

# Wood science education in a changing world: A case study of the UMASS-Amherst building materials & wood technology program, 1965-2005

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## Abstract

This paper discusses the historical and current day need for education in the area of building materials and wood technology as it relates to the economy of Massachusetts. A case study of the Building Materials and Wood Technology (BMATWT) Program at the University of Massachusetts, Amherst is provided. The history of the program and economic and other forces affecting curriculum change are presented. Readers interested in expanding the educational and training offerings for forest products and related industries should benefit from the material presented. A customer-focused approach to curriculum development focusing on students as customers and members of the business community as clients is described. The development of an industry advisory board, student recruitment initiatives, industry relations and interdisciplinary teaching and research are outlined. A core understanding of wood science, building technology, business, and emerging technologies such as engineered wood products contribute to graduate success in the BMATWT and other programs. Historic challenges of student recruitment and revenue generation will continue to be issues of importance in the future, but the fundamental strength of the housing market provides reason for optimism.

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Educational programs offered at the University of Massachusetts, Amherst (UMASS) have often been closely tied with the economy of the Commonwealth of Massachusetts and surrounding regions. Regional uses of wood have been predominantly in the manufacture of ships, pulp and paper, furniture, boxes, and housing. Production and consumption patterns of wood products have been in constant flux throughout Massachusetts' history, resulting in changing educational needs of employees in wood-related industries. This work illustrates the history of the UMASS Building Materials and Wood Technology (BMATWT) degree program and the forces that have shaped its curriculum. The importance of understanding the needs of industry and the potential of collaborative efforts with related disciplines are discussed.

UMASS is a land-grant university with an enrollment of more than 24,000 students and is located in the rural western part of Massachusetts. It began as an agricultural college in 1867; since then, the mission of the university has broadened and expanded to reflect our increasingly diverse culture. Currently, UMASS serves more than 18,000 undergraduate stu-

dents pursuing one or more of 88 degree programs. Another 5,600 graduate students are working toward one of 68 master's or 50 doctoral degree programs.

The Wood Technology program at UMASS began around 1960. A traditional wood, science, and technology program was developed similar to that found in some 20 other university and college degree programs across the United States at the time. One key element of the original curriculum design was consideration of the educational needs for employment

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upon graduation. For example, courses offered in the early years of the program catered to the furniture industry. At that time, the city of Gardner in central Massachusetts was the heart of the furniture industry in New England and one of the centers for the entire United States.

One component of the need for education is the combination of skills and abilities that is currently being demanded by the industries in which students are likely to be employed. A number of researchers throughout the United States have examined the educational needs for various parts of the wood products industry. Hansen and Smith (1997) surveyed wood products manufacturers in Oregon and Virginia to assess a wide variety of educational needs for those employers. Smith et al. (1998) surveyed both employers and alumni of wood science programs and also found a diverse set of needs. And, Testa and Gupta (2004) indicated a need for increased teaching and research in the area of wood based design. Most recently, Bowyer and Ramaswamy (2005) document the curriculum shift at the University of Minnesota to better serve an emerging bio-based products industry.

Today's industries are utilizing materials and systems that are ever more technologically advanced. Technology is advancing at an accelerating rate in computing, telecommunications, and in information-processing systems. This case study looks at the demand for wood science education in Massachusetts, where employers are more likely to be building materials distributors, users, and consumers as opposed to producers. Career paths are varied and include product design and engineering, manufacturing, product distribution, building construction, and product performance.

### Forest products and building materials consumption in Massachusetts

Prior to the arrival of Europeans, the state was completely covered in forest, which was largely removed with the expansion of agriculture during the 19th century (Barten et al. 2001). With the movement of agriculture westward in the United States, the forest returned to Massachusetts; the state is currently about 63 percent forested (USDA 2006). At the same time, the population greatly increased, rising to its present level of 6.4 million (U.S. Census Bureau 2006a). The state ranks 13th in population and 45th in land area among the 50 United States. This makes Massachusetts the third most densely populated of the United States.

As the population has become increasingly urbanized, the import of wood and wood products from other regions of the United States and from Canada has grown. The ability of Massachusetts to supply wood fiber to meet its consumption needs has long been surpassed, and the state is currently a significant net importer of forest products. Berlik et al. (2002) estimates that Massachusetts' wood production accounts for just 2 percent of estimated wood fiber consumption. Using national averages they estimate that per capita consumption of wood products is approximately 1.7 m<sup>3</sup> annually. By comparison, Massachusetts' per capita harvest from sustainable forest removals is only 0.05 m<sup>3</sup>. Berlik et al. (2002) also point out that Massachusetts' per hectare wood harvest rate is low when compared with other nations.

The Forest Products industry in the United States is often divided into three primary segments: building materials, pulp and paper, and hardwood lumber and secondary products (Sinclair 1992). Focusing on the wood products, lumber and

Table 1. — Massachusetts sales values and employment by industry segment, 2002 (U.S. Census Bureau 2002).

NAICS	Description	Value of business (US\$ billions)	No. of employees
321	Wood product manufacturing	0.504	3,588
4233	Lumber & construction material wholesaler	2.546	4,753
4441	Building material & supply dealers	5.734	23,261
2361	Residential building construction	4.360	15,893

building industry segments we can see that, in Massachusetts, manufacturing makes up a small portion of the overall economic activity in the forest products sector. **Table 1** (U.S. Census Bureau 2002a) shows that the wholesale, retail, and building sectors provide 12× the employment as is provided in the manufacturing sector. The economic value of the downstream distribution and construction sectors show an even greater contrast compared to the level of manufacturing activity. State total sales revenue for wholesale, retail, and residential construction total \$12.6 billion annually compared to just \$504 million for wood product manufacturing. **Figure 1** shows the relative sizes, by sales value, for the same business sectors for the entire United States in 2002 (U.S. Census Bureau 2002b).

The residential construction sector is clearly the largest economic sector for wood in the country. The U.S. Census Bureau (2006b) estimates the value of all construction spending in the United States at \$1.2 trillion, with residential construction accounting for 51 percent of the total. It is clear that housing generates a significant portion of overall economic activity. The National Association of Home Builders, (NAHB 2006) reports housing starts reached a peak of 2.0 million in 2005. **Figure 2** shows new home sales rising to 1.2 million in 2005. The UMASS Building Materials and Wood Technology program has adapted over time to meet the educational needs of graduates entering the ever-changing workplace.

### UMASS response to educational needs

The Wood Technology curriculum at UMASS evolved from a long-established Forestry degree program. Courses titled Wood Anatomy and Identification, Properties of Wood, Lumber Manufacturing and Distribution, and Wood Seasoning and Preservation were offered in the early 1960s.

The first mention of a track in Wood Technology, within the Forestry degree program, appeared in the undergraduate catalog for the 1965-66 academic year (UMASS 1965). The following year, the program was renamed Forestry and Wood Technology to reflect the growing importance of the wood technology component (UMASS 1966). Early employers for graduates were from the primary and secondary processing industries. The 1966-67 catalog states "Wood Technologists are employed by wood-processing industries and service-related enterprises such as chemical firms and equipment manufacturers, by research laboratories, merchandizing organizations, and to a lesser degree by public agencies." As noted earlier, furniture manufacturers in and around Gardner, Massachusetts, were significant players in the overall industry. The need for technical understanding of wood manufacture and machining in these industries helped shape the expanding curriculum. The 1966-67 catalog listing of courses under the

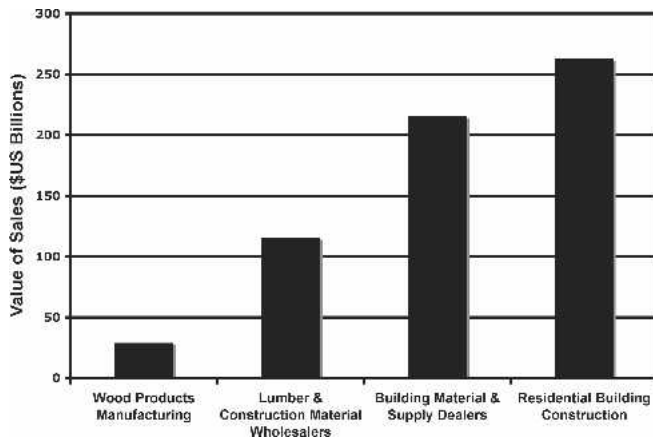


Figure 1. — Value of sales for wood products and residential construction, 2002. (Source: U.S. Census Bureau 2002)

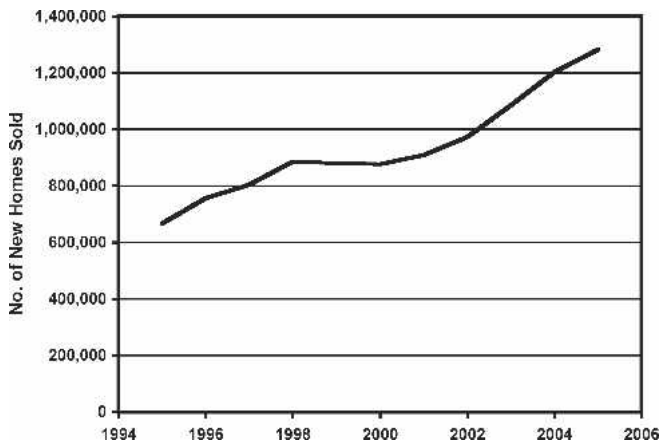


Figure 2. — U.S. sales of new homes. (Source: NAHB 2006)

Wood Technology track included: wood anatomy, timber conversion, forest products, wood properties, machining, seasoning, and adhesives.

Wood Technology became a separate degree program later in the 1970s. By 1984, the curriculum had been expanded slightly, covering Wood Adhesives Technology and Wood Coating Technology separately, and a course in Chemical Processing of Wood was added (UMASS 1984). This curriculum still largely reflected a general Wood Science curriculum with a focus on primary and secondary processing of wood for lumber and furniture manufacture.

By the early 1980s, the wood products industry sector in Massachusetts was changing significantly. The manufacturing sector was beginning to decline. The furniture-manufacturing industry was beginning to move to southern states and overseas. Manufacturers in states such as North Carolina were growing at the expense of traditional centers including Gardner. In Massachusetts, in particular, the information economy began to develop, fueling a general shift in employment from manufacturing to services.

Career opportunities began to shift from production to consumption of wood based products as Massachusetts residents continued to increase their demand for wood products. Population growth and the desire for new and increasingly larger homes drove forest products sales higher at both the whole-

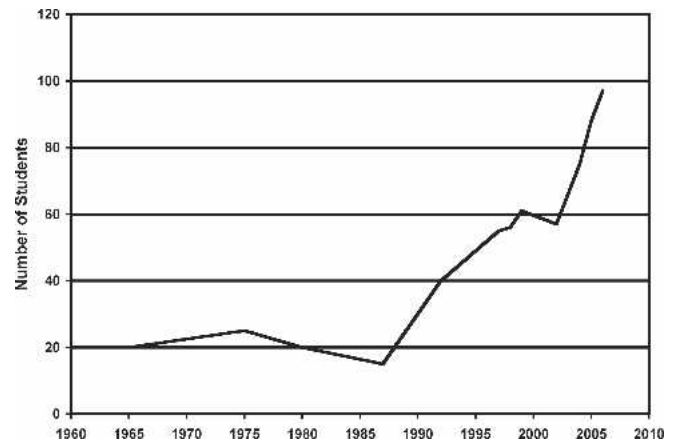


Figure 3. — UMASS BMATWT undergraduate program enrollment.

sale and retail levels. By the mid-1980s, the faculty realized that the program was no longer providing graduates bound for employment in primary and secondary manufacturing. More graduates were finding careers in the sales and distribution of building and other construction-related materials and services. By 1987, undergraduate enrollment had fallen to a level of 15 students, and the program was in danger of elimination. Rebuilding the program was essential.

In response, a revised mission was officially established; building materials technology and management became the new academic theme designed around the traditional wood science and technology core. The plan was to provide new educational offerings, developed in partnership with industry, to better prepare students for the employment opportunities they were actually getting. The industry sectors involved included the distribution and residential construction sectors of the building materials industry.

An industry advisory board was created to provide input to help shape the UMASS program. Advisory board members included representatives from academia, lumber and mill-work manufacturers and wholesalers, and retailers of lumber and building materials. There was high demand by industry for graduates with appropriate educational preparation for careers in these fields. The program's industry clients wanted professionally trained graduates, and everyone involved wanted to increase enrollment to satisfy that demand.

In 1987, the name of the program was officially changed to Building Materials and Wood Technology to reflect the shift in program focus. New faculty with expertise in residential building construction were hired. Repositioning to increase enrollment appears to have worked; **Figure 3** shows a timeline of undergraduate enrollment since the program's inception. Within 5 years (by 1992) enrollment grew to 40 students. Within 10 years (by 1997) it grew to 55 students. The 1997-98 Undergraduate Catalog lists the number of offerings within the major expanded to 13 undergraduate courses (UMASS 1997). The course offerings reflected an added emphasis on management, distribution and marketing, and the technology of residential construction.

**Table 2** depicts the overall shift in focus as shown by the courses offered in 1984-85 and in 2004-05 (UMASS 1984; UMASS 2004). The focus of the program was purposefully and successfully broadened. Having a basic understanding of

Table 2. — Shift in course curriculum from 1985 to 2005.

1984 to 85	2004 to 05
Wood technology program	Building materials and wood technology program
Wood anatomy and identification	Introduction to wood science
Properties of wood	Properties of wood
Primary timber conversion	Energy efficient housing
Forest products	Light-frame structures technology
Wood machining technology	Architectural blueprint reading and estimating
Wood seasoning and preservation	Building materials and forest products marketing
Wood adhesives technology	Business of building
Wood coating technology	Seminar in kiln-drying
Chemical processing of wood	Design and construction of a timber bridge
	CAD in construction and architecture
	Construction materials and methods
	Building materials computing
	Career Development in Building Materials
	Mechanics of building materials
	Design of wood structures

wood properties is a tremendous asset for employment in industry segments related to residential construction. By expanding the curriculum offerings to develop skills in design, management, marketing, and building technology, students are positioned for a variety of career paths. Enrollment has continued to grow, reaching an all-time high of 97 students in 2006.

In addition to faculty review and industry input, graduates of the program also provide feedback that is used in helping to shape the curriculum. Annually the College of Natural Resources and the Environment, where the BMATWT program resides, conducts a survey of alumni. They survey a sample of recent graduates, and a second sample of graduates from the class that graduated 5 years earlier. Alumni are asked both what knowledge and skills they learned were most useful but also what knowledge they have found to be important that was not part of the program. Survey responses are reviewed annually and taken into account when curriculum changes are being considered.

### The UMASS program today: Challenges and the future

The recent growth of engineered wood products (EWP), used in residential and commercial construction, has further shaped the UMASS Building Materials and Wood Technology curriculum. Current course offerings include a two-course sequence concentrating on this area. “Mechanics of Building Materials for Construction” introduces students to the mechanical properties of building materials including EWP. The fundamentals learned in this first course are then applied in a second course titled “Design of Wood Structures.” The engineering services for building with EWP have migrated from the manufacturer to the wholesaler and even retailer level in the building materials distribution chain. Graduates with knowledge in this area are highly sought after in today’s job market. Most recently, a course in computer-aided-design (CAD) and another course focusing on the

physical properties of a range of building materials, titled “Building Materials and Methods,” have been introduced. These new courses expand the curriculum in response to on-going changes in building materials usage and methods.

In addition to the core curriculum of BMATWT courses described above, all UMASS undergraduates are required to fulfill a broad set of general education courses. The BMATWT bachelor of science degree also requires courses in basic sciences, economics, and elective courses in a professional area.

Three full-time and two part-time faculty members made up the BMATWT faculty in 2006. With enrollment nearing 100 students the UMASS–Amherst program represents roughly 20 percent of the estimated 500 students enrolled nationwide in wood science programs (Testa and Gupta 2004). However, student recruitment into the degree program remains a serious challenge. Demand for graduates still out-paces supply by a wide margin. Graduating students are often presented with a choice among multiple job offers that include titles such as; construction manager, retail manager, wholesale manager, sales associate, marketing professional, researcher, technical representative, purchasing/inventory manager, architectural liaison, quality control engineer, and estimator.

Recruiting is undertaken in three primary areas:

- 1) A limited amount of faculty outreach and marketing is done at the high school level to recruit incoming freshmen.
- 2) The greatest number of students are recruited on-campus from the current population of freshmen and sophomore students, many of whom are “undeclared.” Twice each year a student-led effort is undertaken to mail a recruiting flyer to all 8,000 underclassmen on campus.
- 3) The third area of recruiting stems from partnerships with community colleges in Massachusetts and New England. During the 1990s, articulation agreements have been developed with a number of these 2-year degree programs that provide interested graduates with a seamless transition to the 4-year bachelor of science program in BMATWT.

UMASS–Amherst is a state-supported university and significant outside funds must be brought in to fund the educational, research and service activities of the program. Relationships with industry continue to be built, and industry financial support is essential to continuing operations. Funding challenges impact the projects that the BMATWT program undertakes today. Direct State aid for the Amherst campus accounted for only 28 percent of total university revenues in 2005 (UMASS 2005). The remaining 72 percent of revenues, required for the operating budget, were generated from student tuition and fees, sales and services, research grant and contract income, endowment and investment income and federal funds allocations. **Figure 4** shows the relative weight of each of these sources of revenue. The campus administration currently encourages less reliance on state funding sources and our program has responded with two initiatives.

In 1998, an endowment campaign was initiated to raise \$500,000. Endowments historically have generated a sustainable income stream of approximately 5 percent of the total raised. Thus, this campaign was designed to provide a steady flow of approximately \$25,000 to cover annual operating ex-

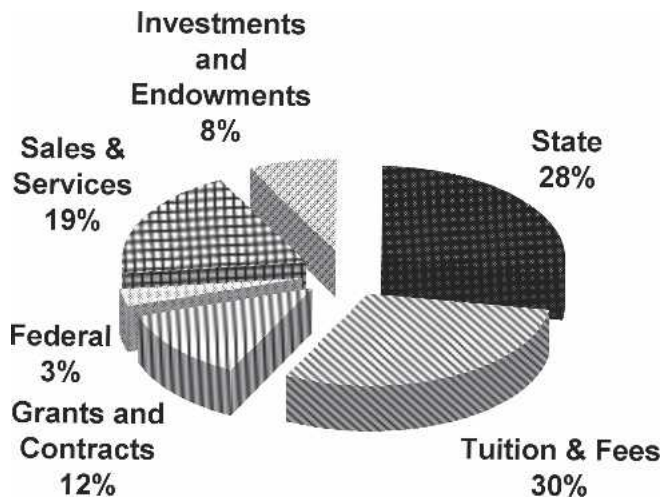


Figure 4. — UMass, Amherst—Source of Funds, FY 2005.

penses and projects for the BMATWT program. Today, fund raising continues as we near the campaign goal.

Secondly, the UMass–Amherst program has historically been heavily weighted toward undergraduate education. We have never successfully graduated a Ph.D. student, and only a handful of master’s candidates have graduated in the past decade. New faculty hires and shifting faculty responsibilities are placing increasing emphasis on graduate level education and outside research funding to support this work.

An interesting development has occurred since the program repositioned its focus toward construction technology: New course offerings have attracted students from many disciplines across the UMass campus. All BMATWT class sizes have grown significantly. Our classes have become valuable “service” courses to the university community. Many courses are listed as “professional electives” that serve a variety of degree programs. The growth in course size also functions as an important recruitment tool. For example: 85 students from 15 different majors enrolled in the fall 2005 Light Frame Structures course. Within the first 3 weeks, 5 students who enrolled in this course were recruited into the BMATWT major.

Since more than 90 percent of the homes built in the United States are wood-based, this provides us with an opportunity to package instruction about the performance of wood-based materials to a broad audience. Enrollment in these courses includes not only building materials students, but engineers, architects, designers, and management students as well. Other undergraduate courses like the Business of Building and Construction Methods and Materials have a similar wide appeal.

Our classes have become interdisciplinary by working in partnership with faculty from Engineering, Environmental Design, Regional Planning, Landscape Architecture, Interior Design, and Art History. The obvious benefit to this approach is that it provides faculty and students from different “building” disciplines with the opportunity to work together—as they do in real-life building projects. Most recently, the BMATWT program has worked with an interdisciplinary team (lead by the Department of Art/Art History) to create the first and only Masters of Architecture program at a state university in the New England states. BMATWT faculty mem-

bers are listed as members of the Architecture faculty and 4 BMATWT courses are required to earn a degree in architecture. Our first “Architecture” class was admitted to the university in fall 2005 semester.

The Masters of Architecture program is unique. The curriculum is composed of courses and advising provided by faculty from several colleges at UMass as well as several affiliated private colleges in the region. As a result of the interdisciplinary structure, the masters program has been cited by the National Architecture Accreditation Board as having the potential to create a “new model for architectural education.” The interdisciplinary culture encourages joint research as well as instruction. Wood scientists, planners, designers, and engineers maintain their own research labs, yet are able to combine valuable expertise whenever the opportunity arises. The development of the architecture program has raised the level of awareness about BMATWT enormously on- and off-campus.

The BMATWT program has grown and prospered. The repositioning of the program to focus on building construction was born from an ongoing assessment of the needs of our regional market and ability to work with an important industry client base. We consider students to be our customers and members of the business community—our clients. Through our continued effort to shape the curriculum to be consistent with changing industry needs, graduates of the program continue to be in high demand. A core understanding of wood science, building technology, business, and emerging technologies such as engineered wood products contribute to their career success. Historic challenges of student recruitment and revenue generation will continue to be issues of importance in the future, but we are very optimistic about our direction.

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