulpwood Logging Contractor Survey. Technical Bulletin 162, Southwest and Southeast Technical Divisions of the American Pulpwood Association in cooperation with the Mississippi Agricultural and Forestry Experiment Station, Mississippi State, MS.
- Watson, W.F., J.M. Kucera, R.K. Matthes, and R.A. Kluender. 1977. Pulpwood Producer Census. Southwest and Southeast Technical Divisions of the American Pulpwood Association. Unnumbered Series, Mississippi Agricultural and Forestry Experiment Station, Mississippi State, MS.
- Weaver, G.H., R.A. Kluender, W.F. Watson, W. Reynolds, and R.K. Matthes. 1981. 1979 Pulpwood Producer Census. Southwest and Southeast Technical Divisions of the American Pulpwood Association. Unnumbered Series, Mississippi Agricultural and Forestry Experiment Station, Mississippi State, MS.
- Weaver, G.H., Bob Izlar, Richard Kluender, W.F. Watson and R.K. Matthes. 1982. 1980 Survey of High Volume Independent Wood Producers in the South. Unnumbered Series, Mississippi Agricultural and Forestry Experiment Station, Mississippi State, MS.
- Wilson, Ed. 1988. Workers' compensation insurance studies. Unpublished presentation at 1988 Fall Meeting of the Southwestern Technical Division, American Pulpwood Association, Inc., Jackson, MS, Nov. 9-10, 1988.
- Wilson, Ed. 1989. Workers' comp: digging in the money pit. *Timber Harvesting* 37(2): 12-14.
- Wilson, Peter, John Gaskin, and Barry Smith. 1988. Otago/Southland Logging Workforce Survey. LIRA Report Vol. 13 No. 17, New Zealand Logging Industry Research Association, Inc. Rotorua, New Zealand.
- Wilson, Shawn, and Robert M. Shaffer. 1986. An opinion survey of Virginia loggers. Unpublished paper of Virginia Polytechnic Institute and State University, Department of Forestry, Blacksburg, VA.
- Young, R.A. 1980. Sociology in Finnish forest research. *The Forestry Chronicle* 56(5): 209-212.
- Yukl, G.A., G.P. Latham, and E.D. Pursell. 1976. The effectiveness of performance incentives under continuous and variable ratio schedules of reinforcement. *Personnel Psychology* 29: 221-231.



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