EVALUATING THE SUBJECT NEEDS FOR WOOD SCIENCE AND FOREST PRODUCTS CURRICULA

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ABSTRACT

Wood Science and Forest Products programs across North America are reevaluating the needs of students and the forest products industry in order to provide the skills necessary to remain competitive in the changing marketplace. While some programs are losing students and even eliminating their wood science curricula, others are increasing enrollment and substantially altering their programs to meet the needs of industry. This research demonstrates how one Wood Science and Forest Products program evaluated and adjusted its curriculum to meet the changing needs of the forest products industry. Graduating seniors, alumni, and employers of alumni were surveyed to evaluate a Wood Science program. In this case study, it was found that all stakeholders rated traditional wood science classes as meeting the needs of students and employers, while improvements are needed in business and communication skills.

Keywords: Wood science education, curricula, evaluation.

INTRODUCTION

The future of wood science education has been of concern to educators and employers for many years. Ellis (1964) reported that the first curriculum designated as wood technology was in 1929 and he defined wood science as, "that body of knowledge applicable to wood as a material, including its origin, properties, and characteristics." Barnes (1979, 1980) in his articles "Education in Wood Science and Forest Products" characterized the status of programs in North America. While Barnes identified a substantial increase in programs since 1963, he concluded that there remained a strong need for graduates. Bowyer (1991) updated Barnes' work and suggested that academic programs may need repackaging to serve the industry better and to attract a greater number of students. At that time, Bowyer saw a greater need for marketing-oriented curricula that include extensive exposure to wood science and technology subjects. That need has been addressed through new marketing programs at Pennsylvania State University, University of Minnesota, University of Washington, University of British Columbia, and Virginia Tech. Lyon et al. (1995) stated that *"There is a crisis in Wood Science and Technology education and this crisis affects the entire forest products industry. Educational pro-*

grams have been declining for over a decade, and unless changes occur, qualified individuals may not be available to work in the industry." The authors go on to state that wood science programs have been adept at integrating other disciplines into basic wood technology to meet the needs of a changing industry. Most recently Ifju (1996) has addressed the concerns over declining enrollments and described active recruiting efforts at major wood science programs.

However, to date very little has been published which addresses the changes that may be needed in wood science curricula to better meet the needs of the industry. A new forest products program at the University of British Columbia is integrating an industrial-university partnership, which will resemble the program at the German Rosenheim Institute. The new five-year program will include a wood science education along with business and marketing skills, and practical experience with modern wood processing equipment. This program was developed in response to the needs identified by the Board of the National Education Initiative of the Furniture and Secondary Manufacturing Industry (Lyon et al. 1995).

Since many wood science and technology programs are struggling with enrollment and survival, they may not be able to implement the sweeping changes that are occurring in British Columbia. For these programs, efforts to continually upgrade existing wood science and forest products (WS&FP) curricula may be the most efficient way to meet industrial needs. This is the situation with Virginia Tech's Department of Wood Science and Forest Products. In the winter of 1996 an evaluation of the Wood Science and Forest Products program at Virginia Tech was conducted to measure how well the department was preparing students for the work environment. The objective of the study was to determine the subject areas that alumni, employers, and current students felt were important for their career success and how well Virginia Tech's WS&FP curricula were addressing these areas.

The purpose of this paper is to provide the results of this case analysis and suggest a methodology that other WS&FP programs can use to evaluate their subject need areas. Ultimately, it is the hope of the authors that this paper will continue to stimulate critical thinking about the future of wood science programs across North America.

Virginia Tech

The Department of Wood Science and Forest Products at Virginia Tech is one of three departments within the College of Forestry and Wildlife Resources. Within the department, there are two undergraduate degree options, Wood Products and Forest Products Marketing/Management. In 1995, these two options had a combined enrollment of 81 undergraduate students or 11% of the total enrollment in the College of Forestry and Wildlife Resources. The 1997 enrollment in the department has risen to 97 students. This represents the largest enrollment among similar programs in the United States and Canada. At the graduate level, the department offers M.F., M.S., and Ph.D. degrees. On average, there are 30–35 graduate students enrolled every year, approximately two-thirds of whom are Ph.D. candidates.

The two undergraduate options in the Department of Wood Science and Forest Products are fully accredited by the Society of Wood Science and Technology (SWST), most recently in May 1995. The departmental programs were also reviewed by the USDA Cooperative State Research Education and Extension Service (CSREES) in April 1994. The review team concluded that the educational program in Wood Science and Forest Products was "one of the premier programs in the U.S."

METHODS

Subject need score

A method advocated by Borich (1980), used by Bratkovich and Miller (1993) to measure the educational needs of Ohio sawmill opera-

tors, and most recently used by Hansen and Smith (1997) to identify the educational needs of the forest products industries in Oregon and Virginia, was adopted to measure the preparedness of Virginia Tech WS&FP students. This method asked respondents to rate the importance of a subject area and how well the WS&FP curricula prepared students in that area. From these two component scores, a subject need score was calculated by subtracting preparedness from importance and multiplying the result by the respondents' mean importance for that item as rated by all respondents. This method resulted in weighting the difference between the two items by the mean of the importance for the subject area being measured. The calculation is:

$$\text{Subject Need Score} = (I - P)(M)$$

where,

I = individual respondent's rating of a subject's importance to career success

P = individual respondent's rating of the WS&FP curricula in preparing them in the subject area.

M = mean of all repondents importance ratings of the subject area

By evaluating the importance and preparedness together, this method identifies those areas in which the curricula are meeting the needs of the students and industry, and the subject areas in which the curricula could enhance their efforts during student development. A low subject need score reflects that respondents feel the WS&FP curricula are meeting their needs in the subject area being evaluated.

Questionnaire design

A questionnaire was designed to assess importance and preparedness in 19 subject areas identified as important. These subject areas were reviewed by faculty within the department and the administration. The subject areas covered basic wood science (properties, pro-

cessing, drying, composites, chemistry, and engineering), business (management science, economics, marketing, accounting, and statistics), as well as writing, speaking, general problem solving, and computer skills.

Sampling

Three distinct groups were surveyed to evaluate the Wood Science and Forest Products curricula. These included current graduating seniors, undergraduate and graduate alumni, and employers of undergraduate and graduate alumni. Survey administration was conducted by mail, fax, and personal interviews.

The mailed questionnaires were sent to 123 alumni during the winter of 1996. Approximately equal numbers of undergraduate and graduate students were contacted. As part of exit interviews, the questionnaire was administered to 11 graduating seniors during their last semester (spring 1996). To evaluate the opinions of employers of the departments' graduates, the questionnaire was sent via facsimile to 22 organizations that employed 30 of our alumni. A cover letter explained the questionnaire and asked for help in understanding how well the curricula prepared graduates to work in their organization.

RESULTS

Respondents

A total of 67 responses from the alumni survey were received, resulting in an overall response rate of 55%. Twenty-four responses came from undergraduate alumni and 43 came from graduate alumni. The fax survey of 26 employers of alumni resulted in 12 usable responses for an overall response rate of 46%. Seven employers had hired undergraduate students, 4 had hired graduate students, and 1 had hired both undergraduate and graduate students. All 11 undergraduate seniors completed surveys.

Alumni were asked to rate the WS&FP curriculum as to how well, overall, it prepared them for their careers. Undergraduate alumni
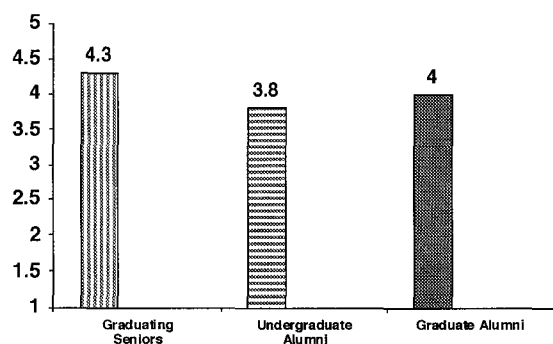
FIG. 1.　Rating of department on preparing students for a career in wood science.

uate alumni. When current graduating seniors were asked their expected starting salary, responses averaged to $27,000.

Employers were asked if they were satisfied with the skills the graduates possessed at the time of their hiring and everyone responded yes. One hundred percent of responding employers indicated that they would recommend the program to a prospective student. When asked if they would hire our graduates again, eight employers responded yes, and four said it would depend on the individual applicant.

Subject area assessment

rated the department as 3.8 on a scale from 1 (poor) to 5 (excellent). Graduate alumni rated the department a 4.0. Current graduating seniors rated the department a 4.3 (Fig. 1). Undergraduates reported starting salaries that averaged to $24,300, while graduate students reported starting salaries that averaged to $28,200. Graduate salaries appeared skewed on the low side, since many respondents were from earlier graduating years than undergrad-

As indicated earlier, a subject need score was developed from the ratings the various groups gave to the importance of a subject area and the preparation they received in that same subject area at Virginia Tech. Tables 1–3 summarize the overall ratings in importance, preparation, and the calculated subject area score. Table 4 compares the subject needs of the four respondent groups. Since sample size was small, a Kruskall-Wallis 1-Way ANOVA

TABLE 1.　*Alumni importance, preparedness, and subject need scores.*

Subject area	Alumni undergraduate students (n = 24)			Alumni graduate students (n = 43)		
	Importance	Prepared	Subject need*	Importance	Prepared	Subject need*
Personnel management skills	4.21 (3)	3.04 (16)	4.91 (1)	3.74 (9)	2.61 (16)	4.47 (1)
Knowledge of business practices	3.88 (7)	3.00 (18)	3.21 (2)	3.39 (12)	2.58 (17)	2.97 (4)
Problem-solving skills	4.54 (1)	3.83 (7)	3.15 (3)	4.81 (1)	3.98 (3)	4.01 (2)
Public speaking skills	4.21 (3)	3.62 (11)	2.45 (4)	4.44 (3)	3.91 (5)	2.37 (6)
Computer skills	4.21 (3)	3.67 (10)	2.28 (5)	4.35 (4)	3.81 (7)	2.32 (4)
Knowledge of statistics	3.58 (11)	3.17 (15)	1.49 (6)	4.02 (6)	4.22 (2)	−0.79 (14)
Writing skills	4.25 (2)	3.96 (5)	1.24 (7)	4.67 (2)	3.93 (4)	3.48 (3)
Knowledge of management science	3.37 (12)	3.04 (16)	1.12 (8)	3.14 (17)	2.54 (18)	2.07 (8)
Math skills	3.79 (8)	3.83 (7)	−0.16 (9)	3.88 (8)	3.74 (10)	0.55 (10)
Knowledge of accounting	2.71 (19)	2.91 (19)	−0.59 (10)	2.61 (19)	2.15 (19)	1.31 (9)
Marketing skills	3.25 (13)	3.50 (12)	−0.81 (11)	3.39 (12)	3.41 (13)	0.12 (13)
Knowledge of wood processing	3.79 (8)	4.39 (2)	−0.88 (12)	3.93 (7)	3.77 (9)	0.35 (12)
Knowledge of marketing	3.17 (15)	3.46 (13)	−0.92 (13)	3.36 (13)	3.27 (14)	0.49 (11)
Knowledge of economics	2.88 (17)	3.33 (14)	−1.32 (14)	3.38 (14)	2.68 (15)	2.56 (5)
Knowledge of wood properties	4.04 (6)	4.56 (1)	−1.58 (15)	4.06 (5)	4.44 (1)	−1.56 (17)
Knowledge of wood engineering	3.21 (14)	3.91 (6)	−1.96 (16)	3.40 (11)	3.91 (5)	−1.74 (18)
Knowledge of wood composites	3.63 (10)	4.35 (3)	−2.21 (17)	3.56 (10)	3.80 (8)	−0.87 (16)
Knowledge of wood chemistry	2.79 (18)	3.72 (9)	−2.28 (18)	2.91 (18)	3.62 (11)	−2.10 (19)
Knowledge of wood drying	3.13 (16)	4.30 (4)	−3.39 (19)	3.32 (16)	3.58 (12)	−0.85 (15)

Scale: 1—unimportant to 5—important.
Number in parentheses is overall ranking of that subject area.
* Subject need = (Importance − prepared)*Mean of importance.

was used to investigate differences among the groups on the ratings of subject need areas.

Undergraduate alumni rated problem-solving skills, writing skills, computer skills, public speaking, personnel management, and knowledge of wood properties as the most important to their career success. These alumni felt that they were best prepared in the areas of wood properties, wood processing, wood composites, wood drying, and writing skills. Undergraduate alumni felt that they received the least preparation in the areas of accounting, business practices, management science, and personnel management. When the subject need score was calculated, the most important subject areas were personnel management, business practices, problem-solving skills, public speaking, and computer skills. The lowest rated subject need scores were in wood drying, wood chemistry, and wood composites (Table 1). Undergraduate alumni feel they are getting proper training in traditional wood science areas.

Graduate alumni rated problem-solving skills, writing skills, public speaking skills, computer skills, and wood properties as the most important in their career success. This group felt that the least important skills to their careers were accounting, wood chemistry, and management science. This group felt that they were best prepared in the areas of wood properties, statistics, problem-solving skills, writing, and wood engineering. They believe that they received the least preparation in the areas of accounting, management science, and business practices. The graduate alumni's highest subject need scores were in the areas of personnel management, problem-solving skills, writing skills, business practice, computer, and public speaking skills. The lowest subject need scores were in wood chemistry, wood engineering, and wood composites (Table 1). Again, it appears that traditional wood science courses are filling the current needs of graduate students. Since graduate students are required to take a year of advanced statistics, the difference between undergraduate and graduate students on this rating can be expected. The results from both groups of

alumni indicate that business and interpersonal skills are the areas in which the program can be improved. This supports Bowyer's suggestions and the changes that have occurred in recent years for increased marketing/management subject areas to be integrated into traditional wood science programs.

Employers of our students felt that the most important areas for career success were problem-solving skills, writing skills, math skills, computer skills, and a knowledge of marketing. These employers felt that the least important to the individuals career success were wood chemistry, management science, and wood engineering. They responded that our undergraduates were best prepared in the areas of computer skills, wood processing, wood properties, wood drying, and problem-solving skills. These individuals responded that our students were least prepared in the areas of personnel management, management science, and accounting. The subject area scores that were rated highest include writing, problem-solving skills, personnel management, math, and a knowledge of marketing. These individuals' lowest rated subject area scores were in the subject areas of wood chemistry, management science, wood processing, and wood engineering (Table 2). This indicates that employers are in agreement with alumni that the WS&FP curricula are meeting the needs of our students.

Current senior students in the department believed that the most important skills for career success included public speaking, management science, personnel management, writing, and wood processing. These students rated accounting, wood drying, and statistics as least important to their career success. They felt that they were best prepared in the areas of wood properties, wood composites, wood processing, wood drying, and writing. They felt that they were least prepared in the subject areas of management science, accounting, and statistics. The most important subject need areas that were calculated included public speaking skills, management science, problem-solving skills, personnel management, and marketing skills. The lowest rated subject need areas were wood composites,

TABLE 2. *Employers' importance, preparedness, and subject need scores.*

Subject area	Employers of students (n = 12)		
	Importance	Prepared	Subject need*
Writing skills	4.50 (2)	3.42 (11)	4.88 (1)
Problem-solving skills	4.75 (1)	3.75 (5)	4.75 (2)
Personnel management skills	4.17 (6)	3.18 (17)	4.17 (3)
Math skills	4.42 (3)	3.67 (6)	3.32 (4)
Knowledge of marketing	4.37 (5)	3.57 (7)	3.13 (5)
Public speaking skills	4.08 (7)	3.33 (14)	3.06 (6)
Knowledge of business practices	3.92 (10)	3.40 (12)	1.96 (7)
Computer skills	4.42 (3)	4.08 (1)	1.47 (8)
Knowledge of wood drying	4.00 (8)	3.82 (4)	0.73 (9)
Knowledge of statistics	3.50 (14)	3.40 (12)	0.40 (10)
Knowledge of accounting	3.54 (13)	3.30 (15)	0.36 (11)
Knowledge of economics	3.64 (12)	3.50 (10)	0.00 (12)
Knowledge of wood properties	4.00 (8)	4.00 (2)	0.00 (12)
Knowledge of wood engineering	3.45 (15)	3.55 (8)	−0.31 (14)
Knowledge of wood processing	3.91 (11)	4.00 (2)	−0.49 (15)
Knowledge of management science	3.11 (16)	3.29 (16)	−0.89 (16)
Knowledge of wood chemistry	3.00 (17)	3.54 (9)	−1.63 (17)

Scale: 1—unimportant to 5—important.
Number in parentheses is overall ranking of that subject area.
* Subject need = (Importance − prepared)*Mean of importance.

wood drying, and wood properties. This reflects that undergraduates believe they are getting proper training in these more traditional wood science areas (Table 3).

Table 4 illustrates that there is no statistical difference between the top five rated subject need areas by the four different groups. Personnel management, business practices, problem-solving skills, public speaking skills, and computer skills were all rated similarly at a 0.05 significance level. With the exception of knowledge of wood composites, there were no statistical differences between the basic wood science courses that were listed. And, in general, these courses were in the lower portions of the subject need areas. In other words, all stakeholders in the curriculum of the department believe that students are getting a good wood science education. The differences between groups all appear in the area of business and marketing. Since the program is divided between those students involved in marketing/management and wood products, this may be expected. Those students who get a business background would most likely rate the importance of those subjects higher than those who

do not. The differences in required curricula may be the reason for the differences in rating in these areas.

Implementation strategy

This study determined that the major subject areas that need to be incorporated into or enhanced in the WS&FP curriculum at Virginia Tech are not in the traditional wood science area. The results indicate that students and employers rate the teaching of traditional wood science classes quite well, and in some instances feel that students may be getting more training than is required for their job success. It was found that a well-balanced wood science and forest products education included training in all traditional wood science areas including: properties, composites, processing, chemistry, drying, and engineering. However, once hired a student probably will not utilize material presented in every course in her/his career. An example is that a student and employer may rate wood chemistry low in importance because a salesperson of solid wood products may not use that knowledge on a reg-

TABLE 3. *Graduating seniors' ratings of importance, preparedness, and calculated subject need scores.*

Subject area	Graduating seniors undergraduate students (n = 11)		
	Importance	Prepared	Subject need*
Public speaking skills	4.73 (1)	3.73 (9)	4.73 (1)
Knowledge of management science	3.73 (11)	2.55 (18)	4.41 (2)
Problem-solving skills	4.64 (2)	3.73 (8)	4.22 (3)
Personnel management skills	4.55 (3)	3.64 (11)	4.14 (4)
Marketing skills	4.50 (6)	3.70 (10)	3.50 (5)
Computer skills	4.45 (7)	3.82 (6)	2.83 (6)
Knowledge of marketing	4.27 (9)	3.64 (11)	2.72 (7)
Knowledge of business practices	4.18 (10)	3.55 (14)	2.66 (8)
Writing skills	4.55 (3)	4.09 (5)	2.07 (9)
Knowledge of accounting	3.09 (19)	2.55 (18)	1.69 (10)
Knowledge of statistics	3.45 (17)	2.91 (17)	1.88 (11)
Knowledge of wood chemistry	3.73 (11)	3.45 (15)	1.02 (12)
Knowledge of wood processing	4.55 (3)	4.36 (3)	0.83 (13)
Knowledge of economics	3.55 (16)	3.36 (16)	0.65 (14)
Math skills	3.73 (11)	3.64 (12)	0.34 (15)
Knowledge of wood engineering	3.73 (11)	3.82 (6)	−0.34 (16)
Knowledge of wood properties	4.45 (7)	4.64 (1)	−0.89 (17)
Knowledge of wood drying	3.45 (17)	4.18 (4)	−2.51 (18)
Knowledge of wood composites	3.64 (15)	4.60 (2)	−2.55 (19)

Scale: 1—unimportant to 5—important.
Number in parentheses is overall ranking of that subject area.
* Subject need = (Importance − prepared)*Mean of importance.

TABLE 4. *Subject need scores of alumni, employers, and graduating seniors.*

Subject area	Alumni undergraduate students (n = 24)	Alumni graduate students (n = 43)	Employers of students (n = 12)	Graduating seniors (n = 11)	Kwaskal-Wallis one-way ANOVA *P*-values
Personnel management skills	4.91 (1)	4.47 (1)	4.17 (3)	4.14 (4)	0.73
Knowledge of business practices	3.21 (2)	2.97 (4)	1.96 (7)	2.66 (8)	0.93
Problem-solving skills	3.15 (3)	4.01 (2)	4.75 (2)	4.22 (3)	0.34
Public speaking skills	2.45 (4)	2.37 (6)	3.06 (6)	4.73 (1)	0.34
Computer skills	2.28 (5)	2.32 (4)	0.40 (10)	2.83 (6)	0.68
Knowledge of statistics	1.49 (6)	−0.79 (14)	1.47 (10)	1.88 (11)	0.05
Writing skills	1.24 (7)	3.48 (3)	4.88 (1)	2.07 (9)	0.13
Knowledge of management science	1.12 (8)	2.07 (8)	−0.89 (16)	4.41 (2)	0.01
Math skills	−0.16 (9)	0.55 (10)	3.32 (4)	0.34 (15)	0.03
Knowledge of accounting	−0.59 (10)	1.31 (9)	0.36 (11)	1.69 (10)	0.03
Marketing skills	−0.81 (11)	0.12 (13)	*	3.50 (5)	0.01
Knowledge of wood processing	−0.88 (12)	0.35 (12)	−0.49 (15)	0.83 (13)	0.17
Knowledge of marketing	−0.92 (13)	0.49 (11)	3.13 (5)	2.72 (7)	0.04
Knowledge of economics	−1.32 (14)	2.56 (5)	0.00 (12)	0.65 (14)	0.01
Knowledge of wood properties	−1.58 (15)	−1.56 (17)	0.00 (12)	−0.89 (17)	0.80
Knowledge of wood engineering	−1.96 (16)	−1.74 (18)	−0.31 (14)	−0.34 (16)	0.67
Knowledge of wood composites	−2.21 (17)	−0.87 (16)	*	−2.55 (19)	0.04
Knowledge of wood chemistry	−2.28 (18)	−2.10 (19)	−1.63 (17)	1.02 (12)	0.59
Knowledge of wood drying	−3.39 (19)	−0.85 (15)	0.73 (9)	−2.51 (18)	0.07

* = In employer survey these items were not measured.
Scale: 1—unimportant to 5—important.
Number in parentheses is overall ranking of that subject area.
Subject need = (Importance − prepared)*Mean of importance.

ular basis, but forest products marketing may be important. Conversely, another student and employer who produce antistain chemicals for the solid wood products industry may rate wood chemistry high in importance and marketing lower in importance.

These results indicate that the department needs to increase its emphasis in nontraditional wood science areas. However, as one faculty member stated during a review of these results, there is no reason that some of these subject areas cannot be implemented in the traditional wood science classes. It is necessary to change the way classes are taught, not necessarily what is taught, in order to provide the students with more opportunities to speak, solve problems, and to write. The department has designated a marketing class as writing-intensive and is currently reviewing another class for writing-intensive designation. Public speaking will be increased in those classes that allow students to present results of their work. The department curriculum committee is determining if a speaking-intensive class should be designated for all students. Mandatory internships or work coöps are being considered for all students to enhance their knowledge of the industry and improve their problem-solving skills.

Increased contact by all faculty with Virginia forest products companies will allow the faculty to introduce "real world" problems into the classroom. A case study approach in more traditional classes could increase the problem-solving abilities of students. Those students who are in the marketing/management option should be advised to take classes in personnel management and business practices. Although computer skills were rated high, the department in recent years has required students to purchase a computer and has implemented many computer-related classroom teaching methods.

SUMMARY

In conclusion, this study provides a framework in which other universities can evaluate their wood science programs. The results of

this case study indicate that curricula could be enhanced in areas outside the traditional wood science field. These areas include communication, problem-solving, and management skills. This study indicates that Virginia Tech stakeholders believe that students are receiving a good traditional wood science education, but that improvements are needed in these other areas. This need is being approached by integrating communication and problem-solving skills in traditional wood science classes through increased student presentations and case studies. One class has been designated as writing-intensive, and other classes are being considered for similar designation.

One way to ensure the future of the wood science programs in North America is to provide the best qualified young women and men for the industry. As the job requirements of the forest products industry change, one method to meet these changes is to evaluate the needs of industry and students on a regular basis. This information can provide the framework for any revision needed in wood science programs. This will not only provide a competitive advantage for the industry, but assure a sound future for wood science programs.

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