THE IDENTIFICATION OF WOOD TECHNOLOGY COMPETENCIES BASED ON THE OPINIONS OF SELECTED INDUSTRY EXPERTS

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CHAPTER I

INTRODUCTION

Industrial technology programs have developed in American colleges and universities as a result of the shift in curricular emphasis in engineering education (Gardner, 1970). Norton and Rudisill (1980) explained this shift:

> In 1935, the titles of the scientist, engineer, technician, and craftsman were generally understood by both industry and academia. By 1945, a gap had occurred in industry between the scientist and engineer because education for scientists had become increasingly research oriented in response to nuclear and aerospace developmental activities (p. 65).

As a result, the additional emphasis in engineering on the physical sciences and mathematics closed the gap between the engineer and the scientist. This, however, created new gaps in the supply of personnel which American industry required to staff production management, facilities management, and to staff cost analysis and estimation functions. "The gaps in knowledge left by changes in engineering education promoted industrial technology programs" with curricula designed to meet the needs of students and to provide program graduates with broad literacy in the physical, chemical, mathematical, political and social sciences, business administration, and history and humanities with a combination of theory and laboratory courses (Lewis and Robinson, 1969, pp. 70-71).

Lewis and Robinson (1969) predicted that industrial technology programs would experience a rapid growth, an improved image and status,

and a continual change to serve the needs of students, their employers, and the institutions providing the educational services. The success of these programs is evidenced by the fact that "industrial technology is now in its second decade as a recognized program of study in institutions of higher education" (Norton and Rudisill, 1980, p. 65).

This study was directed toward one of the specialized industrial technology programs or "options," wood technology. McMurry (1980) found, while surveying the members of the Mississippi Valley Industrial Teacher Education Conference, that less than ten percent of those programs offering baccalaureate degrees in industrial technology included wood technology as either a specialization or option.

In the past, some of the middle management needs of the forest products industry have been met by wood science and technology programs. Barnes (1979), in his study entitled "Education in Wood Science and Technology: A Status Report," identified 25 undergraduate degree programs in wood science and technology; of the 25 undergraduate programs identified, eight existed as options in the traditional forestry curriculum, and seven were administered as separate wood science and technology departments while the balance existed as separate curricula in forestry or other departments. The programs identified by Barnes were housed in departments located at larger universities, primarily land-grant institutions.

In 1978, Atherton (1979) conducted a study designed to assess the forest products curriculum at Oregon State University; one of the 25 wood science and technology curricula identified by Barnes. Atherton sampled employers listed in the Directory of Forest Products Industry and the Directory of Oregon Manufacturers and included alumni from

the Oregon State forest products program. Respondents were asked to rate the importance of courses, subjects, and disciplines that were included in the forest products curriculum. With the exception of Atherton's study, no other research addressing the evaluation of existing curricula in wood science and technology was identified.

Statement of the Problem

Atherton's study of the forest products curriculum at Oregon State University involved random industry input, and included program graduates. Atherton (1979) concluded that new trends in industry may not be generally evident to many in industry. He indicated the importance of relying on "informed individuals" in industry to keep educational institutions "apprised" of new trends.

The problem with which this study was concerned was the lack of information available on the competencies needed by the wood technologist employed in the lumber, composition board, plywood, and secondary wood manufacturing industries. The resultant data may be useful for those responsible for evaluating or updating industrial technology-based wood technology curricula.

Need for the Study

The forest products industry is one of America's most important businesses. The industry is involved with the growing, harvesting, converting, and marketing of forest crops (Smith, 1974). Some of the manpower needs of the forest products industry are met by forestry and/or wood science and technology program graduates. Cornelius (1976, p. 5) suggested "an important part of the forest industry job market

that few forestry graduates consider, or apparently do not even recognize, is production." Cornelius feels there are many more people needed to manage and supervise these production operations than are needed for traditional forestry positions. "In particular, students with a strong mechanical aptitude should be encouraged to consider production as a career goal" (Cornelius, 1976, p. 5).

One subdivision of the forest products industry involved in these production operations, the wood products manufacturing industry, was operationally defined for the purposes of this study as those industries involved in the transformation of wood materials into wood products manufactured either for consumer use or to be used directly in consumer products. The pulp and paper industry was excluded from this definition as were building construction operations. Wood materials manufactured for the construction industry, however, were included as products of the wood products manufacturing industry. For the purposes of this study, the wood products manufacturing industry was further subdivided into four areas: lumber, composition board, plywood, and secondary wood manufacturing.

An industrial technology-based wood technology program designed to prepare middle management wood technologists for the wood products manufacturing industry would help satisfy a need not currently being met by traditional educational programs. Griffiths (1978) and others have identified the "severe shortage of middle management personnel" that exists in the forest products industry. This study was, therefore, designed to utilize knowledgeable people in the industry to identify those competencies needed by the wood technologist employed in the wood products manufacturing industry.

The findings of this study may be of interest to (1) institutions already operating four-year wood technology programs as a basis for curriculum revision, (2) institutions offering industrial technology degrees who might wish to consider the wood technology area as an "option," and (3) institutions interested in developing four-year wood technology programs. In addition, this study might be of interest to researchers in other industrial technology areas who are involved in curriculum revision.

Purpose of the Study

The purpose of this study was to identify those competencies needed by the wood technologist employed in the lumber, composition board, plywood, and secondary wood manufacturing industries.

Research Objectives

The following objectives were formulated to serve as a guide for this research study:

1. To compile a list of wood technologist competency statements based on responses from selected informed individuals from the four areas of the forest products industry that comprise the wood products manfacturing industry.
2. To develop a list of generalized competency statements representative of the competency statements submitted by the respondents to the initial correspondence.
3. To involve selected informed individuals from the wood products manufacturing industry in rating the importance of the

generalized competency statements developed to describe the wood technologist.

4. To compare the subject area ratings of the generalized competency statements on the basis of industry type, i.e. lumber, composition board, plywood, or secondary manufacturing, and by "all respondents" as a group.

Definitions

The following definitions were included to clarify the meanings of specific terms as they relate to this study:

Competency -- A knowledge, skill, attitude, understanding, or judgement which is required of an employee to function in his/her position.

Competency statement generalization -- A general competency statement that was written to represent a group of similar competency statements submitted by respondents.

> Curriculum -- (1) a systematic group of courses or sequences of subjects required for graduation or certification in a major field of study, for example, social studies curriculum, physical education curriculum; (2) A general overall plan of the content or specific materials of instruction that the school should offer the student by way of qualifying him for graduation or certification or for entrance into a professional or vocational field; (3) A group of courses and planned experiences which a student has under the guidance of the school or college; may refer to what is intended, as planned courses and other activities or intended opportunities or experiences, or to what was actualized for the learner, as in actual educational treatment or all experiences of the learner under the direction of the school (Good, 1973, p. 157).

Informed individual -- A person selected by a panel-of-experts to be knowledgeable in the competency needs of the wood technologist employed in the wood products manufacturing industry.

Midmanagement -- "A group of junior administrators through which the coordination responsibilities are executed; also, the stratum of management immediately below top management" (Good, 1973, p. 366).

Rating -- "An estimate, made according to some systematized procedure, of the degree to which an individual person or thing possesses any given characteristic; may be expressed qualitatively or quantitatively" (Good, 1973, p. 468).

Wood technologist -- Operationally defined for the purposes of this study as a middle management person principally involved with the coordination and management of industrial processes centered around the conversion of wood, as a raw material, into various wood products (the pulp and paper segment of the forest products industry was excluded from this definition).

Representative associations -- Those four associations selected as representing the four basic industries that comprise the wood product manufacturing industry.

Assumptions

The following assumptions apply to this study:

1. It was assumed that the informed individuals selected by the panel-of-experts were knowledgeable in the competency needs of the wood technologist in their respective industries.
2. It was assumed that the generalized competency statements agreed upon by an ad hoc committee were representative of those statements originally submitted by the informed individuals.
3. It was assumed that non-response to the correspondences was randomly distributed between the four industry areas.

CHAPTER II

REVIEW OF RELATED LITERATURE

The review of related literature has resulted from the careful investigation of a variety of sources pertaining to the forest products industry and higher education. The information is presented in the following format: (1) the forest products industry, (2) the curriculum, (3) education in wood science and technology, (4) an alternative to traditional educational programs in wood science and technology, and (5) a summary.

The Forest Products Industry

The forest products industry is America's sixth largest business from the standpoint of value added in manufacturing, accounting for approximately seven percent of the Gross National Product. "The industry employs 1.4 million people, with $15 billion in pay and benefits. It includes 57,000 companies, many of them small and family-owned" (Smith, 1974, p. 3). "Permanent forest industries contribute to our national standard of living, and are essential to the nation's economic security and welfare" (National Forest Products Association, 1978, p. 2).

"The skills required to plant, protect, cultivate, harvest, transport and convert trees into useful products are just preliminary steps" (National Forest Products Association, 1978, p. 2). The total employment

in the forest products industry extends through distribution, marketing, remanufacturing, and installation of end products in both the U.S. and worldwide.

> After a tree is harvested, its fibers may be processed in many different ways. The object is always to gain maximum utilization of the whole tree. Thus, in manufacturing, many skills are required, ranging from plant design and construction to plant management, administration, personnel planning, safety, and quality control. These combined abilities create a finished product (National Forest Products Association, 1978, p. 5).

Currently, there exists a shortage of middle management personnel within the forest product industry. According to Griffiths (1978) "numerous executives believe that there is a great handicap in maintaining and expanding production quotas" (p. 58). This has resulted in companies being forced to train their own managers or "buy" experienced individuals from other companies in the industry (Griffiths, 1978).

Ellis (1964) suggested that the scope of the forest product industry alone provided justification for specialized technical training programs. The manpower needs of the industry in both operation and research must be met if the industry "is to maintain a position of eminence" (p. 1).

In recent years, the manpower needs of industry in both general and technical fields have been met by various forms of educational institutions. One common similarity found in nearly all of these institutions is their reliance on a curriculum as a basis for instructional direction.

The Curriculum

John Dewey (1916), in his book Democracy and Education, suggested that nutrition and reproduction are to physiological life as education is to social life. Education provides a means for both the transmittal

and transformation of a culture. A primitive society may perform educational functions without schools or formal curricula simply because informational transfer can be accomplished by direct shared experience. Tanner and Tanner (1980) in Curriculum Development suggest that this is no longer a satisfactory system.

> . . . in the modern, literate, industrial society, the growing complexity of knowledge and life is such that society looks to the school and something that has come to be called the curriculum as necessary for enabling the rising generation to gain the needed insight and power to build a better society (p. 48).

The actual term "curriculum" mentioned above by Tanner and Tanner, may take on a variety of meanings. Dressel (1968), in College and University Curriculum, pointed out that the word curriculum may refer to courses or to the total range of educational experience. "Even the limited sense of the word has two distinct usages: it may include all courses offered by an institution, or it may refer to a specific program or course of study leading to a degree, certificate or diploma" (p. 193).

Tanner and Tanner (1980) suggested that the practical need of making the world more comprehensible has contributed somewhat to the problem of finding a common definition for curriculum. As a result, knowledge has been organized into thought edifices and categories which together, according to Tanner and Tanner, form the curriculum. "Although intended to serve this practical need, these edifices and compartments have come to represent a myriad of knowledge specializations, especially in the university" (p. 51).

Education in Wood Science and Technology

A Definition

The term wood science and technology has come to be used to

describe post-secondary level educational programs directed towards the forest products industry. These programs are of two types, wood science programs and wood technology programs. Ellis (1964) defined the term wood science:

> Wood science is that body of knowledge applicable to wood as a material, including its origin, properties, and characteristics. It embraces knowledge in a number of separate fields -- primarily those of chemistry, physics, biology, engineering science and mathematics. It is interdisciplinary and does not stand alone except in its dedication to a single material, wood (p. 1).

In contrast, Dana and Johnson (1963) suggested that wood technology includes all activities connected with the handling of wood after it leaves the forest, plus the scientific knowledge of wood structure and properties necessary for the intelligent conduct of these activities. Ellis (1964) elaborates on this definition as he describes the duties of the wood technologist:

> The professionally-trained wood technologist applies wood science and related knowledge in making wood more useful to man; activities which involve improvement of the properties and processing of established wood products and the development of new ones. His duties embrace a wide variety of functions, frequently including: procurement of materials; direct supervision of product functions; quality and production control; design of product and processing apparatus; and service to the industry through employment by a supplier to it. . . . His work frequently requires not only an expert knowledge of wood science, but additionally, a sound understanding of industrial manufacturing equipment and methods (p. 2).

In short, the wood technologist must combine engineering, industrial, and scientific know-how with a knowledge of the characteristics, properties, and behaviors of wood (Ellis, 1964).

Because of their interrelationship, the terms wood science and wood technology are commonly combined. Academic departments or degree options are generally titled "Wood Science and Technology" rather than strictly wood science or wood technology.

The Historical Development of Education in Wood Science and Technology

Ellis (1964) suggested that early inclusion of wood technology in the baccalaureate curriculum had its origin with the development of forestry education in this country. In 1920, a Committee of the Scope and Character of Training for Specialists in Forest Products at the Second National Conference on Education in Forestry emphasized four major points that led to the inclusion of wood technology in the forestry curriculum. Dana and Johnson (1963) summarized these four points:

1. There is a very large and as yet undeveloped field of the employment of men technically trained in wood utilization.
2. These men should have a thorough fundamental training in mathematics, physics, chemistry, and botany as a basis for later specialization in any given line, together with sufficient forestry to give them a forestry point of view.
3. Forestry schools, in cooperation with schools of engineering and science, should take the lead in securing the introduction of such curricula. This proposal reflected the committee's conviction that timber management and wood utilization are closely connected.
4. Such curricula should at first be introduced at only a few institutions, with a view to their later expansion as opportunities and demands for the graduates become apparent (pp. 294-295).

One of the most common descriptive names for courses in early forestry for what is known today as wood science and technology was the term "wood utilization." Ellis (1964) discussed the term:

> The name connotes coverage of certain phases of logging (harvesting), description of the major industries, and the principal distribution patterns for forest products, particular lumber. Other names for programs included forest products and forest utilization; the name wood technology did not appear until later, the first curriculum with its name was established in 1929 (p. 6).

The 1930's brought continued progress in the establishment of curricula dealing with one or more aspects of wood utilization. "Among

early curricula of this sort were those at the New York State College of Forestry, Michigan State College, and The University of Michigan" (Dana and Johnson, 1963, p. 295).

The importance of wood in the national economy and the need for professionally trained personnel to direct its use was emphasized strongly as a result of World War II. Dana and Johnson (1963) discussed the effect of World War II on the awareness of wood science and technology:

> Increasing demands for various purposes, coupled with decreasing supplies of high-grade material, underscored the need in the wood-using industries and in research laboratories for experts in the science of wood with special reference to its industrial utilization -- in other words, for wood technologists (p. 296).

The ultimate result of this was the inclusion by more forestry and engineering schools of wood technology in their curricula.

R. F. West (cited in Ellis, 1964), while tracing the development of programs for training men for the wood products industries in forestry schools, identified in 1951, three general and progressive stages in the development of wood technology curricula:

1. The inclusion of courses in wood identification and utilization in general forestry programs with concurrent growth or harvesting, conversion methods and forest products coverage;
2. An increased awareness by old-line wood industries of their need for technically trained men, the development of new wood-based industries and products, an increased productivity in wood utilization research including fundamental work, and the remarkable performance record of wood during the war; and,
3. Specialization resulting from the large increases in technical knowledge about wood properties.

In 1955, Wangaard reviewed college-level educational programs for the forest products industries and classified them into four major groups:

Group 1 -- Schools offering general forestry programs;

Group 2 -- Forestry schools with specialized curricula for training in the forest products industry, but without special orientation to any particular branch of the industry;

Group 3 -- Highly specialized curricula centered around wood technology and wood utilization including subjects such as retail merchandising, residential construction, pulp and paper technology, plastics and cellulose chemistry, wood technology-furniture and purchasing technology; and,

Group 4 -- Engineering schools offering specialized training in the area of construction, with some emphasis on wood in construction.

As the wood science and technology curriculum developed, those involved felt an increasing need for representation through a professional organization. As a result, they organized the American Institute of Wood Engineering in 1958. In 1960, the organization's name was changed to the Society of Wood Science and Technology. According to the organization's constitution (as cited by Dana and Johnson, 1963):

> The purpose of this society is to establish a professional basis for the pursuit of wood science and technology. Its objectives are: (1) to promulgate qualifications for admission to the profession; (2) to foster educational programs directed toward professional advancement; (3) to establish standards of practice and ethics for the profession; (4) to promote research in wood science and wood technology; and (5) to provide a medium of exchange of ideas and technical information relating to wood science and technology (p. 298).

Membership in the society was open to both qualified wood scientists and

technologists but not necessarily to anyone simply interested in the field.

The organization of the Society of Wood and Technology provided a unifying force for the profession. It was shortly after its founding that the Society published an in-depth study titled Education in Wood Science and Technology. The study published in 1964, was conducted by Everett L. Ellis and has been termed by Barnes (1979) and others as a "treatise" on education in wood science and technology.

Current Education in Wood Science and Technology

In 1978, H. M. Barnes (1979), an associate professor in the Department of Wood Science and Technology at Mississippi State University, attempted to determine the current status of education in wood science and technology. The most recent research prior to this effort had been in 1964 when Ellis published the results of a similar study.

Program Growth. Ellis (1964) identified 19 B.S. degree programs; Barnes found the number of programs in wood science and technology (WST) had increased to 25 by 1978. A similar increase in both master's and doctoral programs in wood science and technology also occurred.

> Graduate programs in WST have grown considerably since 1963. Of the 25 schools offering undergraduate programs, only two offer no advanced work. Three additional schools offer only graduate work. Twenty-six schools now offer work at the master's level, compared with 22 programs in 1963. This total represents a gain of ten new programs, yielding a net increase of 19% (p. 245).

Terminal degree programs in wood science and technology had increased by 69 percent between 1964 and 1978.

Program Emphasis. Barnes (1979) also asked respondents to describe

major changes in program emphasis that had occurred since 1963. Sixty-one percent of those responding indicated a move to the more pragmatic aspects of wood science and technology, evidenced by an increase in emphasis on business and industry, production management, etc. "The reasons given for this change were industrial needs and jobs" (p. 245). Eleven percent of those responding indicated a strengthening of the physical science and engineering aspects of their program. Eleven percent also noted increased emphasis on their pulp and paper options while eleven percent indicated a de-emphasis in wood science and technology in favor of the more traditional forestry/forest science programs. Six percent of the respondents indicated no change.

Barnes (1979) asked respondents what changes they expected over the next five years.

> Most schools foresee an increased demand for applied programs, especially with a business emphasis. Such things as an increase in emphasis and number of concentration areas or options, the beefing up of professional and technical aspects of wood as an engineering material, and emphasizing the interdisciplinary approach to studying wood were ideas often expressed (p. 245).

Barnes found faculty sizes in wood science and technology programs ranging from one to twenty with an average of approximately six per undergraduate program, representing a 78% increase in the total number of faculty between 1963 and 1978.

> When asked if their teaching budgets were adequate, 79% responded negatively. Therefore, it may be fair to say that undergraduate WST programs are carried by the research budgets of most institutions. The net result is either to decrease the department's research or, in the most likely case, to carry the teaching programs as an overload (p. 246).

Enrollment Trends. The undergraduate enrollment in wood science and technology remained fairly static during the period from 1952-1969

with an average of 104 B.S. graduates per year. The number of both M.S. and Ph.D. graduates increased slightly during this period. "The decade of the 1970's has seen a large increase in enrollment in B.S. programs, while the number of students graduating from graduate programs has remained fairly constant" (Barnes, 1979, p. 246). Barnes discussed the increase in undergraduate enrollment:

> The increasing undergraduate enrollment presents an exciting picture, although the reasons for the increase are not known. Part of the increase can be attributed to the increase in academic programs. With the increased emphasis on the environment, the resultant increase in enrollment in forestry schools has no doubt generated additional students for WST programs. Also, forest industries may now better realize the value of the professional wood technologist to their company's operations, thus creating a larger demand (p. 247).

Barnes found that currently, total undergraduate enrollment for a typical program averages about 42 students with graduate programs averaging six M.S. students and three Ph.D. students. In addition, 50% of the students enrolled in current programs in wood science and technology had chosen the more pragmatic courses of study in the areas of practical utilization and business options.

Employment of Graduates. The employment of B.S. graduates of wood science and technology programs was reported by the respondents in Barnes' study to be excellent; the demand-supply ratio of 2.3:1 at the time of the study was predicted to increase to 2.8:1. Thus, "the limited employment opportunity currently facing other graduates from forestry schools does not face WST graduates" (Barnes, 1979, p. 252).

Respondents reported that 43.0% of their graduates found employment in production and quality assurance with 22.1% accepting employment in marketing and sales. This trend was predicted by Barnes (1979) to continue.

> With respect to the employing industry, 21.9% of 1977 graduates found positions with the lumber industry, followed by 19.3% with the board industries, and 11.5% in secondary manufacturing. The large percentage of those employed in the lumber industry is perhaps surprising in light of the trend toward greater usage of plywood and composition board, products requiring more sophisticated manufacturing processes. The relatively large number of lumber operations would account for this high total. It seems likely that the composition board industry will employ an increasingly larger percentage of WST graduates in the future, since greater potential for producing engineered products exists for reconstituted products than for solid wood products (pp. 252-253).

An Update on Education in Wood Science and Technology. Barnes' (1979) original report examined the status of education in wood science and technology for the academic year 1978-79. Barnes repeated his study at the completion of the 1978-79 academic year. He found no change in the number of operating undergraduate programs in wood science and technology. Of the 25 programs in existence, eight existed as options in the traditional forestry curriculum, and seven were administered as separate wood science and technology departments, while the balance existed as separate curricula in forestry or other departments. Graduate programs increased with the addition of an M.S. degree program at Michigan Tech University and a Ph.D. program at Mississippi State University. "Other than evolutionary changes, no status changes from last year's report occurred" (pp. 251, 255).

Barnes found little change in the faculty and staffing at the various programs, however, there seemed to be developing a problem in the critical lack of faculty for the programs. The majority of existing faculty responding to the survey reported adequate current facilities and funding; 88% of those "did not expect an increase in either during the coming year" (p. 255).

Enrollments in all three wood science and technology degree programs was slightly higher than had been predicted in the previous survey. Undergraduate enrollment was up 18% and an additional 5% increase was predicted for the following year. Graduate enrollment increased only 3.5%.

> With respect to areas of concentration, most undergraduates (67%) opted for the practical, applied programs of study in utilization or business, while most graduate students (56%) were in the R & D program track (Barnes, 1980, p. 256).

Altogether, 235 students graduated from B.S. programs in wood science and technology during the 1978-79 academic year.

In Barnes' update, the forest products industry was subdivided into nine basic categories: lumber, composition board, plywood, secondary manufacture, building construction, pulp and paper, treating, forest industry suppliers, and others. The first four types of industries listed previously absorbed a majority (52.4%) of the B.S. degree graduates in wood science and technology programs from the 1978-79 academic year. Nearly three-fourths (71.9%) of the 1978-79 B.S. degree graduates in wood science and technology were employed in positions that would be termed midmanagement. Barnes found these graduates were employed in three basic job types: production and quality control, marketing and sales, and research and development. An additional 11.5% of the graduates entered graduate schools. The remainder of the program graduates entered "other" occupations.

Other Institutions Offering Related Curricula

In addition to the 25 universities having wood science and technology undergraduate programs identified by Barnes (1979, 1980), the National Association of Furniture Manufacturers (1981) identified four

additional schools with related programs. Below is a listing of those four and their corresponding departments offering the related programs:

Furniture Marketing
High Point College
High Point, North Carolina

Department of Wood Technology
School of Natural Resources
University of Michigan
Ann Arbor, Michigan

School of Furniture
Department of Industrial Engineering
North Carolina State University
Raleigh, North Carolina

School of Technology and Applied Science
Pittsburg State University
Pittsburg, Kansas

A complete listing of the 25 universities, and their department titles, identified as wood science and technology programs by Barnes may be found in Appendix A.

Curriculum Evaluation in Wood Science and Technology

The forest products curriculum at Oregon State University was one of the curricula identified by Barnes (1980) as being a wood science and technology curriculum. Atherton (1979) conducted a study entitled "Industry Appraisal of Forest Products Curriculum at Oregon State University," in which a mailed questionnaire was utilized to survey a stratified random sample of industry people including Oregon State University Forest Products graduates. According to Atherton (1979):

> The most important part of the questionnaire was rating the importance of 59 subjects, courses, or disciplines within the university with respect to their importance to the individual in his or her present job. Respondents were given choices of 'very important,' 'important,' 'not too important,' or 'not important at all' (p. 265).

Respondents ranked the forest products subjects in plant layout, residue utilization, forest products merchandising, strength properties, physical properties, wood identification, lumber manufacturing, forest products markets, wood chemistry, plywood manufacturing, kiln drying, adhesives, wood treating, and wood anatomy as being "important" or "very important." The forest products subjects or courses in pulp and paper manufacturing, coatings and overlays, composition board manufacturing, timber design, and glulam manufacturing were ranked as being "not too important" or "not important at all." Atherton also further categorized the results of the questionnaire by levels of management, type of industry, and age of respondent.

Atherton asked respondents to rate basic courses included in the forest products curriculum. Courses in statistics, psychology, operations research, physics, and critical-path scheduling were rated as "important" or "very important," and the basic courses in electronics, linear programming, computer simulation, organic chemistry, inorganic chemistry, sociology, botany, calculus, and differential equations as "not too important" and "not important at all."

Each of the business courses included in the forest products curriculum at Oregon State, i.e., economics, production management, management science, accounting, finance, marketing, business law, and data processing, were rated as either "important" or "very important." The industrial engineering discipline was rated as "important" or "very important," however, the disciplines of mechanical engineering, forest management, structural engineering, chemical engineering, forest engineering, electrical engineering, and civil engineering were rated by the respondents as "not too important" or "not important at all."

The communications skill courses in English, report writing, and speech were all rated as "important" or "very important." The miscellaneous courses or subjects in the forest products curriculum in management and labor relations, environment, plant safety, power generation, scaling, and crusing, and logging methods were all rated as either "important" or "very important."

Overall, Atherton (1979) found that communications skills were ranked among the highest subjects by all groups. "Obviously those in industry believe that ability to communicate effectively is a prerequisite to technical and professional effectiveness" (p. 269). Business courses in general were ranked highest by top management with the level of importance declining with decreasing management responsibility. According to Atherton, with few exceptions, "basic courses were ranked lowest by most groups" (p. 270). Also, study in the areas of forest management and engineering were also ranked low with exception of those respondents employed in the paper industry, who ranked chemical, industrial, and mechanical engineering relatively high, "probably because 32% of the respondents in the paper industry were engineers and an additional 15% had some engineering training" (p. 270).

Atherton concluded the report of his study with the following statements:

> We in a university should be responsive to new developments and impending changes within industry and should adapt our curriculum to meet needs. However, new trends may not be generally evident to many in industry, and such trends would not be indicated by a survey. Therefore, we must rely on informed individuals in industry, to apprise us of new trends, or we must maintain close contact with industry so that we ourselves may recognize changes. If we in the university become aware of powerful new tools, techniques, or subjects of future value to industry, we must consider introducing training in these areas into the curriculum. Because, in such an instance, those in industry might be unaware of the capabilities

> of such tools or techniques, the 'new' probably rate low on a survey. It therefore falls upon educators to anticipate as well as be responsive to needs (p. 274).

An Alternative to Traditional Educational Programs in Wood Science and Technology

Introduction

From its earliest beginnings, wood technology curricula included a liberal amount of material relating to forest management, "a situation that has come about in part because of the desire of forestry schools to have graduates of wood technology curricula eligible for membership in the Society of American Foresters" (Dana and Johnson, 1963, p. 296). Ellis (1964) added the following:

> . . . the future relationships between wood science and technology and forestry may become strained or broken due to a drawing apart of these fields as greater and greater degrees of intensification and specialization in both develop (p. 9).

The differences that have emerged between wood science and technology and forestry become especially significant when considered in terms of the geographical locations and limited program numbers. The location of all of the 29 institutions previously identified, with the exclusion of two, are at major universities that operate forestry and/or engineering schools. Since a vast majority of the graduates of wood science and technology programs find employment in positions classified as midmanagement, it seems likely that other educational programs also directed towards this level of employment might be adaptable to the forest products industry. The inclusion of wood technology to these programs could make education more accessible to students, who for various reasons are unable to attend the larger universities, and ultimately supply the forest products industry with needed midmanagement personnel.

Four-Year Degree Programs in Industrial Technology

Four-year industrial technology programs have been developed within the industrial education departments in many former teacher-training institutions in response to a desire to broaden their curricula into other industry-related areas. Kleintjes (1969) attributed the emergence of these four-year industrial technology programs to three developments:

> The change in emphasis in engineering curricula. Increasing emphasis on mathematics and science in the engineering curricula to cope with the complex advancements in technology has gradually eroded the course offerings in shop or skill subjects and left little room for managerial- and personnel-related courses.
>
> The increased enrollments in two-year technical programs of persons capable of continuing in four-year programs. This has brought about a demand for 'transfer' type courses in the technical programs. Out of this development has emerged an articulation in which the greater portion of the skills are handled in the two-year program with emphasis on advanced techniques, supervisory and management offerings, and the rounding out of general educational experiences associated with the baccalaureate degree.
>
> The continually increasing demand by industry for supervisory and management personnel and persons with a combination of technical and general education characteristics to take over areas no longer compatible with modern engineering preparation (p. 115).

The graduates of these four-year programs in industrial technology are often termed "industrial technologists." A presentation at the 1966 American Vocational Association Convention titled "A Progress Report for Four-Year Technology Committee" provided a description of the industrial technologist:

> . . . a college graduate who is associated with managerial and scientific activities in the industrial field. He has a solid background in mathematics, physical sciences, and human relations with extensive educational experience in technical theory and manipulative abilities in the field of specialization as well as closely related fields. He is able to work with scientific personnel and contribute to their ideas as well as to supervise and manage people and to coordinate their

> efforts in the utilization of materials and machines for producing and distributing industrial products (p. 2).

In recent years, a large number of post-secondary programs dealing with the preparation of middle level workers for the manufacturing industries have been developed. Gillie (1973) discussed this:

> A proliferation of post-secondary programs has occurred, particularly during the past twenty years, in response to the great variety of manufacturing-related middle level workers needed (p. 23).

Gillie suggested also that new types of manufacturing-related middle level training programs would evolve and respond to continued advances in technology.

The Current Status of Four-Year Industrial Technology Programs

McMurry (1980) utilized a mailed questionnaire to survey 53 members of the Mississippi Valley Industrial Teacher Education Conference who were listed as department heads/chairmen in the 1978-79 Industrial Teacher Education Directory. Forty-two of the people surveyed returned completed questionnaires; a return rate of 79.25%.

> A total of fifty-seven different technology type programs were reported by thirty-two of the forty-two respondents. This included twenty-six associate, or two-year programs, twenty-four bachelor's level programs, and seven master's level programs (p. 57).

Four different degrees were reported as earned by graduates of the technology-type programs. These included a Bachelor of Science and Bachelor of Arts at the undergraduate level and the Master of Science and Master of Arts at the graduate level. An Associate degree and a one-year certificate were awarded by schools offering the one- or two-year programs.

Enrollments in the various degree programs in technology were reported by McMurry (1980, p. 59) in the following manner: "Based on the data furnished by the respondents, a total of 1,040 students were enrolled in two-year or associate programs, 7,464 in four-year or bachelor's programs, and 272 in master's programs."

Altogether, the respondents identified 35 areas in which options or majors in industrial technology were offered. Of the 42 respondents, only three schools provided an industrial technology option in the "woods" area. Since 32 of the 42 respondents indicated having industrial technology programs, "woods" was represented in less than ten percent of the industrial technology programs at the time of McMurry's study.

Meeting the Midmanagement Needs of the Forest Products Industry Through Industrial Technology Programs

Designing an industrial technology curriculum that would address the needs of the forest products industry would involve integrating "wood-related" technical information into the existing industrial technology curricula. A curriculum tailored to the forest products industry would necessarily need to be narrower in terms of the breadth of the traditional industrial technology curricula. Gillie (1973) discussed broad- and narrow-based curricula.

> The broad-based program is designed to prepare people for a large number of jobs in a broadly defined occupational area. The occupation-related courses in such curricula emphasize the foundational aspects of the occupational area and deal primarily with cognitive applications . . . specific skill development is either limited to a small part of the last occupational courses in the sequence or is omitted completely (pp. 114-115).

Gillie (1973) further suggested that there exists a tendency for many "non-occupational" educators to automatically favor programs that aim at broad occupational areas as opposed to narrow, specialized programs primarily because broad programs provide students with more occupational titles to choose from. "While this makes for attractive reading in the college catalog and brochure, the question of curriculum orientation should not be directed on that basis" (p. 114).

Although the narrow-based program is equal in length to the broad-based program, several differences exist:

1. Most of the courses in the narrow-based curriculum are directly oriented to preparation for specific job entry;
2. The courses in the narrow-based curriculum are usually conducted at a practical level and are designed to deal with potential jobs; and,
3. While laboratory activities in the broad-based curricula serve to examine principles and laws, laboratory programs in narrow-based programs provide a place for the student to develop and practice specific skills necessary for job entry (Gillie, 1973).

A specialized narrow-based curriculum designed to meet the midmanagement needs of the forest products industry would involve the identification of specific technical information relating to that industry. This data, integrated with the general requirements of the broader-based industrial technology program would provide an alternative to the wood science and technology curricula that have traditionally been relied on to supply some of the midmanagement needs of the forest products industry.

Summary

This chapter has presented, initially, a brief overview of the magnitude and importance of the forest products industry. Current literature, as well as telephone conversations with industry leaders, has indicated that there is a great need for midmanagement personnel principally involved with the coordination and management of industrial processes centered around the conversion of wood, as a raw material, into various wood products.

Some of the industry needs at the midmanagement level in the past have been met by the degree programs in wood science and technology. Barnes surveyed these programs in 1978 to determine their status at that time; he identified 25 educational programs offering education in wood science and technology. In addition to these, four other related programs were identified from various sources.

Traditionally, the main concentration of education in wood science and technology has been located within schools of forestry. As a result, many of the programs still reflect a strong forestry influence. This has brought forth a criticism that some of the curricula are tied too closely to traditional forestry education and are not industry related. Atherton (1979) found that the respondents to his study ranked both the disciplines of forest management and forest engineering as either "not too important" or "not important at all."

Another problem relating to the forestry involvement that exists within education in wood science and technology has been the limited number of programs offered. Because of their close developmental association with schools of forestry and/or engineering, most of the existing programs in wood science and technology have been limited to large universities; schools not available to many students.

The changing roles of the scientist and engineer in American society have created a need within industry for personnel trained for midmanagement positions. As a result, industrial technology programs have evolved, initially from two-year programs, into one means of meeting this industry need. Few industrial technology programs, however, have been developed specifically to meet the needs of the forest products industry. A technical program of this nature would offer several advantages to traditional methods of preparing midmanagement workers. The proliferation of industrial technology programs during the 1960's and 1970's has resulted in the development of many programs at the junior/community college level in addition to those at many traditional state teachers colleges. As a result, technical education at these institutions has been accessible to a large number of potential students.

It is for these previously mentioned reasons -- that is, that there have been problems resulting from the close association of wood science and technology and traditional forestry programs, and that industrial technology programs have established their credibility in training middle level workers for industry -- that this study has been directed towards identifying those competencies needed by the wood technologist based on the opinions of experts from the forest products industry. Ultimately, this informaion may be utilized for developing an industrial technology specialization, designed to meet some of the midmanagement needs of the forest products industry.

CHAPTER III

METHODOLOGY

Chapter III describes the procedures utilized in the execution of this research study including the selection of subjects, instrument development, data collection and analysis, and research limitations. The general purpose of the study was to identify those competencies needed by the wood technologist employed in the wood products manufacturing industry; a broad industrial category comprised of the lumber, composition board, plywood, and secondary manufacturing industries. The identification of such competencies may be used (1) for the development of an industrial technology-based wood technology program, (2) for the evaluation of current wood technology programs, and (3) as the basis for communications between the wood products manufacturing industry and the educational sector.

Selection of the Subjects

Employment in the forest products industry was categorized by Barnes (1980) into nine basic industry types: lumber, composition board, plywood, secondary manufacture, building construction, pulp and paper, treating, forest industry suppliers, and others. The first four of these industry types were selected, by definition, to comprise the wood products manufacturing industry because of their commonality of involvement in wood material transformation. It was these four basic

industry types, lumber, composition board, plywood, and secondary manufacture that were the focus of this study.

This study was also concerned with utilizing the opinions of "informed individuals" within these four basic industries previously identified. The decision to utilize informed individuals as subjects, rather than a random industry sample, was based on Atherton's (1979) recognition of utilizing informed individuals to keep educational institutions abreast of "new developments and impending changes within industry" (p. 274).

The process of identifying these informed individuals within each of the four wood product manufacturing industries involved the use of a panel-of-experts comprised of executive officers from four associations. The associations were selected with the aid of Dr. J. E. Langwig, Professor of Forestry, Oklahoma State University, because of their predominance within the industries. Below are listed the four basic industries and Akey's (1981) descriptions of the associations selected to represent them.

Lumber -- National Hardwood Lumber Association

> Founded: 1898. Members: 1400. Staff: 80. United States and Canadian hardwood lumber and veneer manufacturers, distributors, and consumers. Inspects, measures, and certifies hardwood lumber. Maintains inspection training school and conducts short courses at members' lumber yards. Sponsors Hardwood Institute, a promotion program in U.S. and Canada. Maintains library of 1000 volumes (p. 111).

Composition Board -- National Particleboard Association

> Founded: 1960. Members: 20. Staff: 9. Mat-formed wood particle-board and medium density fiberboard manufacturers interested in establishing industry commercial standards with the Department of Commerce and quality standards for performance. Presents awards; compiles statistics; conducts several industry surveys. Publishes promotional and technical bulletins (p. 111).

Plywood -- Hardwood Plywood Manufacturers Association

Founded: 1921. Members: 170. Staff: 18. Manufacturers and pre-finishers of hardwood plywood; affiliate members are suppliers of glue, veneer, machinery and other products to the industry. Conducts laboratory testing of plywood, adhesives, flour, finishes, flamespread and smoke density. Performs glue bond, flamespread and structural listing services. Provides public relations, advertising, marketing, and technical services to members. Represents the industry in legislative matters and keeps members informed on tariff and trade actions. Presents awards. Compiles statistics on hardwood plywood shipments, imports, and uses. Maintains placement service and library of 300 volumes on hardwood plywood manufacturing and uses (p. 110).

Secondary manufacturing -- National Association of Furniture Manufacturers

Founded: 1928. Members: 400. Staff: 14. Manufacturers of household furniture. Associate members are suppliers to the household furniture industry. Provides market research data; industrial relations services; legislative service; scientific, technical and management consulting services; costs and operating statistics; transportation information; and general management and information services. Collects statistics; develops quarterly Econometric Forecast; conducts technical research and consumer marketing research. Co-sponsors International Woodworking Machinery and Furniture Supply Fair, held biennially in Louisville, Kentucky (p. 118).

The chief executive officers of each of the four associations were requested by telephone to identify ten individuals within their respective industries who would be most knowledgeable of the competency needs of the wood technologist. The four lists of names, submitted by this panel-of-experts, identified the 40 individuals who were the subjects in this study.

Development of the Instrument

Van Dalen (1979) suggested that researchers in educational, governmental, industrial, and political organizations often conduct surveys to find solutions for problems. "They collect detailed descriptions of

existing phenomena with the intent of employing the data to justify current conditions and practices or to make more intelligent plans for improving them" (p. 286).

This research study was designed to collect information relating to the competencies needed by the wood technologist employed in selected areas of the forest products industry. Because of the geographic dispersion of the subjects (informed individuals) in the study, a mailed questionnaire was utilized as a survey instrument. According to Van Dalen (1979, p. 153), "mailed questionnaires reach many people in widely scattered areas quickly and at a relatively low cost". Additionally,

> For some studies or certain phases of them, presenting respondents with carefully selected and ordered questions is the only practical way to obtain data. Isolating specific questions for consideration tends to objectify, intensify, and standardize the observations that respondents make (pp. 152-153).

Atherton's (1979) survey of the forest products industry, as a means of evaluating the forest products curriculum at Oregon State University, was based on a questionnaire developed from existing curricular offerings. Since this research study was designed to obtain information that could be used for the development of a wood technology curriculum not already in existence, it was necessary to use a different method of instrument development than the one employed by Atherton.

Initially, the subjects were mailed Correspondence No. 1 which requested them to list the competencies they thought should be possessed by a wood technologist employed in one of the four industries that comprise the wood products manufacturing industry. For example, those subjects identified as being knowledgeable of the needs of the lumber industry were asked to list the competencies needed by the wood

technologist employed in the lumber industry; those identified to be knowledgeable in the needs of the composition board industry were asked to list competencies needed by the wood technologist employed in the composition board industry. A sample of each of the initial personalized cover letters and Correspondence No. 1 forms mailed to the informed individuals in each of the four industries surveyed was included in Appendix B.

The competency statements submitted by the respondents to Correspondence No. 1 were then analyzed and grouped on a basis of similarity. An ad hoc committee was organized to review each of the competency statement groupings and, as a result, 47 "generalized competency statements" were written to reflect the content of each of these groupings.

Correspondence No. 2 consisted of a questionnaire that was developed by randomly ordering the 47 generalized competency statements, submitted by the respondents to Correspondence No. 1, utilizing a table of random numbers from Kerlinger's (1973) Foundations of Behavioral Research. It required the subjects to rate, on a scale of one-to-ten, the importance of each of the generalized competency statements as it applied to their industry. A preliminary form of Correspondence No. 2 was pretested with a selected group of graduate students and professors. Suggestions for revision were utilized and the revised instrument was approved for mailing to the subjects. Correspondence No. 2 and the personalized cover letter explaining it, were illustrated in Appendix E.

Collection of the Data

The first phase of the data collection procedure was initiated

early in December 1981, when the four executive officers of the representative associations were contacted by telephone and requested to identify ten individuals who would be knowledgeable of the competency needs of the wood technologist employed in their respective industries.

February 1, 1982, the 40 subjects identified previously were mailed cover letters and Correspondence No. 1 forms. A word processor was utilized to personalize each correspondence to both the individual and to the type of industry he/she was involved with. The following week, telephone contact was established with the offices of each of the identified "informed individuals" to answer any questions they might have regarding the study and to encourage completion of the initial questionnaire, Correspondence No. 1. On March 1, a follow-up mailing was sent to those subjects who had failed to return the original forms. In both cases, numerical coding was utilized as a method of accounting for returned questionnaires.

The second phase of the data collection process involved mailing Correspondence No. 2; a questionnaire consisting of "generalized competency statements" derived from the Correspondence No. 1 completed forms. The decision to involve all 40 of the original subjects, and not simply those initially returning Correspondence No. 1, was made after evaluating a similar research design utilized by Russo in 1976. Russo found that subsequent mailings to the same group of subjects produced increasingly higher return rates. Because of the relatively small number of subjects involved in this study, and their identfied status as "informed individuals," each of the original subjects were mailed Correspondence No. 2 regardless of their response to Correspondence No. 1.

Correspondence No. 2 and a personalized cover letter were mailed on

April 8, 1982. The forms were numerically coded to allow the researcher to account for those subjects returning questionnaires. On April 24, a second mailing to non-respondents was initiated which included a personalized cover letter, urging questionnaire return, and a second copy of Correspondence No. 2 (the follow-up cover letter for Correspondence No. 2 was illustrated in Appendix E). A telephone follow-up was initiated on May 4 for those subjects still failing to return Correspondence No. 2 forms, and May 8, 1982, was selected as a cut-off date for accepting any further returns.

Analysis of the Data

Initial data analysis began with grouping the competency statements submitted by those subjects responding to Correspondence No. 1. An ad hoc committee was utilized to make recommendations for both the groupings and the wording of the "generalized competency statements" that were designed to be representative of each of the groupings.

Each of the generalized competency statements that were the basis of Correspondence No. 2, were categorized by the ad hoc committee into one of four basic categories. The four categories -- forest products, communications, business, and industrial engineering -- were derived from six basic categories utilized earlier by Atherton (1979). Atherton's categories had been developed from existing curricular offerings in the Oregon State University forest products program. Atherton's categories and the courses included in each were listed below:

1. Forest products courses or subjects -- consisting of plant layout, residue utilization, FP merchandising, strength properties, physical properties, wood identification, lumber manufacturing, forest products markets, wood chemistry, plywood manufacturing, kiln drying, adhesives, wood treating, wood anatomy, pulp and paper manufacturing,

coatings and overlays, composition board manufacturing, timber design, and glulam manufacturing;

2. Communications skills courses -- consisting of English, report writing, and speech;

3. Business courses -- consisting of economics, production management, management science, accounting, finance, marketing, business law, and data processing;

4. Basic courses -- consisting of statistics, psychology, operations research, physics, critical-path scheduling, electronics, linear programming, computer programming, computer simulation, organic chemistry, inorganic chemistry, sociology, botany, calculus, and differential equations;

5. Disciplines -- consisting of industrial engineering, mechanical engineering, forest management, structural engineering, chemical engineering, forest engineering, electrical engineering, and civil engineering; and,

6. Miscellaneous courses or subjects -- consisting of management and labor relations, environment, plant safety, power generation, scaling and cruising, and logging methods.

Because of the nature of the responses submitted on Correspondence No. 1, the ad hoc committee chose to adopt only three of Atherton's categories: forest products, communications, and business. The committee then selected the category of "industrial engineering," rather than "disciplines," because it more closely reflected the main emphasis of several generalized competency statements.

Correspondence No. 2 provided a "one-to-ten" rating scale for each of the generalized competency statements. The mean value on the rating scale was 5.50. The lower one-fourth of the rating scale would, therefore range from 1.00 to 3.25 followed by the scale segment extending to the rating scale mean (3.25 to 5.50). The rating scale segment extending from 5.50 to 7.75 would indicate the area between the rating scale mean and the upper one-fourth of the rating scale. Finally, the rating

scale segment extending from 7.75 to 10.00 would indicate the upper one-fourth of the rating scale.

Item mean ratings for the generalized competency statements were calculated by computing the arithmetic means for responses to individual competencies items. Standard deviations were calculated for each item response to illustrate variability.

Returned questionnaires from Correspondence No. 2 were then grouped as either being from the lumber, composition board, plywood, or secondary manufacturing industries; the four basic industry types previously identified as being components of the wood products manufacturing industry. The generalized competency statement ratings (item ratings) were computed across each of the four industry types and then across all of the respondents as a whole.

Finally, the arithmetic means of the item ratings were grouped utilizing the four subject categories selected by the ad hoc committee. The resulting "mean response ratings" were compared across each of the subject area categories and then by each of the industry types as a means of empirically identifying differences in subject area ratings between the four industry types.

Because of the limited number of subjects in the study, the use of arithmetic means, standard deviations, percentages, and rankings were the only descriptive measures utilized. No statistical procedures to evaluate real differences in ratings between groups were utilized. Also, since subject selection was a nonrandomized procedure, no attempt was made to make any inferences to a larger population.

Limitations

The findings of this study were confined to those subjects identified

as being knowledgeable in the competency needs of the wood technologist employed in the four industries that comprise the wood products manufacturing industry. Therefore, the results are not necessarily representative of the thinking of other individuals at various managerial levels within the forest products industry or in other areas of the forest products industry.

Similarly, since no statistical determinations of significant difference between the various responses and various groups were made, small differences between the ratings or rankings of various questions or groupings of questions may not, in fact, have represented real differences.

CHAPTER IV

RESULTS

This study was based on the opinions of the 40 informed individuals selected by a panel-of-experts as being knowledgeable in the needs of the wood products manufacturing industry. Following the collection of data through mailed questionnaires, Correspondences No. 1 and 2, the findings were tabulated and analyzed by the appropriate techniques to meet the purpose and objectives of the study. Because of the nature of the study and the subject selection method, only descriptive statistics were utilized.

Return Rates

Correspondence No. 1

By February 28, 1982, a total of 20 questionnaires had been returned. On March 1, 1982, a follow-up letter, which included a coded copy of Correspondence No. 1 and a pre-addressed stamped envelope, was mailed to those respondents not returning the initial questionnaires. By March 15, a total of 26 of the original 40 informed individuals had returned questionnaires; a return rate of 65.0 percent. Figure 1 was used to illustrate Correspondence No. 1 returns by industry type.

An ad hoc committee was formed when the initial data gathering process for Correspondence No. 1 was complete. The committee agreed upon 47 generalized competency statements to be used for the development

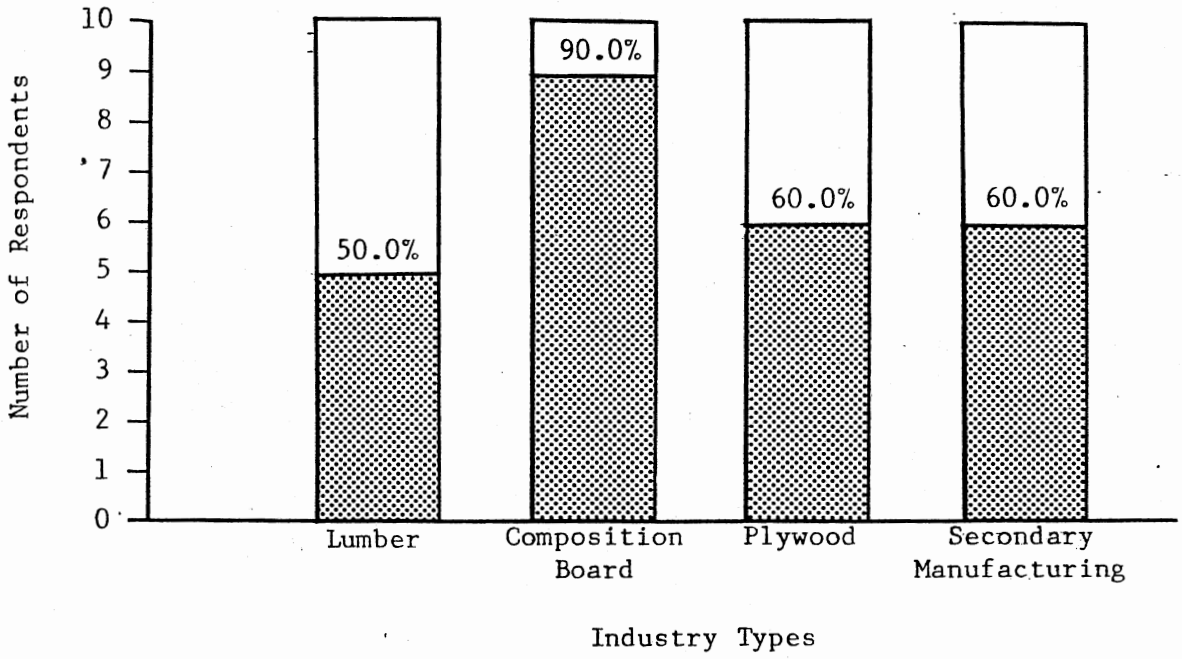

Figure 1. Correspondence No. 1 Returns By Industry Type

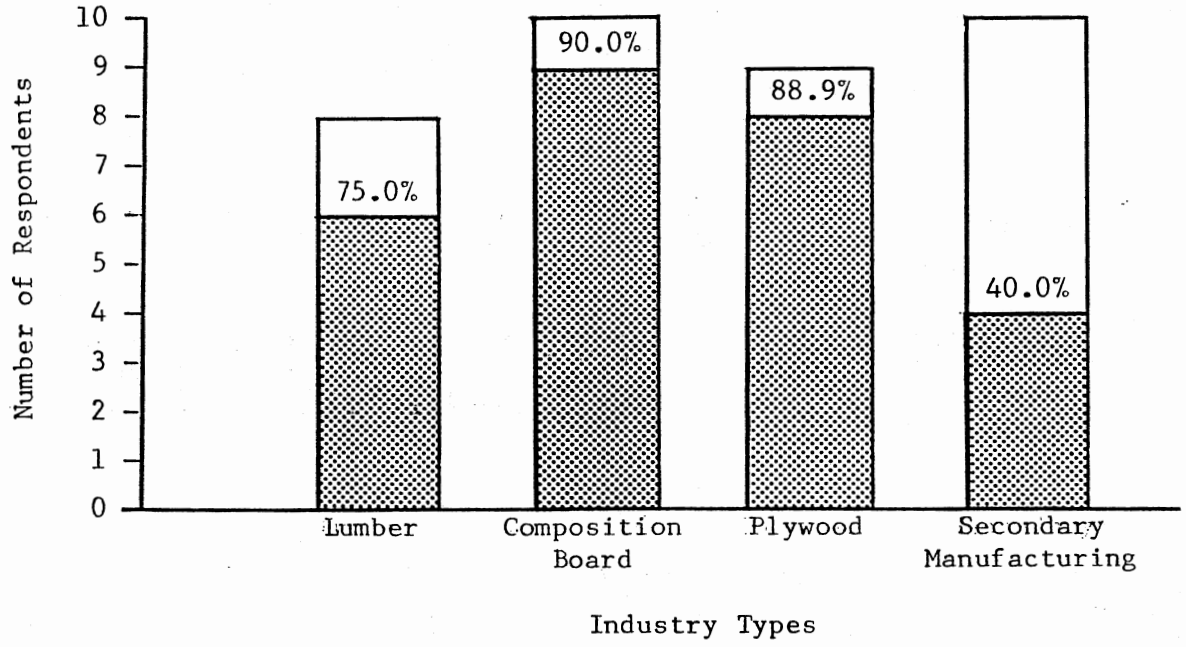

Figure 2. Correspondence No. 2 Returns By Industry Type

of Correspondence No. 2. Additionally, each of the 47 generalized competency statements were categorized as being components or either forest products, communications, business, or industrial engineering subject areas.

Correspondence No. 2

The initial mailing of Correspondence No. 2 on April 8, 1982, included 37 of the original 40 informed individuals. Three of the original subjects returned letters, with uncompleted questionnaires, indicating that they felt too far removed from production to be currently knowledgeable in the competency needs of the wood technologist. Also, six of the remaining 37 subjects assigned other management personnel within their companies to complete Correspondence No. 1; Correspondence No. 2 was mailed to those six people rather than to the six original subjects.

By April 23, 1982, a total of 20 questionnaires had been returned. On April 24, a second mailing to non-respondents was initiated which included a personalized cover letter and a second copy of Correspondence No. 2. By May 1, a total of 24 questionnaires had been returned and on May 4, a telephone follow-up was initiated for those subjects still not responding to Correspondence No. 2. By May 8, 1982, the date selected as a cut-off date for data gathering, a total of 27 of the 37 Correspondence No. 2 forms had been returned. The findings of this study, therefore, were based on a 73.0 percent rate of return. Figure 2 was used to illustrate Correspondence No. 2 returns by industry type.

Data Summary

The data from this research study were collected through the use of

two instruments, Correspondences No. 1 and 2. The data summary, therefore, was presented in two parts. The first part, Data from Correspondence No. 1, examined the findings of the first questionnaire, and the development of competency statements that were used as a basis for Correspondence No. 2. The second part of the data summary examined the data collected from subjects responding to the second questionnaire, Correpondence No. 2.

Data From Correspondence No. 1

Correspondence No. 1 asked the informed individuals to list the competencies they felt were needed by the wood technologist employed in the lumber, composition board, plywood, or secondary manufacturing industries; the four industry types identified as comprising the wood products manufacturing industry. Responses from the 26 subjects returning Correspondence No. 1 forms produced 352 competency statements. The statements submitted were included in Appendix C.

An ad hoc committee was organized to develop a list of "generalized competency statements" based on the original 352 statements submitted by the respondents. The outcome of the committee action was the formulation of 47 generalized competency statements that became the basis for Correspondence No. 2. The original competency statement groupings were illustrated in Appendix D. Also, those original competency statements that were excluded by the ad hoc committee (for reasons of irrelevance or redundancy) were included in Appendix D.

The ad hoc committee, organized previously, was then utilized to categorize the generalized competency statements by subject area. The committee analyzed Atherton's (1979) six subject area categories and

made the decision to adapt the following three to this study: "forest products," "communications," and "business." A subject area category of "industrial engineering" was selected by the committee as a fourth area.

Twenty-seven of the 47 generalized competency statements were identified as being components of the forest products subject area while four were identified as being in the communications subject area. The business subject area was comprised of 12 generalized competency statements and the industrial engineering subject area was assigned four of the generalized competency statements. The categorization of the generalized competency statements by subject area has been illustrated in Tables I, II, III, and IV.

At this point, the 47 generalized competency statements were randomly ordered on Correspondence No. 2 utilizing a computer generated table of random numbers (Kerlinger, 1973). The subjects in the study were asked to rate the importance of each of the generalized competency statements on a ten-point continuum; a "10" being most important, a "1" being least important. After pre-testing, a revised questionnaire was developed and utilized for Correspondence No. 2 (Correspondence No. 2 was illustrated in Appendix E).

Data From Correspondence No. 2

Those subjects responding to Correspondence No. 2 rated each of the generalized competency statements on the ten-point continuum. The arithmetic mean for each item was calculated for "all respondents" and for respondents by industry type, i.e. lumber, composition board, plywood, and secondary manufacturing. Standard deviations were also calculated in order to evaluate the variability of the responses for

TABLE I

GENERALIZED COMPETENCY STATEMENT RATINGS
FOREST PRODUCTS SUBJECT AREA

No.	Generalized Competency Statements	n=6 Lumber means (SD)	n=9 Composition Board means (SD)	n=8 Plywood means (SD)	n=4 Secondary Manufacturing means (SD)	n=27 All Respondents means (SD)
2.	The wood technologist should have a knowledge of the utilization of veneered products.	6.33 (2.07)	5.44 (2.30)	8.50 (1.69)	8.00 (0.82)	6.93 (2.29)
4.	The wood technologist should have a specific understanding of basic woodworking.	7.17 (1.33)	5.89 (2.62)	8.00 (2.33)	8.75 (1.26)	7.22 (2.29)
6.	The wood technologist should have a basic understanding of wood conversion processes.	7.33 (1.03)	7.22 (1.64)	8.75 (1.49)	9.25 (0.96)	8.00 (1.57)
7.	The wood technologist should have a knowledge of the sharpening of wood cutting tools.	3.50 (1.87)	4.56 (1.42)	5.63 (2.00)	6.75 (1.26)	4.96 (1.93)
9.	The wood technologist should understand the quality control of forest products and implement quality control techniques.	8.33 (2.07)	8.33 (1.80)	8.63 (1.06)	8.25 (1.26)	8.41 (1.53)

TABLE I (Continued)

No.	Generalized Competency Statements	n=6 Lumber means (SD)	n=9 Composition Board means (SD)	n=8 Plywood means (SD)	n=4 Secondary Manufacturing means (SD)	n=27 All Respondents means (SD)
11.	The wood technologist should have an understanding of the finishing technology related to the finishing of wood.	7.50 (1.87)	6.33 (1.80)	7.75 (1.91)	8.25 (1.71)	8.41 (1.88)
14.	The wood technologist should be able to relate laboratory research techniques to full scale plant requirements.	7.83 (2.22)	6.44 (3.32)	8.38 (1.41)	8.00 (0.82)	7.55 (2.38)
17.	The wood technologist should have an understanding of basic furniture design; strength of various joining techniques.	6.17 (2.40)	5.00 (2.00)	6.00 (1.93)	7.75 (1.71)	5.96 (2.12)
18.	The wood technologist should have an understanding of forest products marketing.	7.33 (1.86)	6.67 (2.06)	5.50 (1.31)	6.25 (1.31)	6.41 (1.82)
22.	The wood technologist should have a knowledge of the anatomical structure of wood.	6.67 (2.16)	6.89 (3.41)	8.13 (1.55)	8.50 (1.91)	7.44 (2.47)
25.	The wood technologist should have a knowledge of packaging, warehousing, and transporting forest products.	6.33 (2.07)	5.22 (2.73)	6.13 (1.81)	5.75 (2.06)	5.81 (2.17)
26.	The wood technologist should have an understanding of adhesive technology related to gluing of wood.	7.17 (3.25)	7.89 (1.96)	8.63 (1.69)	8.75 (1.50)	8.07 (2.15)

TABLE I (Continued)

No.	Generalized Competency Statements	n=6 Lumber means (SD)	n=9 Composition Board means (SD)	n=8 Plywood means (SD)	n=4 Secondary Manufacturing means (SD)	n=27 All Respondents means (SD)
28.	The wood technologist should have a knowledge of lumber grading procedures.	8.33 (1.86)	4.00 (2.65)	7.13 (1.46)	8.00 (1.83)	6.48 (2.68)
29.	The wood technologist should have a knowledge of wood drying methods and procedures.	8.33 (1.33)	5.78 (2.59)	7.25 (2.19)	8.75 (1.50)	7.22 (2.38)
30.	The wood technologist should have a knowledge of materials commonly substituted for wood products.	6.17 (1.17)	5.44 (1.94)	6.25 (1.75)	6.50 (1.73)	6.00 (1.66)
31.	The wood technologist should be acquainted with the primary equipment present in board manufacturing and processing plants.	7.67 (1.63)	7.00 (1.66)	8.38 (1.60)	7.50 (1.73)	7.63 (1.64)
32.	The wood technologist should have a knowledge of the control of damage to logs.	8.17 (1.94)	3.56 (2.79)	6.25 (1.39)	7.00 (2.94)	5.89 (2.82)
34.	The wood technologist should have a knowledge of the principles of biological deterioration of wood.	7.83 (1.83)	5.56 (3.43)	7.25 (2.25)	6.50 (2.65)	6.70 (2.70)

TABLE I (Continued)

No.	Generalized Competency Statements	n=6 Lumber means (SD)	n=9 Composition Board means (SD)	n=8 Plywood means (SD)	n=4 Secondary Manufacturing means (SD)	n=27 All Respondents means (SD)
35.	The wood technologist should be knowledgeable in the identification of woods.	8.83 (1.33)	6.33 (3.20)	8.88 (1.46)	8.75 (1.26)	8.00 (2.39)
36.	The wood technologist should have a knowledge of the machining characteristics of various wood species.	7.33 (1.37)	6.44 (2.60)	8.00 (1.20)	8.50 (1.29)	7.41 (1.91)
37.	The wood technologist should have an understanding of wood preservation.	7.33 (1.75)	5.44 (2.70)	7.00 (1.85)	7.25 (2.06)	6.59 (2.22)
39.	The wood technologist should have a knowledge of the physical and mechanical properties of wood.	7.83 (1.72)	8.11 (2.26)	8.88 (0.64)	8.75 (1.89)	8.37 (1.69)
41.	The wood technologist should realize the limitations of each wood specie as it relates to the workability of an item.	8.00 (1.67)	6.78 (2.64)	8.00 (1.51)	8.50 (1.73)	7.67 (2.02)
43.	The wood technologist should have a practical "on the ground" knowledge of the processes currently employed by the forest products industry.	9.00 (0.89)	7.22 (2.33)	7.75 (1.28)	8.50 (1.73)	7.96 (1.76)

TABLE I (Continued)

No.	Generalized Competency Statements	n=6 Lumber means (SD)	n=9 Composition Board means (SD)	n=8 Plywood means (SD)	n=4 Secondary Manufacturing means (SD)	n=27 All Respondents means (SD)
45.	The wood technologist should have a knowledge of wood-moisture relationships.	8.67 (1.51)	7.89 (2.32)	8.25 (1.67)	10.00 (0.00)	8.48 (1.83)
46.	The wood technologist should have a basic understanding of the proper application of wood products - both stuctural and non-structural.	7.83 (2.32)	7.11 (2.32)	6.75 (1.49)	9.00 (1.16)	7.44 (2.01)
47.	The wood technologist should have a knowledge of the chemical properties of various wood species.	6.50 (2.17)	6.78 (3.03)	6.68 (1.06)	7.00 (2.50)	6.70 (2.18)
	Column Means	7.39	6.27	7.51	7.95	7.13

TABLE II

GENERALIZED COMPETENCY STATEMENT RATINGS
COMMUNICATIONS SUBJECT AREA

No.	Generalized Competency Statements	n=6 Lumber means (SD)	n=9 Composition Board means (SD)	n=8 Plywood means (SD)	n=4 Secondary Manufacturing means (SD)	n=27 All Respondents means (SD)
3.	The wood technologist should have a knowledge of public relations.	5.50 (1.52)	5.56 (1.94)	5.50 (0.76)	5.75 (3.40)	5.56 (1.76)
13.	The wood technologist should maintain communications with all levels of the organization.	8.17 (1.72)	6.89 (3.30)	8.00 (2.67)	8.25 (1.26)	7.70 (2.41)
42.	The wood technologist should be able to express ideas both in conversation and writing.	8.33 (1.51)	9.56 (0.73)	8.88 (1.23)	9.00 (1.15)	9.00 (1.12)
	Column Means	7.33	7.34	7.46	7.67	7.42

TABLE III

GENERALIZED COMPETENCY STATEMENT RATINGS
BUSINESS SUBJECT AREA

No.	Generalized Competency Statements	n=6 Lumber means (SD)	n=9 Composition Board means (SD)	n=8 Plywood means (SD)	n=4 Secondary Manufacturing means (SD)	n=27 All Respondents means (SD)
1.	The wood technologist should have a good knowledge of business operating procedures.	7.67 (2.07)	6.89 (2.03)	8.00 (1.07)	6.50 (2.08)	7.33 (1.80)
5.	The wood technologist should promote company policies.	7.17 (3.54)	8.00 (1.58)	8.25 (1.04)	8.25 (2.36)	7.93 (2.07)
8.	The wood technologist should have the ability to define responsibilities and organize work.	7.83 (1.94)	8.89 (1.17)	8.00 (1.07)	8.00 (1.41)	8.26 (1.38)
10.	The wood technologist should have problem-solving and decision-making skills.	8.67 (1.21)	9.33 (0.87)	8.63 (1.51)	9.50 (1.00)	9.00 (1.18)
15.	The wood technologist should have a knowledge of basic economics including the forest products area.	9.00 (1.10)	7.33 (1.32)	6.63 (1.19)	7.50 (0.58)	7.52 (1.40)
16.	The wood technologist should have a working knowledge of accounting, including depreciation and taxes.	6.33 (2.50)	5.44 (2.79)	5.38 (0.92)	6.25 (1.89)	5.74 (2.10)

TABLE III (Continued)

No.	Generalized Competency Statements	n=6 Lumber means (SD)	n=9 Composition Board means (SD)	n=8 Plywood means (SD)	n=4 Secondary Manufacturing means (SD)	n=27 All Respondents means (SD)
19.	The wood technologist should have the ability to handle people in a management role.	7.33 (1.96)	8.00 (2.29)	7.13 (1.25)	6.75 (1.50)	7.41 (1.80)
21.	The wood technologist should be knowledgeable in computer utilization.	6.83 (1.72)	6.89 (1.69)	6.25 (1.91)	6.00 (1.41)	6.56 (1.67)
23.	The wood technologist should understand governmental regulations that pertain to industry operation.	6.67 (1.03)	5.89 (2.93)	6.38 (1.69)	6.50 (2.38)	6.30 (2.09)
27.	The wood technologist should be able to produce financial plans.	5.50 (2.35)	6.33 (2.24)	5.38 (1.30)	4.00 (2.00)	5.52 (2.03)
33.	The wood technologist should understand the statistical compilation methods used in the industry.	7.33 (1.51)	6.89 (2.80)	6.25 (2.05)	6.25 (2.87)	6.70 (2.27)
44.	The wood technologist should be able to evaluate personnel performance.	6.17 (0.98)	7.00 (3.16)	6.63 (1.51)	6.75 (2.06)	6.67 (2.11)
	Column Means	7.21	7.24	6.91	6.85	7.08

TABLE IV

GENERALIZED COMPETENCY STATEMENT RATINGS
INDUSTRIAL ENGINEERING SUBJECT AREA

No.	Generalized Competency Statements	n=6 Lumber means (SD)	n=9 Composition Board means (SD)	n=8 Plywood means (SD)	n=4 Secondary Manufacturing means (SD)	n=27 All Respondents means (SD)
12.	The wood technologist should be able to analyze and maintain knowledge of competitive products.	7.33 (2.07)	7.56 (1.88)	6.63 (1.85)	8.50 (1.29)	7.37 (1.84)
20.	The wood technologist should have a good knowledge of steps and/or procedures that reduce operating and manufacturing costs.	8.67 (1.51)	7.22 (2.44)	8.25 (1.04)	8.25 (1.26)	8.00 (1.75)
24.	The wood technologist should have a basic understanding of plant layout.	7.33 (3.14)	6.44 (1.74)	7.88 (1.81)	7.00 (0.82)	7.15 (1.65)
38.	The wood technologist should have a knowledge, attitude, and understanding of safety on the job and its importance to industry.	6.17 (1.17)	9.11 (1.05)	7.50 (1.77)	6.50 (1.91)	7.59 (1.82)
	Column Means	7.38	7.58	7.57	7.56	7.53

individual items. This information was illustrated in Tables I, II, III, and IV.

Items 13 and 40 on Correspondence No. 2, while derived from different competency statement groupings, were similar in content and structure. Despite pre-testing measures, both items were inadvertently included on the questionnaire. The decision was made to eliminate, randomly, either item 13 or 40; item 40 was eliminated. For this reason, the data summary included 46 generalized competency statements rather than 47.

Results of Analysis

Subject Area Ratings By Industry Type

Each of the 46 generalized competency statements that were analyzed from Correspondence No. 2 were categorized as being either forest products, communications, business, or industrial engineering related. The ad hoc committee idenitifed 27 of the generalized competency statements as belonging to the forest products subject area. Three of the generalized competency statements were identified as belonging to the communications subject area while 12 were categorized in the business subject area. Four of the generalized competency statements were identified as belonging to the industrial engineering subject area.

The generalized comptency statement categorizations by subject area were illustrated with Tables I, II, III, and IV. The mean responses, for the generalized competency statements, were listed for the four industry types identified as comprising the wood products manufacturing industry. Individual item means, reported in Tables I through IV, represented the arithmetic means for all responses by each of the four

industry types, and by "all respondents" as a group. Column means (termed later as mean response ratings) were used to represent industry ratings of the individual subject areas. On Table I, for example, the respondents from the lumber industry rated the generalized competency statements in the forest products subject area 7.39; this rating was indicated on the table by the column mean under the lumber category. Generalized competency statement means in the "all respondents" categories provided group-wide ratings for the four subject areas, i.e. forest products, communications, business, and industrial engineering.

Tables I, II, III, and IV also included standard deviation values in parentheses below corresponding item means. The standard deviation values were utilized to indicate the variability of the ratings for individual items. An item which was rated by four respondents as 9, 9, 1, and 1 would have had a mean of 5 and a corresponding standard deviation of 4.62. An item rated by four respondents at 6, 6, 4, and 4 would have had the same mean as the previous item, i.e. 5, however, the standard deviation value of 1.15 would indicate to the reader that the respondents were in closer agreement on the importance of the item. The standard deviation values were included to facilitate the evaluation of the importance of items sharing similar means.

Table V provided a summary of the column means illustrated on Tables I, II, III, and IV. Those respondents from the lumber industry rated the forest products subject area 7.39 while those from the composition board industry rated it 6.27. Respondents from the plywood and secondary manufacturing industries rated the forest products subject area 7.51 and 7.95, respectively. "All respondents" submitted a mean response rating of 7.13 for the forest products subject area.

TABLE V

SUBJECT AREA/INDUSTRY TYPE
SUMMARY TABLE

Industry Type	Subject Areas			
	Forest Products	Communications	Business	Industrial Engineering
Lumber:				
Mean Response Ratings	7.39	7.33	7.21	7.38
Composition Board:				
Mean Response Ratings	6.27	7.34	7.24	7.58
Plywood:				
Mean Response Ratings	7.51	7.46	6.91	7.57
Secondary Manufacturing:				
Mean Response Ratings	7.95	7.67	6.85	7.56
All Respondents:				
Mean Response Ratings	7.13	7.42	7.08	7.53

Response Range 1 to 10; Rating Scale Mean 5.50.

Respondents from the lumber industry rated the communications subject area 7.33 while those from the composition board industry rated it similarly at 7.34. Respondents from the plywood and secondary manufacturing industries submitted mean response ratings of 7.46 and 7.67, respectively. "All respondents" submitted a mean response rating of 7.42 for the communications subject area.

Respondents from the lumber industry rated the business subject area 7.21 while those from the composition board industry rated it 7.24. Respondents from the plywood and secondary manufacturing industries submitted mean response ratings of 6.91 and 6.85, respectively. "All respondents" submitted a mean response rating of 7.08 for the business subject area.

Finally, respondents from the lumber industry rated the industrial engineering subject area 7.38 while those from the composition board industry rated it 7.58. Respondents from the plywood and secondary manufacturing industries submitted mean response ratings of 7.57 and 7.56, respectively. "All respondents" submitted a mean response rating of 7.53 for the industrial engineering subject area.

Subject Area Rankings

Mean responses submitted by the respondents to Correspondence No. 2, for each of the four subject areas, were ranked for the four industry categories and for "all respondents" as a group. Table VI was utilized to illustrate the various rankings.

"All respondents" rated the industrial engineering subject area highest with a mean response rating of 7.53. The communications subject area was rated in second place with a mean response rating of 7.42. The

TABLE VI

SUBJECT AREA RANKINGS
BY INDUSTRY TYPE

Subject Area Rankings	Industry Types				
	Lumber	Composition Board	Plywood	Secondary Manufacturing	All Respondents
First:					
Subject Area	Forest Products	Industrial Engineering	Industrial Engineering	Forest Products	Industrial Engineering
Second:					
Subject Area	Industrial Engineering	Communications	Forest Products	Communications	Communications
Third:					
Subject Area	Communications	Business	Communications	Industrial Engineering	Forest Products
Fourth:					
Subject Area	Business	Forest Products	Business	Business	Business

forest products and business subject areas were rated third and fourth, respectively, by "all respondents" in the study, with mean response ratings of 7.13 and 7.08.

Respondents from the lumber industry rated the forest products and industrial engineering subject areas approximately equal with mean response ratings of 7.39 and 7.38, respectively. The communications and business subject areas were rated third and fourth with respective mean response ratings of 7.33 and 7.21.

Respondents from the composition board industry rated the industrial engineering subject area as most important with a mean response rating of 7.58. The communications subject area was rated in second place with a mean response rating of 7.34. The business and forest products subject areas were rated third and fourth, respectively, by the composition board industry respondents with mean response ratings of 7.24 and 6.27.

Respondents from the plywood industry rated the industrial engineering subject area as most important with a mean response rating of 7.57. The forest products subject area was rated in second place with a mean response rating of 7.51. The communications and business subject areas were rated third and fourth, respectively, by the plywood industry respondents with mean response ratings of 7.46 and 6.91.

Respondents from the secondary manufacturing industry rated the forest products subject area as most important with a mean response rating of 7.95. The communications subject area was ranked in second place with a mean response rating of 7.67. The industrial engineering and business subject areas were rated third and fourth, respectively, by the secondary manufacturing industry respondents with mean response ratings of 7.56 and 6.85.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The primary purpose of this chapter was to review, in an abbreviated form, the purpose of the study, the research objectives, the general methodology, and the findings of the study. In addition, conclusions were presented, based on the analysis and summarization of the data obtained through the conduction of the study and recommendations based on these conclusions were expressed.

Summary of the Study

Purpose of the Study

The purpose of this study was to identify those competencies needed by the wood technologist employed in the lumber, composition board, plywood, and secondary wood manufacturing industries.

Research Objectives Explored in the Study

The following research objectives were formulated to serve as a guide for this research study:

1. To compile a list of wood technologist competency statements based on responses from selected informed individuals from the four areas of the forest products industry that comprise the wood products manufacturing industry.
2. To develop a list of generalized competency statements

representative of the competency statements submitted by the respondents to the initial correspondence.

3. To involve selected informed individuals from the wood products manufacturing industry in rating the importance of generalized competency statements developed to describe the wood technologist.

4. To compare the subject area ratings of the generalized competency statements on the basis of industry type, i.e. lumber, composition board, plywood, or secondary manufacturing, and by "all respondents" as a group.

Design and Conduct of the Study

Following an extensive review of research and literature relating to education in wood science and technology, and to industrial technology curricular offerings, the following steps were carried out in order to obtain the needed information: (1) the informed individuals, the subjects of the study, were identified; (2) a method was selected to develop the instrument, Correspondence No. 2, utilizing a preliminary instrument, Correspondence No. 1; (3) a procedure was designed for distributing the Correspondence No. 1 and 2 forms; and, (4) a method for analyzing the resulting data was chosen.

Early in December, 1981, the executive officers of the "representative associations" - the National Hardwood Lumber Association, the National Particleboard Association, the Hardwood Plywood Manufacturers Association, and the National Association of Furniture Manufacturers - were contacted by telephone and requested to identify ten individuals who would be knowledgeable of the competency needs of the wood

technologist employed in their respective industries, i.e. lumber, composition board, plywood, or secondary manufacturing.

On February 1, 1982, the 40 subjects identifed previously, were mailed personalized introductory cover letters and Correspondence No. 1 forms which requested them to list competencies they felt were needed by a wood technologist employed in their industries. The following week, telephone contact was established with the offices of each of the identified informed individuals to answer any questions they might have had regarding the study and to encourage completion of the initial questionnaire. On March 1, a follow-up mailing was sent to those subjects who had failed to return Correspondence No. 1 forms. Numerical coding was utilized as a method of accounting for returned questionnaires. By March 15, a total of 26 of the original 40 informed individuals had returned Correspondence No. 1 forms; a return rate of 65.0 percent.

An ad hoc committee was utilized to group the 352 competency statements, submitted by respondents of Correspondence No. 1, and to develop generalized competency statements representative of the groupings. Additionally, the ad hoc committee categorized the resulting generalized competency statements as being components of either forest products, communications, business, or industrial engineering subject areas. The 47 statements that resulted were randomly ordered on Correspondence No. 2; a "one-to-ten" rating scale was provided to allow subjects to rate the importance of each statement.

Correspondence No. 2 was mailed to 37 of the original 40 informed individuals on April 8, 1982. Three of the subjects returning Correspondence No. 1 forms indicated they were too far removed from production to be currently knowledgeable of the competency needs of the wood

technologist; Correspondence No. 2 forms were not distributed to these three original subjects. On April 24, a second mailing to non-respondents was initiated which included a personalized cover letter urging questionnaire return, and a second copy of Correspondence No. 2. A telephone follow-up was initiated on May 4 for those subjects still failing to return Correspondence No. 2 forms. By May 8, a total of 27 of the original 37 informed individuals had returned Correspondence No. 2 forms; a final return rate of 73.0 percent.

Findings of the Study

This study was concerned with obtaining information on the competency needs of the wood technologist employed in the lumber, composition board, plywood, and secondary manufacturing industries; the four industries comprising the wood products manufacturing industry. A series of four research objectives were developed to guide the research effort. The following findings of the study were organized around each of the research objectives.

Wood Technologist Competency Statements

The first research objective in the study was concerned with the compilation of a list of wood technologist competency statements based on responses from selected informed individuals from the lumber, composition board, plywood, and secondary manufacturing industries. The objective was accomplished by initially identifying 40 informed individuals, through the use of a panel-of-experts, and requesting them to list competencies they felt a wood technologist employed in their industries should possess. A questionnaire titled Correspondence No. 1 was used to

gather these competency statements. The informed individuals returning Correspondence No. 1 forms submitted a total of 352 competency statements.

Generalized Competency Statements

The second research objective in the study was concerned with the development of a list of generalized competency statements representative of the competency statements originally submitted by respondents. The objective was accomplished by organizing an ad hoc committee to analyze the 352 competency statements submitted by respondents to Correspondence No. 1. The committee first grouped the competency statements by similarity; generalized competency statements were then developed.

The ad hoc committee also categorized each of the generalized competency statements as being components of either the forest products, communications, business, or industrial engineering subject areas. Twenty-seven of the generalized competency statements were identified as belonging to the forest products subject area and four were identified as belonging to the communciations subject area. Twelve of the generalized competency statements were identified as belonging to the business subject area. The remaining four statements were categorized as belonging to the industrial engineering subject area.

Generalized Competency Statement Ratings

The third research objective in the study was concerned with the involvement of selected informed individuals from the wood products manufacturing industry in rating the importance of each of the 47 generalized competency statements. The objective was accomplished by

randomly ordering the 47 generalized competency statements, on Correspondence No. 2 forms, and providing respondents with a "one-to-ten" rating scale.

Forest Products Subject Area. "All respondents" as a group rated the knowledge of wood-moisture relationships as the most important competency in the forest products subject area. Other competencies, in descending order of importance, related to the quality control of forest products, physical and mechanical properties of wood, adhesive technology, wood conversion processes, wood identification, and a knowledge of current processes in industry. Each of the previously mentioned competencies had mean ratings in the upper one-fourth of the rating scale (7.75-10.00).

Nineteen competencies from the forest products subject area were rated between the rating scale mean (5.50) and the upper one-fourth of the rating scale (7.75). In descending order of importance were the competencies relating to wood specie limitations, board manufacturing and processing equipment, laboratory research techniques, wood product application, anatomical structure, and machining characteristics of species, followed by finishing technology, basic woodworking, wood drying, veneered products, chemical properties, biological deterioration, wood preservation, lumber grading, forest products marketing, wood substitutes, basic furniture design, log damage, and forest products packaging, warehousing, and transporting.

Only one of the forest products competencies was rated below the rating scale mean of 5.50. The competency related to the sharpening of wood cutting tools was rated 4.96.

Communications Subject Area. "All respondents" as a group rated the ability to express ideas in conversation and writing as the most important communications subject area competency. Competencies relating to maintaining communications with all levels of the organization and public relations were rated with means greater than the rating scale mean of 5.50. Two of the communications subject area competencies developed were very similar; as a result, the decision was made to randomly eliminate one from the data analysis.

Business Subject Area. "All respondents" as a group rated the competency relating to problem-solving and decision-making skills as the most important competency in the business subject area. Two other competencies, relating to defining responsibilities and promoting company policies, were rated in the upper one-fourth of the rating scale (7.75-10.00).

Nine of the business subject area competencies were rated between 5.50 and 7.75 in importance. The competencies, listed in descending order, related to forest products economics, personnel management, business operating procedures, statistical compilation, personnel evaluation, computer utilization, governmental regulation, accounting, and the ability to produce financial plans.

Industrial Engineering Subject Area. "All respondents" as a group rated the competency relating to the control of operating and manufacturing costs as the most important competency in the industrial engineering subject area. Three other competencies in the industrial engineering subject area were rated between the rating scale mean and the upper one-fourth of the rating scale (5.50-7.75). The competencies, in

descending order of importance, related to industrial safety, analysis of competitive products, and plant layout. None of the industrial engineering subject area competencies were rated by the respondents below the rating scale mean (5.50).

Subject Area Ratings By Industry Type

The final research objective in the study was concerned with the comparison of the subject area mean response ratings by respondents from the lumber, composition board, plywood, and secondary manfacturing industries and by "all respondents" as a group. The objective was accomplished by calculating mean ratings for Correspondence No. 2 items categorized by subject area, i.e. forest products, communications, business, or industrial engineering. Item mean ratings for all items within each subject area were combined and the resulting mean response ratings were used to compare industry response.

The industrial engineering subject area was rated highest in importance by "all respondents" with a mean response rating of 7.53. The respondents from the composition board, plywood, and secondary manufacturing industries submitted similar mean response ratings of 7.58, 7.57, and 7.56, respectively. The industrial engineering subject area was rated slightly lower by the lumber industry respondents with a mean response rating of 7.38.

The communications subject area was rated second highest in importance by "all respondents" with a mean response rating of 7.42. The respondents from the secondary manufacturing industry rated the communications subject area highest with a mean response rating of 7.67 followed by the plywood industry with a mean response rating of 7.46. The

respondents from the composition board and lumber industries rated the importance of the communications subject area similarly with mean response ratings of 7.34 and 7.33, respectively.

The forest products subject area was rated third in importance by "all respondents" with a mean response rating of 7.13. The respondents from the secondary manufacturing industry rated the forest products subject area highest, with a mean response rating of 7.95, followed by the plywood and lumber industries with mean response ratings of 7.51 and 7.39, respectively. The forest products subjects area was rated lowest in importance by respondents from the composition board industry with a mean response rating of 6.27.

Finally, the business subject area was rated lowest in importance by "all respondents" with a mean response rating of 7.08. The respondents from the composition board industry rated the business subject area highest with a mean response rating of 7.67, followed by the lumber industry with a mean response rating of 7.46. The respondents from the plywood and secondary manufacturing industries submitted similar mean response ratings of 6.91 and 6.85, respectively, for the business subject area.

It should be noted that slight differences in mean response ratings may not reflect real differences. No statistical tests of significant difference were utilized because of the subject selection method and the limited group size. The rating scale utilized on Correspondence No. 2 ranged from one-to-ten; a mean for the rating scale being 5.50. Each of the twenty mean response ratings were greater than the rating scale mean. Assuming that the respondents viewed the rating scale as a series of equal graduations, all of the mean response ratings could be considered "above average" in importance.

Conclusions

The inspection of the findings of this study prompted the researcher to reach several conclusions concerning the competencies needed by the wood technologist employed in the wood products manufacturing industry:

1. A wood technology program designed to prepare middle management wood technologists for the wood products manufacturing industry, will provide educational preparation for each of the generalized wood technology competencies identified in the study.
2. A good wood technology program, based on the 46 generalized competency statements developed in this study, will provide adequate training for middle management wood technologists employed in any of the four industries that comprise the wood products manufacturing industry.
3. The ability to communicate and solve problems are extremely important competencies needed by the wood technologist employed in the wood products manufacturing industry.

Recommendations

The following recommendations were made by the researcher following the completion of the study:

1. A curriculum designed to prepare middle management wood technologists for the wood products manufacturing industry should include courses, or other instruction, in the subject areas of forest products, communications, business, and industrial engineering.

2. A broad-based wood technology curriculum should prepare wood technologists for employment in any of the four industry areas that comprise the wood products manufacturing industry, i.e. lumber, composition board, plywood, and secondary manufacturing.
3. A wood technology curriculum should provide the student with learning experiences that attempt to develop the qualities expressed in the 46 generalized competency statements analyzed.
4. The subject selection utilizing the executive officers of trade associations to identify "informed individuals" within their industries has proven to be an effective method of obtaining information from industry, exemplified by the questionnaire return rate of 73.0 percent. It is recommended that other researchers wishing to obtain industry input utilize a similar subject selection method.
5. The instrument developed for the study, Correspondence No. 2, should be distributed to a random sample of wood product manufacturing industry managers to determine if differences exist in the way industry managers and "informed individuals" rate the importance of the generalized competency statements.
6. Further research is needed to identify important components of the generalized competency statements developed in this study.

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APPENDICES

APPENDIX A

PROGRAMS OF STUDY IN WOOD SCIENCE AND TECHNOLOGY

INSTITUTIONS OFFERING PROGRAMS OF WOOD SCIENCE AND TECHNOLOGY IN NORTH AMERICA

The following institutions were identified by Barnes (1980) as offering a B.S. degree program in wood science and technology.

Auburn University
Department of Forestry
Alburn, AL

University of British Columbia
Faculty of Forestry
Vancouver, BC

University of California
Forestry and Resource Mgt.
Berkeley, CA

Clemson University
Department of Forestry
Clemson, SC

Colorado State University
Department of Forest and Wood Science
Ft. Collins, CO

University of Idaho
Department of Forest Products
Moscow, ID

University of Illinois
Department of Forestry
Urbana, IL

Iowa State University
Department of Forestry
Ames, IA

Louisiana State University
School of Forestry and Wildlife Management
Baton Rouge, LA

Louisiana Tech University
School of Forestry
Ruston, LA

University of Maine
Forest Products Lab.
Div. of Forestry
Orono, ME

University of Massachusetts
Wood Technology Section, Forestry, and Wildlife Management
Amherst, MA

Michigan Tech University
Department of Forestry
Houghton, MI

University of Minnesota
Department of Forest Products
St. Paul, MN

Mississippi State University
Department of Wood Science and Technology
Mississippi State, MS

University of Missouri
School of Forestry, Fisheries, and Wildlife
Columbia, MO

State University of New York ESF
Department of Wood Products Engineering
Syracuse, NY

North Carolina State University
Department of Wood and Fiber Science
Raleigh, NC

Oregon State University
Department of Forest Products
Corvallis, OR

Pennsylvania State University
School of Forest Resources
University Park, PA

Purdue University
Department of Forestry and
Natural Resources
West Lafayette, IN

Virginia Polytechnic Institute
and State University
Department of Forest Products
Blacksburg, VA

West Virginia University
Division of Forestry
Morgantown, WV

University of Toronto
Faculty of Forestry
Toronto, ONT

University of Washington
Division of Physical Science,
Utilization Technology
Seattle, WA

APPENDIX B

COVER LETTER, CORRESPONDENCE NO. 1

FORMS AND FOLLOW-UPS

Oklahoma State University

SCHOOL OF OCCUPATIONAL AND ADULT EDUCATION

STILLWATER, OKLAHOMA 74078
CLASSROOM BUILDING 406
(405) 624-6275

February 1, 1982

Name
Company
Address
City, State Zip

[Personalized Cover Letter and Correspondence No. 1 Form; Lumber Industry]

Dear _____:

I am in the final stages of an advanced study program in industrial education at Oklahoma State University. One of the requirements of the study program is to conduct a research activity in an area of personal interest. I have selected the area of mid-management manpower needs in the forest products industry.

In order to have a meaningful and useful research activity, I need the help of people like yourself and others in the lumber industry. In fact you and nine other persons have been identified by a panel-of-experts as persons with perhaps the most knowledge about the area under consideration.

As an industry leader, you are in a unique position to make a valuable contribution to both this study and to education and industry in general. Your participation in the study will involve responding to two correspondences:

Correspondence No. 1 -- (enclosed with this letter)

Requests you to list competencies you think a "wood technologist" should possess (see attachment for further information).

The list of competencies from each industry expert will be compiled from Correspondence No. 1.

Correspondence No. 2 --

Requests you to rank the importance of each competency identified using a priority rating scale.

From the data obtained from Correspondence No. 2, a summary of the competencies needed by a wood technologist, in order of priority, will be finalized and made available to you and others in both industry and education interested in the findings of the study.

The information obtained from this study may be used to: (1) develop a university wood technology curriculum designed to provide the forest products industry with wood technologists, (2) evaluate and improve programs already in existence, and (3) provide a communication link between higher education and industry.

The success of this study depends on the cooperation of industry experts such as yourself. Please fill out Correspondence No. 1 and return it in the self-addressed, stamped return envelope as soon as possible.

Sincerely,

Robert F. Alsup, Jr.
Graduate Research Associate

RFA/cg
Attachment

_____

Dr. Lloyd Wiggins
Advisor

CORRESPONDENCE NO. 1
(To be returned in the self-addressed, stamped return envelope)

PURPOSE OF THE STUDY:

This study is designed to identify those competencies needed by a "wood technologist" employed in the lumber industry, based on the opinions of experts within the industry. Such information may be used for new educational program development, current program evaluation, and as a basis for communications between industry and higher education.

DEFINITIONS:

Competency--a knowledge, skill, attitude, understanding, or judgement which is required of an employee to function in his/her position.

Wood Technologist--a middle management person principally involved with the coordination and management of industrial processes centered around the conversion of wood, as a raw material, into various wood products (the pulp and paper segment of the forest products industry is excluded from this definition).

DIRECTIONS:

Please list competencies you think best describe what the wood technologist in the lumber industry should be capable of demonstrating.

If you have any questions please feel free to telephone me at work (405) 624-7414 or (405) 377-1614, home.

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You may write on the back of this sheet or attach additional sheets if necessary.

February 1, 1982

Name
Company
Address
City, State Zip

[Personalized Cover Letter and Correspondence No. 1 Form; Composition Board Industry]

Dear _____:

I am in the final stages of an advanced study program in industrial education at Oklahoma State University. One of the requirements of the study program is to conduct a research activity in an area of personal interest. I have selected the area of mid-management manpower needs in the forest products industry.

In order to have a meaningful and useful research activity, I need the help of people like yourself and others in the composition board industry. In fact you and nine other persons have been identified by a panel-of-experts as persons with perhaps the most knowledge about the area under consideration.

As an industry leader, you are in a unique position to make a valuable contribution to both this study and to education and industry in general. Your participation in the study will involve responding to two correspondences:

Correspondence No. 1 -- (enclosed with this letter)

Requests you to list competencies you think a "wood technologist" should possess (see attachment for further information).

The list of competencies from each industry expert will be compiled from Correspondence No. 1.

Correspondence No. 2 --

Requests you to rank the importance of each competency identified using a priority rating scale.

From the data obtained from Correspondence No. 2, a summary of the competencies needed by a wood technologist, in order of priority, will be finalized and made available to you and others in both industry and education interested in the findings of the study.

The information obtained from this study may be used to: (1) develop a university wood technology curriculum designed to provide the forest products industry with wood technologists, (2) evaluate and improve programs already in existence, and (3) provide a communication link between higher education and industry.

The success of this study depends on the cooperation of industry experts such as yourself. Please fill out Correspondence No. 1 and return it in the self-addressed, stamped return envelope as soon as possible.

Sincerely,

Robert F. Alsup, Jr.
Graduate Research Associate

RFA/cg
Attachment

Dr. Lloyd Wiggins
Advisor

CORRESPONDENCE NO. 1
(To be returned in the self-addressed, stamped return envelope)

PURPOSE OF THE STUDY:

This study is designed to identify those competencies needed by a "wood technologist" employed in the composition board industry, based on the opinions of experts within the industry. Such information may be used for new educational program development, current program evaluation, and as a basis for communications between industry and higher education.

DEFINITIONS:

Competency--a knowledge, skill, attitude, understanding, or judgement which is required of an employee to function in his/her position.

Wood Technologist--a middle management person principally involved with the coordination and management of industrial processes centered around the conversion of wood, as a raw material, into various wood products (the pulp and paper segment of the forest products industry is excluded from this definition).

DIRECTIONS:

Please list competencies you think best describe what the wood technologist in the composition board industry should be capable of demonstrating.

If you have any questions please feel free to telephone me at work (405) 624-7414 or (405) 377-1614, home.

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You may write on the back of this sheet or attach additional sheets if necessary.

Oklahoma State University

SCHOOL OF OCCUPATIONAL AND ADULT EDUCATION

STILLWATER, OKLAHOMA 74078
CLASSROOM BUILDING 406
(405) 624-6275

February 1, 1982

Name
Company
Address
City, State Zip

[Personalized Cover Letter and Correspondence No. 1 Form; Plywood Industry]

Dear _____:

I am in the final stages of an advanced study program in industrial education at Oklahoma State University. One of the requirements of the study program is to conduct a research activity in an area of personal interest. I have selected the area of mid-management manpower needs in the forest products industry.

In order to have a meaningful and useful research activity, I need the help of people like yourself and others in the plywood industry. In fact you and nine other persons have been identified by a panel-of-experts as persons with perhaps the most knowledge about the area under consideration.

As an industry leader, you are in a unique position to make a valuable contribution to both this study and to education and industry in general. Your participation in the study will involve responding to two correspondences:

Correspondence No. 1 -- (enclosed with this letter)

Requests you to list competencies you think a "wood technologist" should possess (see attachment for further information).

The list of competencies from each industry expert will be compiled from Correspondence No. 1.

Correspondence No. 2 --

Requests you to rank the importance of each competency identified using a priority rating scale.

From the data obtained from Correspondence No. 2, a summary of the competencies needed by a wood technologist, in order of priority, will be finalized and made available to you and others in both industry and education interested in the findings of the study.

The information obtained from this study may be used to: (1) develop a university wood technology curriculum designed to provide the forest products industry with wood technologists, (2) evaluate and improve programs already in existence, and (3) provide a communication link between higher education and industry.

The success of this study depends on the cooperation of industry experts such as yourself. Please fill out Correspondence No. 1 and return it in the self-addressed, stamped return envelope as soon as possible.

Sincerely,

Robert F. Alsup, Jr.
Graduate Research Associate

RFA/cg
Attachment

Dr. Lloyd Wiggins
Advisor

CORRESPONDENCE NO. 1

(To be returned in the self-addressed, stamped return envelope)

PURPOSE OF THE STUDY:

This study is designed to identify those competencies needed by a "wood technologist" employed in the plywood industry, based on the opinions of experts within the industry. Such information may be used for new educational program development, current program evaluation, and as a basis for communications between industry and higher education.

DEFINITIONS:

Competency--a knowledge, skill, attitude, understanding, or judgement which is required of an employee to function in his/her position.

Wood Technologist--a middle management person principally involved with the coordination and management of industrial processes centered around the conversion of wood, as a raw material, into various wood products (the pulp and paper segment of the forest products industry is excluded from this definition).

DIRECTIONS:

Please list competencies you think best describe what the wood technologist in the plywood industry should be capable of demonstrating.

If you have any questions please feel free to telephone me at work (405) 624-7414 or (405) 377-1614, home.

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You may write on the back of this sheet or attach additional sheets if necessary.

Oklahoma State University

SCHOOL OF OCCUPATIONAL AND ADULT EDUCATION

STILLWATER, OKLAHOMA 74078
CLASSROOM BUILDING 406
(405) 624-6275

February 1, 1982

Name
Company
Address
City, State Zip

[Personalized Cover Letter and Correspondence No. 1 Form; Secondary Manufacturing Industry]

Dear _____:

I am in the final stages of an advanced study program in industrial education at Oklahoma State University. One of the requirements of the study program is to conduct a research activity in an area of personal interest. I have selected the area of mid-management manpower needs in the forest products industry.

In order to have a meaningful and useful research activity, I need the help of people like yourself and others in the secondary wood manufacturing industry. In fact you and nine other persons have been identified by a panel-of-experts as persons with perhaps the most knowledge about the area under consideration.

As an industry leader, you are in a unique position to make a valuable contribution to both this study and to education and industry in general. Your participation in the study will involve responding to two correspondences:

Correspondence No. 1 -- (enclosed with this letter)

Requests you to list competencies you think a "wood technologist" should possess (see attachment for further information).

The list of competencies from each industry expert will be compiled from Correspondence No. 1.

Correspondence No. 2 --

Requests you to rank the importance of each competency identified using a priority rating scale.

From the data obtained from Correspondence No. 2, a summary of the competencies needed by a wood technologist, in order of priority, will be finalized and made available to you and others in both industry and education interested in the findings of the study.

The information obtained from this study may be used to: (1) develop a university wood technology curriculum designed to provide the forest products industry with wood technologists, (2) evaluate and improve programs already in existence, and (3) provide a communication link between higher education and industry.

The success of this study depends on the cooperation of industry experts such as yourself. Please fill out Correspondence No. 1 and return it in the self-addressed, stamped return envelope as soon as possible.

Sincerely,

Robert F. Alsup, Jr.
Graduate Research Associate

RFA/cg
Attachment

Dr. Lloyd Wiggins
Advisor

CORRESPONDENCE NO. 1

(To be returned in the self-addressed, stamped return envelope)

PURPOSE OF THE STUDY:

This study is designed to identify those competencies needed by a "wood technologist" employed in the secondary wood manufacturing industry, based on the opinions of experts within the industry. Such information may be used for new educational program development, current program evaluation, and as a basis for communications between industry and higher education.

DEFINITIONS:

Competency--a knowledge, skill, attitude, understanding, or judgement which is required of an employee to function in his/her position.

Wood Technologist--a middle management person principally involved with the coordination and management of industrial processes centered around the conversion of wood, as a raw material, into various wood products (the pulp and paper segment of the forest products industry is excluded from this definition).

DIRECTIONS:

Please list competencies you think best describe what the wood technologist in the secondary wood manufacturing industry should be capable of demonstrating.

If you have any questions please feel free to telephone me at work (405) 624-7414 or (405) 377-1614, home.

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You may write on the back of this sheet or attach additional sheets if necessary.

Oklahoma State University

SCHOOL OF OCCUPATIONAL AND ADULT EDUCATION

STILLWATER, OKLAHOMA 74078
CLASSROOM BUILDING 406
(405) 624-6275

March 1, 1982

Name
Company
Address
City, State Zip

[Personalized Follow-up Letter, Correspondence No. 1]

Dear _____:

You and several other leaders in the forest products industry were recently mailed an introductory letter and a form asking you to list competencies that you think best describe what the "wood technologist" in your industry should be capable of demonstrating.

I need your immediate help in this matter. Currently, less than 50% of the original forms have been completed and returned. More responses will have to be obtained in order to give this study meaning. Please fill out Correspondence No. 1 and return it in the self-addressed, stamped return envelope by no later than March 10. If you have already responded to Correspondence No. 1, please disregard this letter.

If you have any questions, please feel free to telephone me at work (405) 624-7414 or (405) 377-1614, home.

Sincerely yours,

Robert F. Alsup, Jr.
Graduate Research Associate

Enclosure
RFA/cg

APPENDIX C

COMPETENCY STATEMENTS SUBMITTED

BY RESPONDENTS

ORIGINAL STATEMENTS FROM
CORRESPONDENCE NO. 1

Math through algebra and geometry.

Chemistry through two semesters of organic chemistry.

Physics.

Wood chemistry.

Wood identification.

Wood anatomy.

Glued wood products and processes.

Data processing.

Computer programming.

Instrumentation.

Chemical properties of wood species.

Principles of programming and operation of computers.

Industrial engineering in the areas of hydraulics, pneumatics, steam, and heat conversion.

Fiber design as related to types of refining units and optimum physical properties of wood.

Glues and gluing.

Statistics.

Working knowledge of cost accounting.

Quality control techniques.

Laboratory and research techniques.

Communications (employee).

Industrial psychology.

Public speaking.

Letter and report writing.

Business Law.

Problem-solving skills.

Decision-making skills.

Leadership ability.

Desire to achieve.

Understand human relations.

Realize that customer's expectation of product must be known.

Knowledge of wood species.

Knowledge of physical properties of woods.

Knowledge of past and current conversion technology.

Knowledge of wood drying procedures and methods.

Knowledge of good forestry practice.

Knowledge of forest harvesting methods.

Knowledge of raw material procurement and measurement.

Knowledge of means of transporting raw and finished goods.

Knowledge of saw filing (band and circle).

Knowledge of basic metal working.

Knowledge of basic welding.

Knowledge of basic woodworking.

Knowledge of basic plumbing.

Knowledge of electricity (1 and 3 phase).

Knowledge of electric control devices (mechanical and electronic).

Knowledge of lubrication systems and products used.

Knowledge of gasoline and diesel engines.

Knowledge of development and use of compressed air.

Knowledge of energy transmission using liquids.

Knowledge of elementary thermodynamics (heat and energy relations).

Knowledge of elementary mechanics (statics).

Knowledge of mechnical drawing - including electrical schematic prints.

Knowledge of state and federal labor laws.

Knowledge of first aid.

Knowledge of accounting, including depreciation and taxes.

Ability to communicate ideas.

Ability to formulate future planning.

Ability to define responsibilities and organize work.

General knowledge of process.

Familiarity with and ability to produce financial plans.

Mechanical aptitude.

Technical writing.

Oral presentation.

Logic.

Accounting.

Business Law.

Economics (basic).

Chemistry.

Physics (2 semester minimum).

Wood identification.

Wood anatomy.

Wood drying.

Preservation.

Chemistry.

Finishing.

Adhesion (glue).

Macro and microscopic structure.

Mechanical properties.

Machining and machinery.

Industrial engineering courses.

Plant layout.

Production control.

Quality control.

Time and motion study.

General industrial engineering.

Should promote company policies and support management.

Should keep plant well informed of quality, personnel, and equipment status.

The wood technologist should be responsible for leading and supervising employees.

Should be required to maintain quality standards and policies of the company.

Should initiate efforts to improve quality.

Should initiate efforts to reduce costs.

Should see that quality control personnel are trained to perform their jobs as outlined.

Should assist production superintendent in anything concerning quality control.

Should calculate resin and wax usage closely with production superintendent in controlling usage.

Should maintain quality control program that will help minimize manufacture of off-standard board and prevent shipment of such board as on-grade board.

Should be responsible for complete orderly documentation of quality control tests and related data.

Should review closely all data collected, analyze and make recommendations or corrections as the situation dictates.

Should work closely with all plant department superintendents.

Should handle customer complaint problems with the sales and marketing departments.

Should represent the mill in trade association technical matters.

Should accept other duties and responsibilities as required.

Should analyze and maintain current knowledge of competitive products.

Should keep the sales department advised of specification and codes applicable.

Should secure code and industry approvals.

Wood identification. This should be done on a sight basis, and of course would vary from region to region and certainly would not be absolute as the properties vary.

Specie yields. For example, the yield on magnolia and ash are a lot higher that oak. It would also be helpful to have some knowledge in commercial specie categories (I am speaking of National Hardwood Lumber Rule yields of #1 Common and Better).

Deterioration factors. Studies could be made to determine how much deterioration takes place from the time a tree is felled until it is cut into lumber. I am sure you are aware that this varies from region to region, and weather has much to do with this.

Cruising of hardwood timber.

Planting of hardwood timber.

Ability to handle people in a management role.

Complete knowledge of production processes used in the manufacture of composite boards.

A thorough understanding of wood properties and adhesives.

Raw material procurement.

Good knowledge of business operating procedures.

Good knowledge of steps and/or procedures that reduce operating and manufacturing costs.

Thorough understanding of profit and loss statement and how to prepare it.

Public relations as it pertains to the media and the community at the local level.

Good knowledge of plant safety.

Good knowledge of EPA permit and regulatory requirements.

Good knowledge of OSHA regulations.

Good knowledge of union arbitration.

A good working knowledge of wood species, structure, and fiber characteristics of the various softwoods and hardwoods available to the industry in the U.S.A.

. . . a good background in general organic, and wood chemistry for relating the chemical phases of the process and the raw materials used.

Be reasonably mathematically oriented, and understand statistical compilation and statistical quality control methods used in the industry.

Be acquainted with the primary equipment present in board manufacturing and processing plants, for example, refiners, flakers, dryers, presses, sanders, saws, etc.

Be able to relate laboratory condition experiments to full scale plant requirements.

Must be able to interpret technical data and to express that data in a clear, concise manner in both the form of written and oral reports.

Should have had some experience, or good instructing in the art of getting along with, and directing the actions of subordinates.

Be a good organizer and planner for projects that may fall within his/her realm.

. . . have the initiative to promote new ideas and to accept new ideas diplomatically, in an unbiased manner.

Identify wood species used in furniture manufacture.

Know the characteristics of each species.

Know machining peculiarities of each species.

Know lumber grading and tallying.

Knowledge of lumber pricing.

Know best uses of each species.

Know kiln drying procedures and equipment for various species.

Know when and how to use veneers.

Procedures for making veneered panels.

Knowledge of all woodworking machinery and their use.

Know the various glues - their advantages, disadvantages and costs.

Know assembly techniques and clamping.

Understand humidity effects on wood.

Understand the various finishing materials and their use.

Understand basic furniture design, strength of various joining techniques.

Understand quality control of lumber and furniture manufacturing, and respective techniques.

Know lumber purchasing techniques.

Know veneer purchasing techniques.

Understand wood substitutes - i.e. plastics, particle board, etc.

Learn proper lumber stacking and air drying techniques.

Knowledge of lumber harvesting, the various ways of sawing logs and cutting veneer.

Know uses of the various ways lumber and veneer are manufactured - i.e. quarter sawn, rotary cut, etc.

To be thoroughly familiarized with all facets (departments) of the operations in the manufacturing of the finished product.

Understand the process of manufacture of the veneer to be used or worked (i.e. logs sliced, half rounded, rotary cut, etc.). This will acquaint the person as to the various appearances resulting therefrom.

Know what specie of lumber is primarily available to one's operation for the purpose of making lumber cores, and also, which has the most versatility. Study characteristics of the lumber to see which compliments face veneer to be used on panel (i.e. wide grain veneer with wide grain lumber.)

Realize the limitation of each specie of wood to be worked as it related to the workability of the item.

Time and experience will govern the use of various types of machinery in working the different woods; i.e. what veneers can be spliced directly from a knife joint and which must first be run through a jointer before splicing.

Make available to all involved personnel all technical information relative to products (raw materials) used in manufacturing procedure, i.e. bonding agent - extenders - adhesives, etc.

Thoroughly understand limitations of machinery being used.

Impress thoroughly with all employees the necessity for manufacturing quality products. Finished goods to be minutely inspected before shipping.

All supervisors to reevaluate personnel periodically and to have most versatile employees at key positions.

It is important to have supervisors work closely with persons in his/her department to develop best working relationship possible.

Production personnel to constantly feed ideas and thoughts back to higher management for possible upgrade in production procedure.

Periodic meeting between production, sales, engineering and upper management people for better understanding of company's operation. This results in each department being familiar with other department's problems and limitations.

Understand fully a working relationship should a union contract exist. This relates to applying terms of contract to work performance, schedules, promotion factors, etc. Also, make suggestions to management for better verbage for upgrading contract.

. . . a wood technologist should never rest on his laurels but constantly strive to broaden his visions to keep abreast of increased knowledge of the industry - be it technical or otherwise. Remember the enthusiasm radiated by management at any level will be telegraphed to every member of the work force.

Dendrology.

Macroscopic identification.

Microscopic identification.

Wood-moisture relationships.

Physical and chemical properties of woods.

Organic chemistry - specialized with respect to wood and related materials.

Adhesives.

Industrial engineering.

Time and motion studies.

Plant layout.

Methods analysis.

Mechanical engineering.

HVAC including boilers.

Pneumatics including air compressors.

Dust collection systems.

Strength of materials.

Electrical engineering.

Lighting.

Transformers, capacitors, and power wiring.

Motors.

Drafting - minimal coverage.

Machinery and cost justifications.

Economics.

Business administration.

Personnel administration.

People skills.

Communications.

Computer orientation.

Basic hydraulics.

Blue print reading.

Interpretation of electrical schematics.

Adhesives and their application.

Wood identification - tree identification.

Anatomical structure of wood.

Botany.

Strength and related physical properties of wood by species.

Engineering mechanics.

Physics.

Chemistry.

Logic.

Public speaking.

English.

Report writing.

Mechanical drawing and design.

Math, at least to calculus.

Machinability of wood by species and various cutting actions.

Basic woodworking machines.

Basic principles of management, Maslowe, McGreggor, Drucker, etc.

Time and motion study - methods and layout.

Conveyors and related equipment.

Veneer and plywood manufacture.

Techniques of finishing.

Psychology.

Good verbal communication skills.

Good written communication skills.

Ability to get along with people.

Positive outlook - optimist.

Leadership ability.

Understanding of management principles and philosophy.

Basic understanding of wood conversion processes.

Specific understanding of wood machining.

Specific understanding of wood drying.

Understanding of adhesive technology related to gluing of wood.

Understanding of wood mechanics.

Basic understanding of managerial accounting.

Understanding of wood-fluid relationships.

A knowledge of principles of biological deterioration of wood.

Understanding the finishing technology related to finishing of wood.

Basic skills in math and physics (through calculus, analytic geometry).

Industrial engineering skills - quality control functions, plant layout, etc.

Understanding of statistics.

Basic knowledge of wood anatomy and structure - wood identification.

Basic understanding of forest products economics.

Basic understanding of proper application and use of wood products - both structural and non-structural.

Understanding of forest products marketing.

Understanding of forest products harvesting.

Understanding of wood preservation.

Handling of hardwood logs, including storage to minimize damage and degrade.

Prevention and control of insect damage to hardwood logs.

Quality control in the manufacture of hardwood lumber.

Manufacture of hardwood lumber and equipment used.

Air drying of hardwood lumber and stacking equipment and procedures.

Kiln drying of hardwood lumber including micro-wave and blow box operation.

The machining and working of hardwood lumber products.

Hardwood lumber lamination and adhesives used in laminated hardwood products.

Decay resistance and preservatives used in hardwood lumber products.

Identification of hardwoods.

Strength, shear bending stress and other physical qualities of hardwoods.

The treatment, packaging, shipment and storage of hardwood lumber and products.

Hardwood lumber rules, grades and specifications.

Uses of various hardwoods and their requirements.

Finishing and coating of hardwood lumber products and panelling.

The hardwood lumber markets - suppliers and users.

Identification of trees and their woods.

Physical properties of wood.

Mechanical properties of wood.

Lumber handling and grading.

Air drying and pre-drying of lumber.

Conventional kilns and kiln schedules.

Solar kilns and other energy efficient innovations.

Veneer drying and grading.

Collecting and using wood waste as fuel.

Theory of cutting and planing wood.

Glues and gluing.

Development and theory of shaping and lathe heads.

Theory of sharpening all cutting tools.

High speed steel vs. carbide-tipped tools.

Basic methods of constructing with wood.

Window and door construction.

Home building basics.

Furniture design and construction.

Sanding: theory and materials.

Wood finishing: varnishes, oils, lacquers, waters.

Wood finishing application systems.

Treatment of finished goods before packaging - rubbing and polishing.

Packaging, warehousing and transporting.

Production engineering theory.

Principles of management I and II.

Accounting I and II.

Economics I and II.

Sales and marketing theory.

Credit and collecting theory.

Business law.

Computer basics.

Educational background to make decisions.

Experience or training in all areas of manufacturing.

Ability to work with people.

Self-starter to get results.

Personality to grow and adjust to change.

Common sense to use technical training and apply to every day operation.

Honesty with company, self and co-workers.

Ability to express ideas both in conversation and writing.

Stand-up for convictions, but not be afraid to change when shown a better way.

Able to communicate with top management and common laborer.

Make decisions based on fact rather that fiction.

Confidence in self and knowledge.

Working knowledge of related departments such as cost, accounting, production control, legal, insurance and personnel.

Desire to grow in knowledge and keep up with new ideas and developments.

Ambitious - for self and company.

Willing to assume responsibilities.

Some instruction in problems of gathering capital to finance any enterprise or product line within an enterprise.

Understanding of the need for profitability of each product or process in order to justify investment by owners of the enterprise.

General knowledge of sales and marketing principles to gain appreciation of the demands of the marketplace.

Practical "on the ground" knowledge of the processes currently employed by the wood products industry.

Contact in the field and classroom with the most competent and innovative businesses and scientists.

Instruction in labor relations and motivational techniques to assure productivity in the use of each manufacturing process.

Exchange of research and scientific information among all wood technology institutions - perhaps an educational cross reference system by publication and/or computer.

Knowledge of forest management, silviculture, and forest engineering methods and challenges as they relate to product requirements.

Knowledge of machinery maintenance and specifications for all equipment commonly used in woodworking.

Attendance at Forest Products Research Society meetings on local, regional and national levels.

Overview of national wood utilization problems presented by research branch of forest service and Forest Products Laboratory personnel.

Knowledge of the physical and chemical properties of wood.

Knowledge of wood bonding and glues especially as this applies to the bonding of small particles.

Knowledge and ability to perform strength testing of materials.

Writing skills necessary to make clear, concise technical reports.

Public speaking skills.

Knowledge and skill at performing inorganic and organic chemical testing.

Understanding of accounting.

Skill in budgeting of costs and materials.

High level math skills especially statistical analysis.

The attitudes and judgement needed to direct the work of others.

A basic understanding of processing and handling materials.

The knowledge, attitude, and understanding of safety on the job and its importance in industry.

A strong background in chemistry.

A better than average knowledge of physics.

Knowledge of both foreign and domestic wood species.

Awareness of standard code and regulations for industry.

Public speaking.

Advanced mathematics and physical and laboratory sciences.

High sense of mechanical aptitude.

Good command of both oral and written communication in the English language.

General knowledge of accounting principles.

Personnel management.

Statistics.

General chemistry.

Organic chemistry.

Properties of wood general.

Wood drying process.

Principles of wood gluing.

Marketing principles.

Economics.

Hydraulics.

Principles of industrial engineering.

Application and uses of wood products in construction.

Generation and transmission of steam.

Fundamentals of business management.

APPENDIX D

GENERALIZED COMPETENCY STATEMENT DEVELOPMENT

GENERALIZED COMPETENCY STATEMENTS DEVELOPED
FROM CORRESPONDENCE NO. 1

Note: The original statements appear in the accompanying subtopics.

The wood technologist should be able to relate laboratory and research techniques to full scale plant requirements.

a. Laboratory and research techniques.
b. Be able to relate laboratory condition experiments to full scale plant requirements.
c. Knowledge and ability to perform strength testing of materials.
d. Knowledge and skill at performing inorganic and organic chemcal testing.
e. Advanced mathematics and physical and laboratory sciences.

The wood technologist should understand the quality control of forest products and implement quality control techniques.

a. Quality control techniques.
b. Quality control.
c. Should initiate efforts to improve quality.
d. Should see that quality control personnel are trained to perform their jobs as outlined.
e. Should assist production superintendent in anything concerning quality control.
f. Should maintain quality control program that will help minimize manufacture of off-standard and prevent shipment of such board as on-grade board.
g. Should be responsible for complete orderly documentation of quality control tests and related data.
h. Be reasonably mathemetically oriented, and understand statistical quality control methods used in the industry.
i. Impress thoroughly with all employees the necessity for manufacturing quality products. Finished goods to be minutely inspected.
j. Quality control in the manufacture of hardwood lumber.
k. Understand quality control of lumber and furniture manufacturing, and respective techniques.

The wood technologist should have a working knowledge of accounting, including depreciation and taxes.

a. Working knowledge of cost accounting.
b. Knowledge of accounting, including depreciation and taxes.
c. Accounting.
d. Basic understanding of managerial accounting.
e. Accounting I and II.
f. Working knowledge of related departments such as cost, accounting, production control, legal, insurance and personnel.
g. Understanding of accounting.
h. General knowledge of accounting principles.

The wood technologist should understand the statistical compilation methods used in industry.

a. Statistics.
b. Be reasonably mathemetically oriented, and understand statistical compilation and statistical quality control methods used in the industry.
c. Understanding of statistics.
d. High level math skills especially statistical analysis.
e. Statistics.

The wood technologist should have a basic understanding of wood conversion processes.

a. Fiber design as related to types of refining units and optimum physical properties of woods.
b. Basic understanding of wood conversion processes.
c. Knowledge of past and current conversion technology.

The wood technologist should be acquainted with the primary equipment present in board manufacturing and processing plants.

a. Complete knowledge of production processes used in the manufacturing of composite boards.
b. Be acquainted with the primary equipment present in board manufacturing and processing plants, for example refiners, flakers, dryers, presses, sanders, saws, etc.

The wood technologist should have a knowledge, attitude, and understanding of safety on the job and its importance to industry.

a. Knowledge of first aid.
b. Good knowledge of plant safety.
c. A knowledge, attitude, and understanding of safety on the job and its importance in industry.

The wood technologist should have the ability to define responsibilities and organize work.

a. Ability to formulate future planning.
b. Ability to define responsibilities and organize work.
c. Be a good organizer and planner for projects that may fall within his/her realm.

The wood technologist should promote company policies.

a. Should promote company policies and support management.
b. Should be required to maintain quality standards and policies of the company.

The wood technologist should have a good knowledge of business operating procedures.

a. Good knowledge of business operating procedures.
b. Business administration.
c. Basic principles of management, Maslowe, McGreggor, Drucker, etc.
d. Understanding of management principles and philosophy.
e. Principles of management I and II.
f. Fundamentals of business management.

The wood technologist should be able to evaluate personnel performance.

a. All supervisors to reevaluate personnel periodically and to have most versatile employees at key positions.
b. Personnel management.

The wood technologist should have a good knowledge of steps and/or procedures that reduce operating and manufacturing costs.

a. Should initiate efforts to reduce costs.
b. Good knowledge of steps and/or procedures that reduce operating and manufacturing costs.
c. Skill in budgeting of costs and materials.

The wood technologist should be able to produce financial plans.

a. Familiarity with and ability to produce financial plans.
b. Thorough understanding of profit and loss statement and how to prepare it.
c. Some instruction in problems of gathering capital to finance any enterprise or product line within an enterprise.
d. Understanding of the need for profitability of each product of process in order to justify investment by owners of the enterprise.

The wood technologist should be able to analyze and maintain knowledge of competitive products.

a. Should analyze and maintain current knowledge of competitive products.

The wood technologist should maintain communications with all levels of the organization.

a. Working knowledge of related departments such as cost, accounting, production control, legal, insurance and personnel.
b. Should work closely with all plant department superintendents.
c. Should keep the sales department advised of specification and codes applicable.
d. Periodic meeting between production, sales, engineering and upper management people for better understanding of company's operation. This results in each department being familiar with other department's problems and limitations.

The wood technologist should be knowledgeable in computer utilization.

a. Data processing.
b. Computer programming.
c. Principles of programming and operation of computers.
d. Computer orientation.
e. Computer basics.

The wood technologist should have a knowledge of the anatomical structure of wood.

a. Wood anatomy.
b. Wood anatomy.
c. A good working knowledge of wood species, structure, and fiber characteristics of the various softwoods and hardwoods available in the U.S.A.
d. Anatomical structure of wood.

e. Basic knowledge of wood anatomy and structure - wood identification.
f. Macro and microscopic structure.

The wood technologist should be knowledgeable in the identiication of woods.

a. Wood identification.
b. Wood identification.
c. Wood identification. This should be done on a sight basis, and of course would vary from region to region and certainly would not be absolute as the properties vary.
d. Identify wood species used in furniture manufacture.
e. Macroscopic identification.
f. Dendrology.
g. Microscopic identification.
h. Wood identification - tree identification.
i. Identification of hardwoods.
j. Identification of trees and their woods.
k. Basic knowledge of wood anatomy and structure - wood identification.

The wood technologist should have a knowledge of the chemical properties of various wood species.

a. Wood chemistry.
b. Chemical properties of wood species.
c. . . . a good background in general organic and wood chemistry for relating the chemical phases of the process and the raw materials used.
d. Physical and chemical properties of woods.
e. Knowledge of the physical and chemical properties of wood.
f. Organic chemistry - specialized with respect to wood and related materials.

The wood technologist should understand governmental regulations that pertain to industry operations.

a. Knowledge of state and federal labor laws.
b. Good knowledge of EPA permit and regulatory requirements.
c. Good knowledge of OSHA regulations.
d. Awareness of standard code and regulations for industry.

The wood technologist should have a specific understanding of basic woodworking.

a. Knowledge of basic woodworking.
b. Machining and machinery.
c. Time and experience will govern the use of various types of machinery in working different woods; i.e. what veneers can be spliced directly from a knife joint and which must first be run through a jointer before splicing.
d. Thoroughly understand limitations of machinery being used.
e. Knowledge of all woodworking machines and their use.
f. Basic woodworking machines.
g. Specfic understanding of wood machining.
h. The machining and working of hardwood products.
i. Theory of cutting and planing wood.

j. Development and theory of shaping and lathe heads.
k. Manufacture of hardwood lumber and equipment used.
l. Sanding: theory and materials.

The wood technologist should have a practical "on the ground" knowledge of the processes currently employed by the forest products industry.

a. General knowledge of process.
b. To be thoroughly familiarized with all facets (departments) of the operations in the manufacturing of finished product.
c. Understand the process of manufacture of the veneer to be used or worked, (i.e. logs sliced, half-rounded, rotary cut, etc.).
d. Hardwood lumber lamintation and adhesives used in laminated hardwood products.
e. Window and door construction.
f. Home building basics.
g. Experience or training in all areas of manufacturing.
h. Practical "on the ground" knowledge of the processes currently employed by the wood products industry.
i. A basic understanding of processing and handling materials.
j. Collecting and utilizing wood waste as fuel.
k. Know the uses of the various ways lumber and veneer are manufactured - i.e. quarter sawn, rotary cut.
l. Should calculate the resin and wax usage closely with production superintendent in controlling usage.
m. Application and uses of wood products in construction.

The wood technologist should realize the limitations of each wood specie as it relates to the workablilty of an item.

a. Knowledge of wood species.
b. Specie yields. For example, the yield on magnolia and ash are a lot higher than oak. It would also be helpful to have some knowledge in commercial specie categories (I am speaking of National Hardwood Lumber Rule yields of #1 Common and Better).
c. Know the characteristics of each specie.
d. Know the best uses of each specie.
e. Realize the limitation of each specie of wood to be worked as it relates to the workability of the item.
f. Know what specie of lumber is primarily available to one's operation for the purpose of making lumber cores, and also, which has the most versatility. Study the characteristics of the lumber to see which compliments face veneer to be used on panel (i.e. wide grain veneer with wide grain lumber).
g. Uses of various hardwoods and their requirements.
h. Knowledge of both foreign and domestic wood species.

The wood technologist should have a knowledge of the machining characteristics of various wood species.

a. Know machining characteristics of each species.
b. Machinability of wood species and various cutting actions.

The wood technologist should have a knowledge of packaging, warehousing, and transporting forest products.

a. Knowledge of means of transporting raw and finished goods.

b. The treatment, packaging, shipment and storage of hardwood lumber and products.
c. Packaging, warehousing and transporting.

The wood technologist should have a knowledge of the sharpening of wood cutting tools.

a. Knowledge of saw filing (band and circle).
b. Theory of sharpening all cutting tools.
c. High speed steel vs. carbide-tipped tools.

The wood technologist should have a knowledge of the control of damage to logs.

a. Handling of hardwood logs, including storage to minimize damage and degrade.
b. Prevention and control of insect damage.
c. Prevention and control of stain in hardwood logs.

The wood technologist should have basic understanding of the proper application of wood products - both structural and non-structural.

a. Basic understanding of proper application and use of wood products - both structural and non-structural.
b. Basic methods of constructing with wood.
c. Furniture design and construction.
d. Home building basics.
e. Application and uses of wood products in construction.

The wood technologist should have an understanding of basic furniture design; strength of various joining techniques.

a. Understand basic furniture design, strength of various joining techniques.
b. Furniture design and construction.

The wood technologist should have a knowledge of wood-moisture relationships.

a. Understand humidity effects on wood.
b. Wood-moisture relationships.
c. Understanding of wood-fluid relationships.

The wood technologist should have an understanding of forest products marketing.

a. Knowledge of lumber pricing.
b. Understanding of forest products marketing.
c. Sales and marketing theory.
d. Credit and collecting theory.
e. The hardwood lumber markets - suppliers and users.
f. General knowledge of sales and marketing principles to gain appreciation of the demands of the marketplace.
g. Knowledge of raw material procurement and measurement.
h. Raw material procurement.
i. Know lumber purchasing techniques.
j. Know veneer purchasing techniques.
k. Marketing prinicples.

The wood technologist should have a knowledge of the utilization of veneered products.

a. Know when and how to use veneers.
b. Procedures for making veneered panels.
c. Veneer and plywood manufacture.
d. Veneer drying and grading.

The wood technologist should have a knowledge of lumber grading procedures.

a. Know lumber grading and tallying.
b. Lumber handling and grading.

The wood technologist should have an understanding of the finishing technology related to the finishing of wood.

a. Finishing.
b. Understanding the various finishing materials and their uses.
c. Techniques of finishing.
d. Understanding the finishing technology related to finishing of wood.
e. Finishing and coating of hardwood products and panelling.
f. Wood finishing: varnishes, oils, lacquers, waters.
g. Wood finishing application systems.
h. Treatment of finished goods before packaging - rubbing and polishing.

The wood technologist should have a basic understanding of plant layout.

a. Industrial engineering: time and motion studies, plant layout, methods analysis.
b. Industrial engineering skills - quality control functions, plant layout, etc.
c. Time and motion study - methods and layout.
d. Plant layout.
e. Conveyors and related equipment.
f. Instrumentation.
g. Dust collection systems.
h. Principles of industrial engineering.

The wood technologist should have a knowledge of the principles of biological deterioration of wood.

a. Deterioration factors. Studies could be made to determine how much deterioration takes place from the time a tree is felled until it is cut into lumber. I am sure you are aware that this varies from region to region, and weather has much to do with this.
b. A knowledge of principles of biological deterioration of wood.

The wood technologist should have an understanding of wood preservation.

a. Preservation.
b. Understanding of wood preservation.
c. Decay resistance and preservatives used in hardwood lumber products.

The wood technologist should have a knowledge of wood drying methods and procedures.

a. Knowledge of wood drying procedures and methods.
b. Wood drying.
c. Know kiln drying procedures and equipment for various species.
d. Learn proper lumber stacking and air drying techniques.
e. Specific understanding of wood drying.
f. Air drying of hardwood lumber and stacking equipment and procedures.
g. Kiln drying of hardwood lumber including micro-wave and blow box operation.
h. Air drying and pre-drying of lumber.
i. Conventional kilns and kiln schedules.
j. Solar kilns and other energy efficient innovations.
k. Veneer drying and grading.
l. Wood drying process.

The wood technologist should have a knowledge of basic economics including the forest products area.

a. Economics (basic).
b. Economics.
c. Basic understanding of forest products economics.
d. Economics I and II.
e. Economics.

The wood technologist should have problem-solving and decision-making skills.

a. Problem-solving skills.
b. Decision-making skills.
c. Should review closely all data collected, analyze and make recommendations or corrections as the situation dictates.
d. Educational background to make decisions.
e. Common sense to use technical training to apply to everyday operation.
f. Make decisions on fact rather than fiction.

The wood technologist should have an understanding of adhesive technology related to gluing of wood.

a. Glued wood products and processes.
b. Glues and gluing.
c. Adhesion (glue).
d. A thorough understanding of wood properties and adhesives.
e. Know the various glues - their advantages, disadvantages and costs.
f. Adhesives.
g. Adhesives and their application.
h. Understanding of adhesive technology related to gluing of wood.
i. Hardwood lumber lamination and adhesives used in laminated hardwood products.
j. Glues and gluing.
k. Know assembly techniques and clamping.
l. Knowledge of wood bonding and glues especially as this applies

to the bonding of small particles.
m. Principles of wood gluing.

The wood technologist should have a knowledge of public relations.
a. Realize that customer's expectation of product must be known.
b. Should handle complaint problems with the sales and marketing.
c. Should represent the mill in trade association technical matters.
d. Should secure code and industry approvals.
e. Public relations as it pertains to the media and the community at the local level.

The wood technologist should have a knowledge of the physical and mechanical properties of wood.
a. Mechanical properties of wood.
b. Mechanical properties.
c. Strength and related physical properties of wood by species.
d. Understanding of wood mechanics.
e. Mechanical properties of wood.
f. Knowledge of physical properties of wood.
g. Physical and chemical properties of wood.
h. Physical properties of wood.
i. Strength, shear bending stress and other physical qualities of hardwoods.
j. Knowledge of the physical and chemical properties of wood.
k. Knowledge and ability to perform strength testing of materials.
l. Properties of wood general.

The wood technonolgist should have the ability to handle people in a management role.
a. Industrial psychology.
b. Understand human relations.
c. Ability to handle people in a management role.
d. Should have had some experience, or good instructing in the art of getting along with, and directing the actions of subordinates.
e. It is important to have supervisors work closely with persons in his/her department to develop best working relationship possible.
f. People skills.
g. Psychology.
h. Ability to get along with people.
i. Leadership ability.
j. Leadership ability.
k. Personnel administration.
l. The wood technologist should be responsible for leading and supervising employees.
m. Ability to work with people.
n. Honesty with company, self and others.
o. Stand-up for convictions, but not be afraid to change when shown a better way.
p. Instruction in labor relations and motivational techniques to assure productivity in the use of each manufacturing process.

q. The attitudes and judgement needed to direct the work of others.
r. . . . have the initiative to promote new ideas and to accept new ideas diplomatically and in an unbiased manner.

The wood technologist should be able to express ideas in both a conversation and in writing.

a. Communications (employee).
b. Public speaking.
c. Letter and report writing.
d. Ability to communicate ideas.
e. Technical writing.
f. Communications.
g. Public speaking.
h. Oral presentation.
i. Communications.
j. Public speaking.
k. English.
l. Report writing.
m. Good verbal communication skills.
n. Good written communication skills.
o. Must be able to interpret technical data and to express that data in a clear, concise manner in both the form of written and oral reports.
p. Ability to express ideas both in conversation and writing.
q. Able to communicate with top management and common laborer.
r. Writing skills necessary to make clear, concise technical reports.
s. Public speaking skills.
t. Public speaking.
u. Good command of both oral and written communication in the English language.

The wood technologist should maintain communications with various levels of the organization.

a. Should keep plant well informed of quality, personnel, and equipment status.
b. Make available to all involved personnel all technical information relative to products (raw materials) used in manufacturing procedures, i.e. bonding agents - extenders - adhesives, etc.
c. Production personnel constantly feed ideas and thoughts back to higher management for possible upgrade in production procedure.

The wood technologist should have a knowledge of materials commonly substituted for wood products.

a. Understand wood substitutes - i.e. plastics, particle board, etc.

COMPETENCY STATEMENTS FROM CORRESPONDENCE NO. 1 NOT UTILIZED

Note: The following unedited competency statements submitted by respondents to Correspondence No. 1, were not used directly as a basis for the development of generalized competency statements. The decision to eliminate these statements was based on the recommendation of an ad hoc committee organized to evaluate the responses to Correspondence No. 1.

Physics.

Physics (two semesters minumum).

Physics.

Basic skills through math and physics (through calculus and analytical geometry).

A better than average knowledge of physics.

Math through algebra and geometry.

Math, at least to calculus.

Knowledge of energy transmission using liquids.

Engineering mechnaics.

Knowledge of development and use of compressed air.

Pnuematics including air compressors.

Knowledge of elementary thermodynamics (heat and energy relations).

Knowledge of elementary mechanics (statics).

HVAC including boilers.

Strength of materials.

Knowledge of mechanical drawing - including electrical schematic points.

Drafting - minimal coverage.

Blue print reading.

Mechanical drawing and design.

Interpretation of electrical schematics.

Knowledge of lubrication systems and products used.

Knowledge of electricity (1 and 3 phase).

Knowledge of electric control devices.

Electrical engineering: lighting, transformers, capacitors, and power wiring, motors.

Knowledge of basic metal working.

Knowledge of basic welding.

Chemistry through two semesters of organic chemistry.

General chemistry.

Organic chemistry.

Chemistry.

Chemistry.

Chemistry.

Basic skills in chemistry.

A strong background in chemistry.

Business law.

Knowledge of state and federal labor laws.

Business law.

Good knowledge of union arbitration.

Understand fully a working relationship should a union contract exist. This relates to applying terms of contract to work performance, schedules, promotion factors, etc. Also, make suggestions to management for better verbage for upgrading contract.

Machinery and cost justifications.

Knowledge of machinery maintenance and specifications for all equipment commonly used in woodworking.

. . . a wood technonolgist should never rest on his laurels but constantly strive to broaden his visions to deep abreast of increased knowledge of the industry - be it technical or otherwise. Remember the enthusiasm radiated by management at any level will be telegraphed to every member of the workforce.

Self-starter to get results.

Desire to grow in knowledge and keep up with new ideas and developments.

Ambitious - for self and company.

Contact in the field and classroom with the most competent and innovative businesses and scientists.

Exchange of research and scientific information among all wood technology institutions - perhaps an educational cross reference system by publication and/or computer.

Attendance at Forest Products Research Society meetings on local, regional, national levels.

Overview of national wood utilization problems presented by research branch of the forest service and Forest Products Laboratory personnel.

Knowledge of good forestry practice.

Knowledge of forest harvesting methods.

Cruising of hardwood timber.

Planting of hardwood timber.

Harvesting of hardwood timber.

Knowledge of lumber harvesting, the various ways of sawing logs and cutting veneer.

Dendrology.

Botany.

Understanding of forest products harvesting.

Knowledge of forest management, silviculture, and forestry engineering methods and challenges as they relate to product requirements.

Logic.

Logic.

Knowledge of gasoline and diesel engines.

Knowledge of basic plumbing.

Hydraulics.

Generation and transmission of steam.

APPENDIX E

COVER LETTER, CORRESPONDENCE NO. 2

FORMS AND FOLLOW-UP

Oklahoma State University

SCHOOL OF OCCUPATIONAL AND ADULT EDUCATION

STILLWATER, OKLAHOMA 74078
CLASSROOM BUILDING 406
(405) 624-6275

April 8, 1982

Name
Company
Address
City, State Zip

[Personalized Cover Letter and Correspondence No. 2 Forms; All Industries]

Dear _____:

Our attempt at Oklahmoma State University to gather data concerning the needed competencies of the wood technologist employed in the forest products industry has been very promising. Responses to Correspondence No. 1 have produced 342 competencies. As a result of this large number of competencies submitted, a special committee, knowledgeable in research and the forest products industry, was formed to develop a list of generalized competency statements that were representative of the original 342 statements submitted.

The generalized competencies have been listed on Correspondence No. 2. You are being asked to rate the importance of each of the competencies on a scale of one-to-ten; a one would indicate a competency rated as least important, a ten would indicate a competency rated as most important. The responses from all of the completed Correspondence No. 2 forms will be combined and the resulting information will supply the data needed for the study.

The success of this research study depends upon industry experts such as yourself. Please complete Correspondence No. 2 and return it in the self-addressed, stamped return envelope. I am hoping to complete the data gathering phase of the study by May 1, 1982 so I would greatly appreciate your prompt response. If you have any questions, please feel free to telephone me at (405) 624-7414, office, or (405) 377-1614, home.

Sincerely,

Robert F. Alsup, Jr.
Graduate Research Associate

RFA/cg
Attachment

CORRESPONDENCE NO. 2

The wood technologist employed in the forest products industry must possess certain competencies in order to carry out his/her job. Below are the generalized competency statements that were derived from the responses to Correspondence No. 1. Please rate the importance of each statement on the rating scale provided, by placing a check (✓) above the appropriate number. A rating of 1 would indicate "least important;" a rating of 10 would indicate "most important." An example competency statement is provided.

EXAMPLE: most important least important

The wood technologist should possess basic skills in physics.

10	9	8	7	6	5	4	3	2	1
/	/	/	/	/✓/	/	/	/	/	/

1. The wood technologist should have a good knowledge of business operating procedures.

10	9	8	7	6	5	4	3	2	1
/	/	/	/	/	/	/	/	/	/

2. The wood technologist should have a knowledge of the utilization of veneered products.

10	9	8	7	6	5	4	3	2	1
/	/	/	/	/	/	/	/	/	/

3. The wood technologist should have a knowledge of public relations.

10	9	8	7	6	5	4	3	2	1
/	/	/	/	/	/	/	/	/	/

4. The wood technologist should have a specific understanding of basic woodworking.

10	9	8	7	6	5	4	3	2	1
/	/	/	/	/	/	/	/	/	/

5. The wood technologist should promote company policies.

10	9	8	7	6	5	4	3	2	1
/	/	/	/	/	/	/	/	/	/

6. The wood technologist should have a basic understanding of wood conversion processes.

10	9	8	7	6	5	4	3	2	1
/	/	/	/	/	/	/	/	/	/

7. The wood technologist should have a knowledge of the sharpening of wood cutting tools.

10	9	8	7	6	5	4	3	2	1
/	/	/	/	/	/	/	/	/	/

8. The wood technologist should have the ability to define responsibilities and organize work.

10	9	8	7	6	5	4	3	2	1
/	/	/	/	/	/	/	/	/	/

9. The wood technologist should understand the quality control of forest products and implement quality control techniques.

10	9	8	7	6	5	4	3	2	1
/	/	/	/	/	/	/	/	/	/

10. The wood technologist should have problem-solving and decision-making skills.

10	9	8	7	6	5	4	3	2	1
/	/	/	/	/	/	/	/	/	/

most important least important

11. The wood technologist should have an understanding of the finishing technology related to the finishing of wood.

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12. The wood technologist should be able to analyze and maintain knowledge of competitive products.

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13. The wood technologist should maintain communications with all levels of the organization.

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14. The wood technologist should be able to relate laboratory research techniques to full scale plant requirements.

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15. The wood technologist should have a knowledge of basic economics including the forest products area.

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16. The wood technologist should have a working knowledge of accounting, including depreciation and taxes.

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17. The wood technologist should have an understanding of basic furniture design; strength of various joining techniques.

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18. The wood technologist should have an understanding of forest products marketing.

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19. The wood technologist should have the ability to handle people in a management role.

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20. The wood technologist should have a good knowledge of steps and/or procedures that reduce operating and manufacturing costs.

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21. The wood technologist should be knowledgeable in computer utilization.

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22. The wood technologist should have a knowledge of the anatomical structure of wood.

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23. The wood technologist should understand governmental regulations that pertain to industry operation.

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24. The wood technologist should have a basic understanding of plant layout.

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25. The wood technologist should have a knowledge of packaging, warehousing, and transporting forest products.

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26. The wood technologist should have an understanding of adhesive technology related to gluing of wood.

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27. The wood technologist should be able to produce financial plans.

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28. The wood technologist should have a knowledge of lumber grading procedures.

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29. The wood technologist should have a knowledge of wood drying methods and procedures.

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30. The wood technologist should have a knowledge of materials commonly substituted for wood products.

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31. The wood technologist should be acquainted with the primary equipment present in board manufacturing and processing plants.

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32. The wood technologist should have a knowledge of the control of damage to logs.

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33. The wood technologist should understand the statistical compilation methods used in the industry.

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34. The wood technologist should have a knowledge of the principles of biological deterioration of wood.

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35. The wood technologist should be knowledgeable in the identification of woods.

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36. The wood technologist should have a knowledge of the machining characteristics of various wood species.

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37. The wood technologist should have an understanding of wood preservation.

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38. The wood technologist should have a knowledge, attitude, and understanding of safety on the job and its importance to industry.

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39. The wood technologist should have a knowledge of the physical and mechanical properties of wood.

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40. The wood technologist should maintain communications with various levels of the organization.

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41. The wood technologist should realize the limitations of each wood specie as it relates to the workability of an item.

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42. The wood technologist should be able to express ideas both in conversation and in writing.

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43. The wood technologist should have a practical "on the ground" knowledge of the processes currently employed by the forest products industry.

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44. The wood technologist should be able to evaluate personnel performance.

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45. The wood technologist should have a knowledge of wood-moisture relationships.

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46. The wood technologist should have a basic understanding of the proper application of wood products - both structural and non-structural.

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47. The wood technologist should have a knowledge of the chemical properties of various wood species.

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Let me once again thank you for assisting with this research study. Please return this form, Correspondence No. 2, in the pre-addressed, stamped envelope provided. If you would like a summary of the findings of this study, please sign your name in the blank below.

Signed _____

Oklahoma State University

SCHOOL OF OCCUPATIONAL AND ADULT EDUCATION

STILLWATER, OKLAHOMA 74078
CLASSROOM BUILDING 406
(405) 624-6275

April 24, 1982

Name
Company
Address
City, State Zip

[Personalized Follow-up Letter, Correspondence No. 2]

Dear _____:

You and several other leaders in the forest products industry were recently mailed an introductory letter and a form asking you to "rate" the importance of each of 47 generalized competency statements that were developed to describe the employment needs of the "wood technologist."

I need your immediate help in this matter. Currently, less than 50% of the original forms have been completed and returned. More responses will have to be obtained in order to give this study meaning. Please fill out Correspondence No. 2 and return it in the pre-addressed, stamped return envelope by no later than May 1. If you have already responded to Correspondence No. 2, please disregard this letter.

If you have any questions, feel free to telephone me at work, (405) 624-7414, or home, (405) 377-1614.

Sincerely yours,

Robert F. Alsup, Jr.
Graduate Research Associate

Enclosure
RFA/cg

VITA[2]

Robert Franklin Alsup, Jr.

Candidate for the Degree of

Doctor of Education

Thesis: THE IDENTIFICATION OF WOOD TECHNOLOGY COMPETENCIES BASED ON THE OPINIONS OF SELECTED INDUSTRY EXPERTS

Major Field: Occupational and Adult Education

Biographical:

Personal Data: Born in Poplar Bluff, Missouri, April 25, 1951, the son of Robert F. and Fern Alsup; married to Barbara, February 23, 1979.

Education: Graduated from Murray University School, Murray, Kentucky, in May, 1969; received Bachelor of Science degree with a comprehensive area in Industrial Education from Murray State University in December, 1973; received Master of Science degree in Industrial Arts Education from Oklahoma State University, Stillwater, Oklahoma, May, 1981; completed requirements for Doctor of Education degree in Occupational and Adult Education at Oklahoma State University, July, 1982.

Professional Experience: High school industrial arts teacher, Livingston County Schools, Smithland, Kentucky, 1974-75; high school and middle school industrial arts teacher, Crittenden County Schools, Marion, Kentucky, 1975-79; employed as graduate teaching assistant and graduate research associate in the Industrial Arts Education Department, Oklahoma State University, Stillwater, Oklahoma, July, 1979, to present; internship at Campbell Rhea Manufacturing, Paris, Tennessee, Summer, 1981.

Professional Organizations: Oklahoma Council of Industrial Arts Teacher Educators, Epsilon Pi Tau, Ancient and Beneficient Order of the Red Red Rose.