IDENTIFYING NEEDS FOR A PAPER AND PRINTING SCIENCE CURRICULUM

Ronald B. Larson

Associate Professor
Department of Marketing, Haworth College of Business
Western Michigan University
1903 West Michigan Avenue
Kalamazoo, MI 49008-5430

John A. Ferguson

Former Director
Paper Technology Foundation
Western Michigan University
4651 Campus Drive
Kalamazoo, MI 49008-5441

Thomas W. Joyce

Professor
Department of Paper Engineering, Chemical Engineering, and Imaging
College of Engineering and Applied Sciences
Western Michigan University
Kalamazoo, MI 49008

Raja Aravamuthan

Professor
Department of Paper Engineering, Chemical Engineering, and Imaging
College of Engineering and Applied Sciences
Western Michigan University
Kalamazoo, MI 49008

and

Peter Parker

Associate Professor
Department of Paper Engineering, Chemical Engineering, and Imaging
College of Engineering and Applied Sciences
Western Michigan University
Kalamazoo, MI 49008

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ABSTRACT

A survey on the skill needs for individuals starting careers in the paper industries was sent to people who were familiar with the field. Respondents rated the skill categories of Interpersonal Characteristics, Communication Skills, and Technical Skills as the most important. In the course topics section, five areas received scores that suggested emphasis increases could be helpful. The results helped the faculty examine the current curriculum and identify opportunities for enhancing student skills. This survey could be used as a model for other curricula evaluations, and the results could serve as benchmarks for comparing programs and for tracking changes in needs over time.

Keywords: Paper science, printing science, undergraduate curriculum, industry survey.

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INTRODUCTION

By regularly evaluating their curricula, educators can learn how they can better meet the needs of employers and students. As these needs evolve, input from various stakeholders (e.g., alumni, employers, faculty, and students) and comparisons with other schools can suggest ways to enhance programs. In 1999, the Western Michigan University (WMU) Paper Technology Foundation's Board of Trustees recommended that the curriculum in the paper science, printing science, and paper engineering areas at WMU should be evaluated. This paper summarizes the findings from a survey designed to assess the educational needs of undergraduates seeking successful careers in the paper industries. The survey was an important component of the Accreditation Board for Engineering and Technology (ABET 2000) accreditation process. It was one method by which stakeholders could influence curriculum contents and help ensure that graduates meet employer needs. Besides being benchmarks for programs preparing students to work in the paper industries, the approach and findings may also serve as a pattern for program evaluations in many other areas.

METHODS

Many organizations regularly survey stakeholders to identify strengths and opportunities for improvement. A fairly thorough review of the engineering literature found few examples of academic stakeholder surveys. Three studies were noted that focused on forest products. Virginia Tech faculty used a survey to learn more about the general skill needs for wood science and forest products curricula (Smith et al. 1998). Alumni of the College of Agriculture and the School of Forest Resources and Conservation at the University of Florida were surveyed on how satisfied they were with their degree (Osmond et al. 1998). Paun and Shook (1997) asked faculty at many schools about the need to incorporate more emphasis on marketing into a forest products curriculum. Although these surveys addressed some questions involved in an educational assessment, the Paper Technology Foundation wanted a larger, more comprehensive analysis.

One applied area in academia that has used a variety of methods to identify educational needs and opportunities is agribusiness. This sector covers the input supply, production, distribution, and marketing of food, fiber, forestry, and horticultural products (Goldberg 1985). Because paper and printing are components of this large business sector, assessment studies for agribusiness curricula were chosen as models for this research.

Many assessment options have been used in the agribusiness sector. Some of the methods that involve stakeholders include faculty and administration surveys to identify trends (Blank 1987; Comer et al. 1994), employer skill-needs surveys (Broder and Houston 1986; Morrison and Edwards 1987; Harbstreit et al. 1989), graduate earnings analyses (Barkley 1992; Broder and Deprey 1985; Preston and Broder 1990), student and peer teacher ratings, current student satisfaction surveys, exit interviews of graduates, and placement rate comparisons (Perry 1995).

Assessment of alumni satisfaction is another common tool for program evaluation (e.g., Bekkum 1993). One study found that alumni satisfaction was correlated with intentions to participate in departmental activities, suggesting additional benefits from improving program quality and stakeholder satisfaction (Gwinner and Beltramini 1995).

Another useful approach is to compare the program requirements and curricula at different schools (e.g., Larson 1996). In the paper science and engineering area, Ramaswamy et al. (1998) compared the course requirements at 10 universities. They identified many similarities in the programs and some variations in their emphasis to help improve the curriculum at the University of Minnesota. This study was also used to examine differences in program requirements.

To meet the Paper Technology Foundation's Board of Trustees' request, the skills survey method was selected. A survey instrument was designed to identify WMU's program strengths and where there might be opportunities for im-

provement. Parts of the questionnaire were based on surveys that were used to assess student needs for careers in the agribusiness field (Litzenberg and Schneider 1988; Howard 1989). Feedback from faculty members and from industry leaders helped in the design of the paper and printing subject-matter questions and in the fine-tuning of the instrument. The survey asked respondents to rate the importance of a variety of skills for careers in the paper industries. Respondents were given the opportunity to add written comments. The survey also asked WMU alumni whether adequate emphasis was given to key topics in the curriculum.

The five-page survey instrument was divided into eight parts. The first six sections dealt with skills, experiences, and characteristics. Respondents rated each item based on their importance using a 7-point scale with "7" being critically important and "1" being not important. Items were grouped into the six sections titled: Technical Skills; Computer, Information, and Data Skills; Previous Experience; Communication Skills; Business and Economics Skills; and Interpersonal Characteristics. The next section asked about their employer, their current position, and their education. The final section asked WMU alumni whether particular courses needed emphasis changes using a 7-point scale ("7" being much more emphasis, "4" being adequate, and "1" being much less emphasis).

In July and August 2000, 1148 surveys were mailed to individuals in the Paper Technology Foundation's database. Most of these people were WMU alumni. During August and September, 204 surveys were returned, yielding a response rate of 17.8%. Respondents had a variety of experiences in the paper industries. More than half of the respondents worked at firms whose primary business was either manufacturing or converting; specifically a paper/paperboard mill or a pulp mill. About 18% of the respondents had experience in the mill technical area, 13% had experience in production operations, 13% worked in new product development, 10% had experience in quality assurance/customer service, and nearly 10% had experience in senior management. About 34 respondents (nearly 17% of the sample) had earned Master of Business Administration degrees. A few addresses in the database were incorrect. Some retired individuals sent in comments that they felt their responses to a survey on the current needs of graduates might not be relevant. These two factors and the length of the survey limited the response. However, the response rate compares quite favorably to similar industry surveys.

SURVEY RESULTS

The percentage in the top box using a 5-point rating scale and the mean are considered some of the best indicators of customer satisfaction and service quality (Hurley and Estelami 1998). A 7-point scale was used in this survey to give respondents more opportunities to express different ratings for the skills and course topics. When surveys ask respondents for a rating on a 7-point scale, it is common to combine the top two categories for analysis. This is usually referred to as a top two "box" score. The percentage of respondents who selected one of the top two choices ("boxes") and the average response were used to evaluate the results. Standard deviations were calculated to compare the dispersion of the responses.

Both the percentage selecting one of the top two boxes and the average response generated the same overall ranking of the six skills. The top three were Interpersonal Characteristics, Communication Skills, and Technical Skills. Computer, Information, and Data Skills, Business and Economics Skills, and Previous Experience were ranked four, five, and six. To assess the content validity of these averages, Cronbach's coefficient alpha was computed for each of the six groups (Cronbach 1951). The alpha coefficients ranged from 0.799 for Computer, Information, and Data Skills to 0.918 for Interpersonal Characteristics, suggesting a high level of internal reliability for the six categories (Peterson 1994).

Some might be surprised that Previous Experience had the lowest ranking of all the skill categories. However, this result was consistent with similar research. In the late 1980s, surveys of

U.S. agribusiness managers (Litzenberg and Schneider 1988) and of Canadian agribusiness managers (Howard 1989) both produced the same ranking of the six categories with Interpersonal Characteristics and Communication Skills ranked first and second and Previous Experience ranked sixth. One difference between the two agribusiness studies and this study was that Business and Economics Skills were rated third in the agribusiness surveys and fifth in the paper industries career survey.

Technical skills

Twenty-nine technical skills were listed in the survey. Table 1 shows each of these skills along with the percentage of responses in the top two categories (i.e., "7" or "6"), the mean response, and the standard deviation. The skill rated most critical was "Papermaking (forming, pressing, drying)." More than 94% of the responses were in the top two boxes. This skill received an average rating of 6.64 on the 7-point scale. "Wet end chemistry" [top-two-box score of 80.2%, average of 6.15], "Process engineering (design, optimization)" [74.6%, 5.98], and "Paper physical properties (analysis, measurement)" [71.5%, 5.98] had the next highest ratings.

To check if skill needs differed by employment area, the sample was split into two groups, those whose company's primary business was either Paper/Paperboard Mill or Pulp Mill

Table 1. *Ranked rating of technical skills (7 is critically important and 1 is not important).*

	% of Responses in Top 2 Boxes	Average Response	Standard Deviation
Papermaking (forming, pressing, drying)	94.2%	6.64	0.62
Wet end chemistry	80.2%	6.15	0.89
Process engineering (design, optimization)	74.6%	5.98	1.06
Paper physical properties (analysis, measurement)	71.5%	5.98	0.94
Coating	66.0%	5.83	1.08
Experimental design and statistical analysis	54.7%	5.57	1.17
Pulping processes	53.7%	5.61	1.07
Chemical engineering (mass and energy balance)	53.6%	5.57	1.20
Bleaching processes	52.1%	5.47	1.19
Systems engineering (control, modeling)	50.5%	5.49	1.19
Recycling and deinking options	48.4%	5.41	1.21
Safety regulations and engineering	44.8%	5.18	1.41
Kraft chemical recovery (process and cycle)	44.4%	5.22	1.30
Fluid flow and heat transfer	34.9%	5.07	1.22
Water quality, regulations and engineering	30.7%	4.81	1.29
Air quality, regulations and engineering	28.6%	4.73	1.31
Solid waste, regulations and engineering	27.6%	4.55	1.37
Printing and inks	25.8%	4.65	1.32
Converting	25.1%	4.75	1.23
Electronic publishing and computer graphics	23.0%	4.33	1.45
Fiber supply	21.6%	4.55	1.23
Offset printing	20.0%	4.34	1.41
Gravure presswork	13.8%	3.97	1.42
Flexographic presswork	13.3%	3.98	1.40
Physicochemical analytical techniques	11.1%	4.13	1.23
Finishing and bindery operations	10.6%	3.80	1.28
Fiber identification	7.9%	3.69	1.33
Raw material (forest genetics and biology)	6.8%	3.41	1.36
Graphic arts and design	5.8%	3.40	1.33
Total	37.9%	4.91	1.50

(N=105) and those whose primary business was something else. The average scores for each technical skill were compared. None of the averages differed by more than 0.4 points. The correlation between the averages in each of the two groups was 0.982. This suggests that the technical skill needs were similar in the major areas where graduates work.

Individuals who were familiar with recent WMU Paper Science or Paper Engineering graduates were asked to rate their skills using a 7-point scale with "7" indicating that graduates are very strong in this area and "1" indicating very weak in this area. The widest gap between skill importance and graduate ratings was for "Safety regulations and engineering." All respondents to this question (N=192) gave this skill a 5.18 average score, generally important but not of critical importance. However, the average rating by people familiar with WMU graduates (N=34) was 3.65, a gap of 1.53 points, suggesting that safety could be stressed more. When these results were shared with WMU faculty, they looked for opportunities to increase their coverage of safety regulations and engineering in their courses.

Computer, information, and data skills

Table 2 shows that respondents rated two of the ten computer skills quite high: "Spreadsheet personal computer software" [top-two-box score of 74.5%, average of 6.05] and "Word processing/presentation software" [70.4%, 5.96]. Individuals who were familiar with recent WMU Paper Science or Paper Engineering graduates gave students ratings of more than 5.5 in these two areas, suggesting that the program is giving students an adequate background in these areas. Written comments by respondents suggested that adding a computer analysis team project might be helpful. Several skill areas received relatively low scores, suggesting that these areas may not need any augmentation in the curriculum.

Previous experience (including co-op and internship)

In Table 3, 84.8% of the respondents gave "Pulp and Paper employment" a rating of "7" or "6." The average was 6.37. The nine other categories had average scores of less than 4.5. The responses suggest that experiences in some areas may be more useful than experiences in other areas. Some respondents also made written comments about the importance of practical, on-the-job experiences while in school.

Communication skills

Four of the twelve communication skills had particularly high scores. Table 4 shows that more than 90% of respondents rated "Give clear and concise instructions" in one of the two top boxes. The average score with this skill was

TABLE 2. *Ranked ratings of computer, information, and data skills.*

	% of Responses in Top 2 Boxes	Average Response	Standard Deviation
Spreadsheet personal computer software	74.5%	6.05	0.98
Word processing/presentation software	70.4%	5.96	1.07
Database personal computer software	52.9%	5.49	1.20
Use of the Internet	52.9%	5.24	1.53
Statistical software	41.5%	5.29	1.11
Use computers in management decision making	38.3%	4.93	1.44
Computer accounting systems	10.2%	3.98	1.30
Design programs/work with programmers	8.0%	3.64	1.38
CAD/CAM software	7.6%	3.83	1.27
Website construction and maintenance	4.3%	2.89	1.38
Total	36.2%	4.73	1.63

TABLE 3. *Ranked ratings of previous experience (including co-op and internship).*

	% of Responses in Top 2 Boxes	Average Response	Standard Deviation
Pulp and Paper employment	84.8%	6.37	0.83
Extracurricular activities	21.6%	4.12	1.64
Chemical industry employment	20.3%	4.43	1.34
Converting industry employment	20.3%	4.25	1.37
Developing business plan	19.6%	3.90	1.64
Engineering employment	17.4%	4.46	1.24
Supply industry employment	16.7%	4.19	1.37
Printing industry employment	15.4%	4.03	1.41
Consultant employment	7.6%	3.18	1.50
Forestry employment	4.9%	2.98	1.33
Total	23.0%	4.20	1.63

6.47. The other key skills were: "Speak clearly/concisely about technical information" [top-two-box score of 85.1%, average of 6.26], and "Listen and carry out instructions" [85.0%, 6.35], and "Write technical reports" [83.5%, 6.31]. "Facility with a foreign language" did not appear to be critically important to most respondents. Many also wrote about the need to help students develop their communication skills.

A variety of methods could be employed to improve student communication skills without adding requirements or making major course changes. Options for enhancing student communication skills include requiring students to write short memos (one to three paragraphs) summarizing recent articles in industry publications and asking them to lead class discussions on the articles, requiring each student in a class to write a short memo describing a different current industry issue and sharing these memos with the class, and encouraging students to participate in an extracurricular speech contest or a case study competition where student teams examine a paper or printing business problem and present their solutions to a panel of judges.

Business and economics skills

In Table 5, only one of the seventeen Business and Economics Skills, "Identification of objec-

TABLE 4. *Ranked ratings of communication skills.*

	% of Responses in Top 2 Boxes	Average Response	Standard Deviation
Give clear and concise instructions	90.2%	6.47	0.70
Speak clearly/concisely about technical information	85.1%	6.26	0.80
Listen and carry out instructions	85.0%	6.35	0.86
Write technical reports	83.5%	6.31	0.88
Listen and summarize oral presentations	68.9%	5.94	1.03
Informal presentation skills	68.0%	5.95	0.97
Formal presentation skills	62.9%	5.78	1.09
Express creative ideas in writing	61.3%	5.73	1.17
Read specific technical information	56.5%	5.68	1.06
Handling customer relations/complaints	56.5%	5.60	1.26
Negotiation skills	46.9%	5.35	1.25
Facility with a foreign language	7.8%	3.52	1.47
Total	64.4%	5.75	1.30

TABLE 5. *Ranked ratings of business and economics skills.*

	% of Responses in Top 2 Boxes	Average Response	Standard Deviation
Identification of objectives and goals	66.7%	5.80	1.01
Identify and manage risk	39.4%	5.06	1.29
Paper economics	37.3%	5.10	1.29
Process and product layout	37.2%	5.01	1.27
Monitor and evaluate performance areas	36.5%	5.04	1.26
Capital budgeting and investment	33.7%	4.82	1.35
Read and use financial statements	30.9%	4.81	1.36
Coordinate human/physical resources	26.6%	4.69	1.34
Budgeting and economic analysis	26.6%	4.57	1.34
Understand accounting concepts	24.2%	4.82	1.16
Inventory management systems	17.7%	4.24	1.25
Corporate finance	14.9%	4.22	1.36
Forecasting and pricing	13.5%	3.98	1.46
Resource and environmental economics	10.5%	3.98	1.32
Human resource planning	9.3%	3.96	1.32
U.S./international forestry/paper products policy	5.7%	3.69	1.34
Tax management	1.6%	2.69	1.21
Total	25.4%	4.50	1.46

tives and goals," had a relatively high rating [top-two-box score of 66.7%, average of 5.80]. "U.S./international forester/paper products policy" and "Tax management" had some of the lower scores in the survey. Increasing the course requirements in these skill area does not appear to be critically important.

Interpersonal characteristics

As one might expect, all fourteen skills in this section were rated as very important (Table 6). More than 92% of the respondents gave "Self-motivation" a top-two-box rating. The average score for this characteristic was 6.58. Other key interpersonal characteristics were "High moral/ethical standards" [top-two-box score of 89.2%, average of 6.53], "Work with others/team player" [89.2%, 6.44], and "Positive work attitude" [88.2%, 6.56]. "Select and supervise employees" [average of 5.48] was the lowest, although a majority of the respondents [52.8%] gave this skill a "7" or a "6." Options to help students grow in these areas include discussing more ethical dilemmas in classes, requiring more team projects, and providing more mentors and role models (e.g., inviting more industry leaders to speak on campus and in classes).

Course topic areas needing more emphasis

Paper Science, Paper Engineering, and Printing alumni were asked to rate thirty-one course topics on a 7-point scale with "7" indicating that much more emphasis is needed, "4" indicating adequate emphasis in the program, and "1" indicating that much less emphasis is needed. Because the program had changed since some of the alumni had graduated, many of the needs that were identified had already been addressed. One lesson for future surveys is to include a question about when alumni graduated to learn if some perceived needs may have been ameliorated with recent curricula changes.

More than 150 responses were received for each course topic. None of the areas had an average score above six (Table 7). The five areas with the highest scores were: "Management" [top-two-box score of 45.7%, average of 5.38], "Computer analysis" [44.9%, 5.35], "Business writing" [38.0, 5.20], "Ethics" [37.5%, 5.13], and "Speaking to business audiences" [36.6%, 5.22]. Faculty examined the current curriculum to see if there were

TABLE 6. *Ranked ratings of interpersonal characteristics.*

	% of Responses in Top 2 Boxes	Average Response	Standard Deviation
Self-motivation	92.8%	6.58	0.66
High moral/ethical standards	89.2%	6.53	0.73
Work with others/team player	89.2%	6.44	0.83
Positive work attitude	88.2%	6.56	0.71
Self-confidence	85.6%	6.31	0.78
Work without supervision	82.6%	6.34	0.88
Apply technical skills	82.1%	6.21	0.84
Fulfill promises	82.0%	6.32	0.97
Provide leadership	74.9%	6.11	0.91
Personal time management	74.9%	6.09	1.08
Work under varied conditions	69.2%	6.01	1.01
Delegate responsibility and authority	66.0%	5.84	1.07
Motivating and managing others	64.6%	5.86	1.17
Select and supervise employees	52.8%	5.48	1.27
Total	78.2%	6.19	0.99

opportunities for increasing the coverage of these topics in the program. The four areas with the lowest averages were: "Biology" [3.1%, 3.65], "Forestry" [3.2%, 3.87], "Physics" [6.2%, 4.07], and "Humanities" [8.2%, 3.94]. These scores were close to the "adequate emphasis" level, suggesting that alumni do not believe major shifts in course requirements are needed to address key student and employer needs.

SUMMARY

Stakeholder surveys can be very useful for identifying the skills students need for different career paths. This survey highlighted many skills that are very useful for paper science, printing science, and paper engineering graduates. It also identified some skill areas that are not critically important. WMU's faculty used this information to identify areas of strength and opportunities for improvement. Although the survey did not discover any major curriculum issues for the program, some minor changes in course content and in extracurricular activities were identified that may help students who are interested in careers in the paper industries. Other schools could use similar surveys of their stakeholders to learn how needs for their graduates may differ and to identify areas where they could improve to provide students a stronger foundation for their careers. Periodic use of the survey instrument could discover emerging skill needs and identify other skills that may be less important in the future.

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TABLE 7. *Ranked ratings of course topics (7 is much more emphasis and 1 is much less emphasis).*

	% of Responses in Top 2 Boxes	Average Response	Standard Deviation
Management	45.7%	5.38	1.08
Computer analysis	44.9%	5.35	0.88
Business writing	38.0%	5.20	1.02
Ethics	37.5%	5.13	1.14
Speaking to business audiences	36.6%	5.22	1.10
Internet applications	31.1%	4.95	1.12
Papermaking processes	30.1%	4.98	1.06
Coating materials and processes	28.2%	4.83	1.06
Labor relations	28.1%	4.76	1.19
Accounting/Finance	27.6%	4.91	1.07
Chemical engineering	25.6%	4.78	1.10
Professional selling	24.2%	4.52	1.30
Environmental health and safety	22.2%	4.65	1.15
Paper properties	22.1%	4.69	1.03
Business logistics	21.9%	4.58	1.16
Printing and imaging	19.6%	4.60	1.10
Mathematics/Calculus/Statistics	18.5%	4.43	1.07
Micro (firm) economics	14.8%	4.51	0.93
Marketing/Advertising/Promotion	13.8%	4.24	1.17
Macro (U.S. and international) economics	13.7%	4.39	0.96
Recycling processes	13.6%	4.51	0.85
General chemistry	12.9%	4.40	0.85
Organic chemistry	12.4%	4.18	1.07
Mechanical engineering	11.9%	4.43	1.08
Pulping processes	11.1%	4.43	0.79
Electrical engineering	9.4%	4.23	1.07
International trade	9.4%	4.16	1.07
Humanities	8.2%	3.94	1.06
Physics	6.2%	4.07	0.98
Forestry	3.2%	3.87	0.95
Biology	3.1%	3.65	0.97

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