Learning through Service: Wood in Design and Engineering

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Abstract

''Wood in Design and Engineering'' is a new course at Mississippi State University that is specifically designed to demonstrate how the philosophies and functions of all three departments in the College of Forest Resources interact with regard to the resource, material, and utilization of wood and forest products, while making a tangible contribution to both the university and the community. The course brings together undergraduate and graduate students from all three departments and uses hands-on methods of teaching concepts and interrelationships, ideas often discussed but rarely encountered in the overall context of forestry, wood science, and wildlife biology. A recent group project was to design and construct a cutaway of a 19th century joiner shop and two display cases based upon variations of the trestle table to showcase antique woodworking tools for the ''Treasures from the Vault'' exhibition at Mississippi State. Personal projects included tables, bows, settles, desks, memorial crosses, and turkey calls, among others. The students gained a greater appreciation about forestry, forest products, markets, wood, woodworking, teamwork, safety, and themselves.

The woodworker can fix anything but the crack of dawn and the broken heart, and make everything but a living.

—Anonymous

Natural resources students are offered ''bricks'' of knowledge throughout their higher education but are rarely given instruction on how to ''build a house.'' They become well versed in the biological and social constructs of the forest by learning to consider it as either a sustainable investment for the greater economic good, a source of materials for further production, or habitat for creatures. However, the divergence of disciplines can result in students being unable to ''see the forest for the trees.'' The interactions among constructs are complex and therefore are often bypassed in lecture and discussion. Curricula often rely upon internships and cooperative educational programs with businesses or agencies to provide students with the real-world experience of how the fields interact—managing trees to efficiently produce wood while preserving the capability of the site to sustain the flora and fauna of the ecosystem. The treatment of the key words in the previous sentence—managing, efficiently, producing, preserving, and sustain—are often handled in a one-dimensional manner depending on the course or the curriculum. Educational internships and independent studies usually are designed around an individual student's personal grasp of the topic as opposed to learning to work safely as part of a team. However, the world is multidimensional, and working with the material of a resource that is far from uniform requires the practitioner to be able to think in multiple dimensions as well. Internships and cooperative education alone cannot fill the void.

Degrees have been granted to students in wood science (wood science and technology, forest products, or some form thereof) for more than 80 years, with additional smaller programs contained within forest science departments (Ellis 1964). Programs have had to be fluid throughout that time to keep up with the changing needs in the field. For instance, programs were originally grounded in the fundamentals of anatomy, mechanics, physics, and chemistry, and were then expanded into industrial processing and business management beginning as early as the 1950s to keep up with emerging needs (Kynoch 1953). Student numbers grew with the recognition of wood science's role in forest management and industrial utiliza-

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tion, leading to the increased hiring of laboratory and manufacturing specialists (Jorgensen and Lew 1969). Barnes (1979) wrote of a high-water mark in the field in his first status report, when enrollment, number of faculty, and degree-granting programs were at all-time highs. Thoughts of new university programs as well as expansion into additional concentrations and interdisciplinary approaches were even in the works (Barnes 1980).

Shortly thereafter, these numbers began to fall, and we have been fighting a steady decline for 30-plus years (Lyon et al. 1995). Programs have continued to evolve to meet the changing needs, but the exodus of students has regrettably continued (Bowyer 1991, Smith et al. 1998). Recent departmental mergers and even program elimination have occurred due to budgetary constraints and the low number of students, faculty, and staff in forest products (Shupe 2009). The evolution of wood science is now to that of a multidisciplinary approach of training young professionals with strong and wide-ranging general skills, core technical knowledge, and a dedicated interest in natural resources (Kitchens et al. 2011).

"Wood in Design and Engineering": Course Description

Classes often become stratified and sometime stultified, while tests for the most part focus on the individual's recollection of factual knowledge. The special topics course ''Wood in Design and Engineering'' (WDE) was developed and first offered in Spring 2008 at Mississippi State University's (MSU) College of Forest Resources (CFR) with the intent of reaching across departmental lines to interest students in learning more about the resource, the material and its uses, and how their specialization interacts with and affects the other disciplines (Youngs 2003). This course sought to address many weaknesses associated with traditional natural resources instruction through encouraging the students to ask questions, consider more than their own academic specialty, seek their own answers, take an active role in applying their knowledge to design and construction, and explore topics and concepts further with guidance, coaching, and discussion provided by the instructors. Breaking away from the traditional test, paper, and presentation approach to grading meant that the C student would be put on a level playing field with the A student. Both were brought together, away from their comfort zones, at an off-campus woodshop by using a hands-on team approach to teaching concepts that are often discussed but rarely encountered.

The practical use of fundamental principles was the central theme to the three overall objectives of the course. The first was for students to be able to relate natural resources management to wood science by applying designing principles to the construction of wood-based structures. The second was the proper selection of tools for woodworking based on species, wood anatomy, and properties. The third was professional development by advancing one's scientific knowledge, personal growth, and appreciation for students in other programs in the college. These objectives were achieved by promoting both social and leadership skills through active participation, teamwork, artistic communication, and brainstorming (Thompson 1997, Barnes 2003). Alter egos would be allowed to live, and even thrive. Life skills would be learned through the four stages of a group project as each student brought different talents and experience to the course:

- Forming: This is the initial feeling-out period. Individuals get to know one another and ideas are introduced. The meek and the bold become distinguishable.
- Storming: Each person begins to recognize the others' personalities and tendencies. Strengths and weaknesses become apparent. Professional discussions arise over the optimal outcome and the path for goal achievement.
- Norming: The coming-together period. Each member realizes that others bring unique aspects and skills to the project. Different perspectives are recognized and accommodated. Plans are agreed to and implementation gains momentum.
- Performing: Teams emerge from the cluster of individuals. Attitudes shift from doubtful and independent to confident and cooperative. Goals come within reach and are met or surpassed.

Teams were task oriented and transitory. Groups were encouraged to change members as desired during the entire process to bring in a different skill set or to simply get an understanding of what another group was working on—to learn. Sharing visions and ideas to maximize each person's unique skills was encouraged.

A holistic view of wood as both a natural and manufactured product, following Bloom's taxonomical breakdown of learning objectives into cognitive, affective, and psychomotor domains (Ferris and Aziz 2005), was adopted to integrate knowledge from the three departments of the college, Forestry, Forest Products, and Wildlife, Fisheries, and Aquaculture. The intent was to give students access to a broad range of understanding across disciplines. Critical thinking was promoted in order for the students to effectively (1) define the purpose of their project, (2) select the proper material (species, grade, size, etc.) to meet that purpose, (3) choose the proper tools for working the material to fit the purpose, and (4) evaluate how effectively the end use conforms to the original intent. The markets and value of the native species, the factors that determine wood quality and use, the result of different management regimens on wood quality, and the resulting effects on other land uses were all discussed. Factoids—those statements often accepted as fact that are not necessarily true—were pointed out, debated, and experienced through the actual construction of wooden members, structures, and products. The anticipated outcomes from their research, learning, and service were the knowledge, skills, and abilities to produce a tangible contribution to both the university and the community.

Professional development involves advancing one's scientific knowledge, learning the importance of that knowledge within and beyond one's field, and enhancing personal growth. Students learned that forestry, forest products, and wildlife biology are unique and diversified fields that interact in ways they had not known until gaining a greater appreciation of the following.

- Forestry: Different end uses require different management techniques; the difference between volume and value.
- Forest Products: There are productive and marketable uses for species that are considered to have little value; a market can be created for unique products.

- Wood: The various grains, colors, weights, and characteristics of many southern species and some exotics.
- Woodworking: Using the grain to one's advantage; species, joint, and tool selection.
- Teamwork: Verbal and physical cooperation among the groups.
- Themselves: New or possibly unknown skills. Learning how to recover from mistakes and what is taken from that experience.

Class Arrangement

Both college and university administrations recognized that the course fell within the mission of MSU and pledged their support. The first WDE course was taught in the spring semester of 2008 utilizing sweetgum, *Liquidambar styraciflua*, in timber frame construction with the end result being a 16 by 48-foot building put on exhibit and used as a classroom for the Mid-South Forestry and Equipment Show that summer. The building, shown in Figure 1, now resides at the CFR's Dorman Lake near campus and is a case study in durability employing this technique. A presentation on the course and building to the college's advisory committee in autumn led to several companies promising their support for the follow-up class.

The success of the first offering led to a doubling of enrollment for the sequel in the spring semester of 2009. The project for this class involved constructing displays for the Cully A. Cobb and Virgil Priester antique tool collections donated to the Forest Products Department. A portion of the collections would be presented as part of MSU's ''Treasures from the Vault'' exhibition showcasing collections and works from departments across campus. Materials for the project were donated by Barge Forest Products Company and Anderson-Tully Company. An eclectic group of students—immigrant, veteran, logger, firefighter, entrepreneur, and aspiring pastor, to name a few—signed on. All three departments were represented for the first time by undergraduate and/or graduate students. Students were challenged with not only producing designs for the displays, but also designing at least one individual project to further enrich their knowledge, creativity, and woodworking ability. Classes were scheduled from 1:00 to 5:00 p.m. on Friday afternoons, but students stayed later and often enjoyed a dinner.

Figure 1.—The post-and-beam building constructed in 2008 for the Mid-South Forestry and Equipment Show.

Grading for the course was based upon both group and individual achievements. Three criteria, creativity, contribution, and teamwork, were graded on a scale of 1 to 10 and added together to give a possible score of 30 for the design of the group project(s). The construction process was graded likewise, giving a total group score of 60 points.

Individual projects were assessed by a student's willingness to independently search for knowledge, the quality of each project as a demonstration of one's acquired skills, and the presentation of the finished product. The student's willingness to learn was based upon class attendance and participation. Quality was judged by how the finished project met the original purpose and the end use. The final presentation was rated on conciseness, clarity, and professional appearance. Each criterion was graded on a scale of 1 to 10 and added together to give a possible score of 30.

An additional requirement was a written, single-spaced, two-page course evaluation worth 10 points. This review was required to include, but not be limited to, each student's expectations of the course, how the course did (or did not) meet or exceed those expectations, skills developed via this course (technical, life, etc.), as well as how those skills were applied throughout the semester and will benefit the student's future work and/or research. The total score was out of a possible 100 points and grades were awarded on a 10-point scale.

Course Timeline

After introductions, students were told of the course's requirements and objectives. Safety and respect for tools were stressed (and continually emphasized). A ''6-foot shelf'' of reference books and magazines was made available for the students to ''go look it up'' and not simply take the word of the instructors. Little time was allowed for doubt to creep in. Questions of uncertainty were quickly replaced by ''Do you have an idea?'', ''Can you draw?'', ''What do you know about joints?'', and ''Who knows how to run the lathe?''

Early discussions focused on three main topics: forestry and wood utilization, wood structure and properties, and structural design. Forestry and wood utilization focused on forest management, economics, the wood supply system, and forest products manufacturing and marketing. Wood structure and properties concentrated on the anatomy, physics, and mechanics of species as well as the variation both between and within species. Structural design centered on the purpose of the structures and their end use, appearance, aesthetics, and appeal, in addition to diagramming the distribution of forces and stresses, along with design values and stress grades of the timbers and lumber. A hardwood lumber grading short course was also included.

A consensus was reached early in the design process. The display would be a cutaway of a vintage joiner's shop using post and beam construction with sweetgum timbers. The sheathing would be rough cypress boards while flooring would be tongue-and-groove, vertical-grained southern yellow pine. A second challenge was for the students to plan and build 3 by 6-foot covered display cases using southern pine 1 by 4s and 2 by 12s based on variations of the basic trestle table design.

Subsequent lectures focused on machining and machineability, joints, adhesion, and finishing as the projects

evolved. Machineability emphasized workpiece size and material, tool selection, cutting conditions, and the various processes, both traditional and current, by which wood can be worked. Many joints were discussed, particularly the mortise and tenon, dovetail, biscuit, butt, dowel, tongue-and-groove, and miter. Adhesion focused on adhesive types, surfacing, bonding, and pressing. Finishing topics included purpose, types, and application.

The topic of power and hand tools was particularly highlighted. Students were introduced to equipment, such as the jointer, lathe, chain mortiser, table and radial arm saws, and the benefits of a dust collector system. The use of hand tools was covered as well, given the purpose of the display. For many of the students, it was their first exposure to ''the way things used to be done'' with hand planes (both metal and wooden), handsaws, chisels, as well as tools they had never heard of (spoke shave, old wives tooth, spoon gouge, slicks, etc.). Some tools even developed an identity, particularly the mallets ''Blackie'' (a more than 100-year-old square mallet from a hard maple burl) and ''The Judge'' (a new gavel-style mallet hand-turned of hickory). Everyone learned that these older tools had stories to tell, and working with those tools led to new stories as well as skills. Tutorials on tool sharpening were offered to those interested.

As work progressed on the displays, word spread throughout the college. The museum exhibit opened in early April, and the displays received much airtime and coverage as ''Treasures from the Vault'' was being promoted in preparation for the spring alumni weekend. Figure 2 illustrates the final constructions, Figure 2A shows the joiner's shop cutaway, and Figures 2B and 2C illustrate the ''round'' and ''butterfly'' tables. All who have seen them have stated that they exceeded any expectations they may have had. In fact, the WDE presentation spurred other exhibitors to expand upon their presentations. The displays have been a public relations success for the college and are now on permanent display in the CFR.

Personal growth among the students was noticed during the group and individual projects. Wallflowers began to blossom. Those who started with indecision and conformity began to contribute and question. Reticence was replaced with verbal and physical cooperation among the groups. The students gained an appreciation for design and artistic expression on a range of personal works, such as tables, picture frames donated to the Center for America's Veterans, duck calls, turkey calls, two English longbows, a compound bow, two memorial crosses for deceased siblings (one shown in Fig. 3), a desk, a cedar chest, an entertainment center, and even a swatter to combat bumblebees as spring arrived. An antique rifle and shotgun were refinished and brought back to life. A third display table, the ''Logo'' table shown in Figure 4, was built to support a children's summer camp; it is now housed in the foyer of the Forest Resources building as a symbol of the students' achievements.

Students discovered how to differentiate between efficiency and effectiveness. Early on students were reaching for the power tools to achieve quick results. This was to be expected given the high-tech, instant-access society in which they were raised. Power tools were definitely more efficient because they could produce more per unit time. But it also allowed for making a bigger mistake quicker as well. One stroke of a hand plane was not nearly as efficient as running a board through a planer or jointer. However, the slower removal made the ability to recover from a mistake considerably better, which increased the students' confidence and comfort during construction. They realized effectiveness measured not only efficiency but also satisfaction. More importantly, they found an escape from exams, term papers, and student loans while in the rhythm of a hand plane or turning on the lathe.

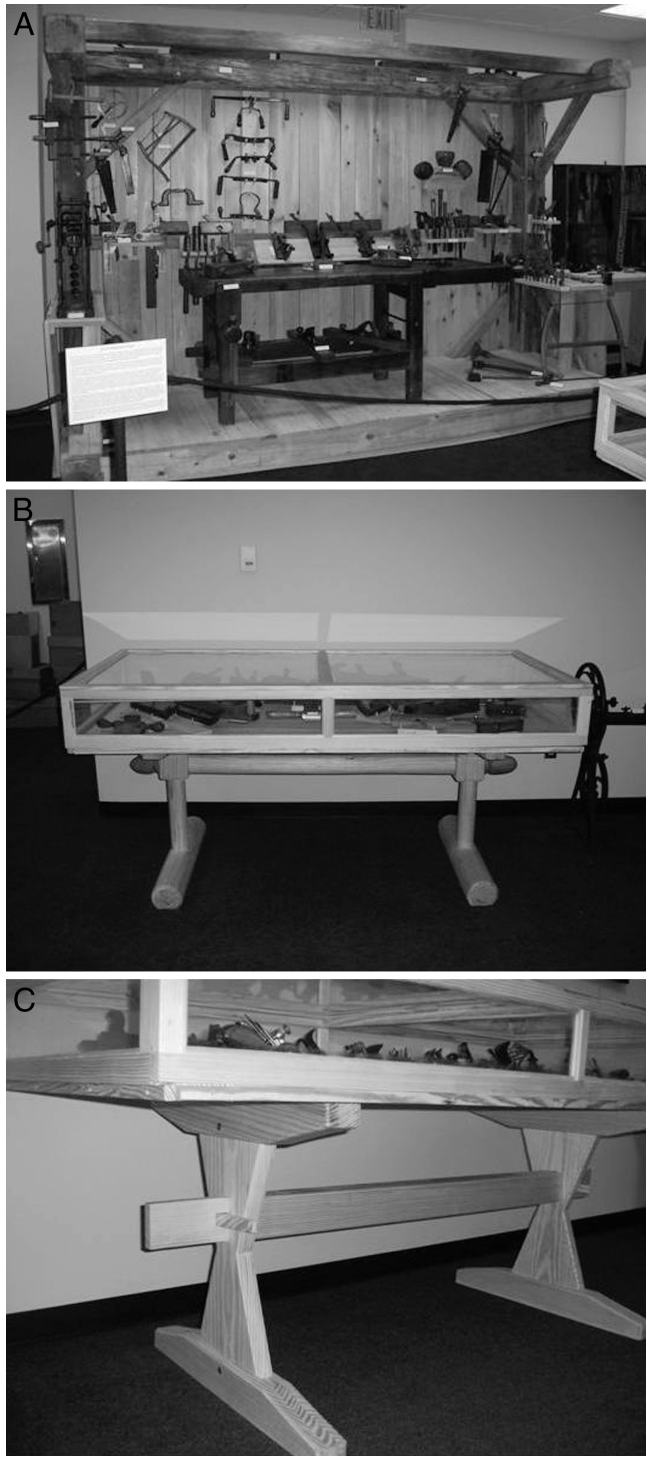

Figure 2.—The finished displays for the "Treasures from the Vault" exhibition: (A) the cutaway of a joiner's shop; (B) the "round" table; (C) the "butterfly" table.

Figure 3.—Forest Products master's student Benny Green's memorial cross.

Figure 4.—The "Logo" table featured at the T. K. Martin Center for Technology and Disability's Camp Jabber Jaw, a camp for children with special needs. The theme for the camp was "A Night at the Museum."

Course Evaluations Indicate We Are on the Right Track

The final exam spotlighted variations of one central theme—what did you learn? One student's response was, ''No one has ever asked me that.'' Others said, ''How can I put into words what I learned?'' The responses were far reaching; the faculty themselves were enlightened by the responses. For example:

''More attention needs to be paid to how we manage our forests—faster is not always better.'' ''There is a difference between volume and value.'' ''How a tree grows affects its market value.'' ''Markets, and the wood they favor, change with time; there are no guarantees that the preferred species or material of today will still be sought after 10, 20, or 30 years from now.'' ''The forest products industry is complex with many different aspects resulting in an infinite number of products.'' ''There are productive and marketable uses for species that are considered to have little value; a market can be created for unique products.''

Students discovered the different grains, colors, weights, and characteristics of many southern species and some exotics. Working with wood also heightened their senses. Planing southern pine did not garner much attention; planing leopard wood turned heads simply from the noise of the planer. Someone could be in another room and others would smell when cedar was being worked. Rings per inch could be closely estimated by touch alone. Hickory cutoffs from the bows regularly fed the smoker for after-class grillings.

People want to be passionate about their work and take pride in it. Students learned that forestry, forest products, and wildlife biology are unique, fascinating, and diversified fields, yet they interact in ways the students had not previously known. The acoustical qualities of various species for duck calls intrigued both the forestry and forest products students. Forestry and wildlife students learned that certain characteristics, such as knots and bird pecks, may not necessarily be defects if they are desired in the end use. Forest products and wildlife students began to understand how diversified forestry is in that different products demand different management techniques.

Inspiring Self-Learning

Learning does not end when class dismisses—it is continual. What began as a 4-hour course that met on Friday afternoons in January evolved into students arriving shortly after 11:00 a.m. and staying until 8:00 or 9:00 p.m. People coming to the shop on evenings or weekends soon became the norm rather than the exception. While all of the personal projects were not able to be finished within the semester timeframe, work continued through the summer. This did not go unnoticed by faculty and administrators.

A question raised early on by one of the students was ''How do I go about making it?'' The answer was, ''Take a log, carve everything away that does not look like it, and you will have it.'' The message to be taken from that was: Do not stand at the station waiting on a train to take you on the journey through life. You have to be willing to advance yourself; if you become lost during your travels, do not worry, someone will help steer you back on track.

The students learned to appreciate the beauty of wood as a material and the pleasures of working with it. They learned it is all right to take a chance (except where safety was involved), just plan a strategy for recovery if something goes wrong. Other people have knowledge and skills, figure out how to make use of them. It is not about *if* one will make a mistake because making mistakes is a fact of life. It is how a person recovers from those mistakes and what is taken from that experience. They found that most mistakes were correctable; those that were not became food for the shop stove. More importantly, they learned how the disciplines of the three departments mesh together in meeting society's

expectations of good resource management, whether the resource is people, trees, wood, or wildlife.

Moving Forward in Implementing "Classroom-Based" Experiential Learning

Experiential learning is valuable to understanding the proper management of resources, time, and perhaps most importantly, people. Recruiting students for courses on the subject of wood, though, can be a challenging proposition (Ifju 1996). The success of the exhibition led to submitting a proposal to continue this special topics class as a regular course, with a decision by the university's curriculum committee to be made in 2011. The 2010 class renovated the timber frame building by dressing and matching several species of hardwood lumber for the interior walls. Adding a wrap-around porch has been proposed for the 2011 class.

Covering wood science with one introductory course of classroom instruction is according to Kynoch (1953), ''analogous to saying one leg of a table is the whole table.'' The evolution of many natural resources programs, though, is marginalizing the forest products curriculum to just that. This course attempts to fill an emerging gap in natural resources by teaching wood fundamentals in an applied setting. It has already succeeded in satisfying Zink's (1997) four tenets to a successful program: (1) administrative support at the department, college, and university level, (2) a positive relationship with career counselors and potential employers, (3) facilitate student networking, and (4) full faculty participation.

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