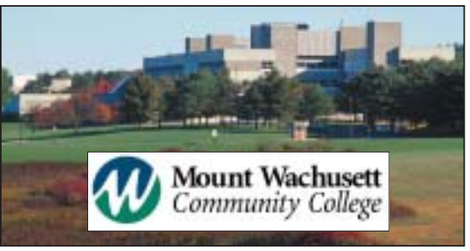
WOOD STRUCTURE AND PROPERTIES. . .

Mount Wachusett Community College in Gardner, Mass. and Wood Digest *have teamed up to present a series of college-level wood technology courses. This is the sixth in the series.*

By Ken Hanson, Wood Technologist

THE FOREST AND WOOD PRODUCTS Institute at Mount Wachusett Community College (MWCC) in Gardner, Mass. has partnered with *Wood Digest* magazine to present a series of college-level wood technology courses. Readers may enroll at MWCC on a distance learning basis for college credit. The courses will be taught using popular wood technology textbooks, coupled with online lessons, discussions and exams. The online component will use the MWCC Distance Learning System known as "Blackboard."

Over the next two years, *Wood Digest* magazine will publish monthly articles based on the course content from the Mount Wachusett Community College's Wood Products



Technology curricula. The initial course is titled "Wood Structure and Properties." Articles from this material will continue through the summer of 2003. The second course, "Wood Machining," will continue on to September 2004. For more details on this online course and its syllabus, visit the website at http://www.mwcc.mass.eduHTML/default.html.

For college credit, application and registration information about this Distance Learning Course, please follow these step-by-step procedures:

Step 1. Go to the MWCC website at http://www.mwcc.mass.edu/HTML/default.html.

a. Open the Business and Industry page.

b. Open the Forest and Wood Products Institute page.

c. Open *Wood Digest* courses.

Step 2. Open either the course registration form and/or the syllabus for your review.

Step 3. Print out the registration form and fill in all the requested blanks.

Step 4. Mail, fax or scan/e-mail the form to the Forest and Wood Products Institute. The numbers and addresses are on the form. The fee amounts are preprinted.

Step 5. Contact the instructor Ken Hanson at (978) 630-9179 or khanson@mwcc.mass.edu with questions.

Step 6. Upon registration confirmation, the institute will e-mail you a welcoming packet of information and your first homework assignment. It is required that you will have Internet access. Due to the rolling enrollment process, any student may start this course ANYTIME throughout the 12-month period, with completion in September 2003. There is NO maximum number of students.

COURSE OUTLINE

The first half of the course begins with an overview of structure of wood and covers:

- The physical characteristics of hardwoods and softwoods
- Wood identification
- Strength characteristics
- How and why moisture has such a dramatic effect on wood

The second half of the course covers wood properties, including:

- Adhesives
- Engineered wood products
- Machining, house construction
- Furniture production

The series of *Wood Digest* articles will highlight specific topics throughout the course. They will guide both the student and the *Wood Digest* reader through the technological uses of wood so they may all become better in their chosen profession. The enrolled student will take quizzes, exams, and form discussion and study groups. They will receive three undergraduate credits per course, which may be used toward the completion of a degree at MWCC or any partnering college of their choice.

To all new students and readers: MWCC and *Wood Digest* are excited about being able to offer these Wood Technology courses in this new, exclusive format. We welcome your enrollment to the college, your questions and comments as we start this Wood Structure and Properties wood technology course.

MOISTURE AND WOOD — PART 6 OF 12

A SHORT REVIEW OF THE PREVIOUS FIVE MONTHS

Moisture in wood affects many of its properties. Understanding and knowing the cell structure will help explain how water moves in softwoods and hardwood. For example, we have studied tyloses and know that they greatly retard moisture movement in White Oak. The strength values of wood in its orthotropic planes are also affected by the moisture content. Dry lumber has higher strength values than freshly sawn lumber when subjected to various strength tests.

GENERALLY SPEAKING...

In a tree's structure, every species contains a high percentage of *sap*. Some trees have a higher sap content in their cellular structure than other trees. Typically, the weight ratio of sap to woody material of an average growing tree is considered to be 30 to 200 percent (depending on the species). In general, softwoods have a higher sap content than hardwoods and sapwood has a higher sap content than heartwood. Charts are available to advise the woodworker about what percentage of freshly cut wood is actually sap. For example, the United States Forest Service publication of the *Wood Handbook* is available on-line. The appropriate chapter relating to moisture content can be found at http://www.fpl.fs.fed.us/documents/FPLGTR/fplgtr113/CH03.pdf. If you have a copy of the book, refer to Chapter Three. Another excellent resource about moisture and wood is Chapter Six in R. Bruce Hoadley's book *Understanding Wood - 2nd edition.*

WHAT EXACTLY IS THE SAP?

The sap in wood is actually a mixture of water and natural sugars, dissolved minerals and other nutrients commonly found in the soil. This mixture of ingredients will vary depending on the species of tree and where it was growing. Perhaps the best known sap is from the sugar maple tree (Acer saccharum). When making maple sugar syrup, the water in 35 to 45 gal. of sugar maple sap is boiled off to produce 1 gal. of pure maple syrup. Since sap is predominantly water, I will refer to it as moisture. When describing how much moisture is in wood, we refer to it as the moisture content or MC. The moisture content in wood is expressed as a percentage of weight of the moisture (water) vs. the weight of the dry wood. There are different ways of calculating the MC of wood. They are always compared to the *oven-dry method*, which will be described in next month's installment.

THE STORY:

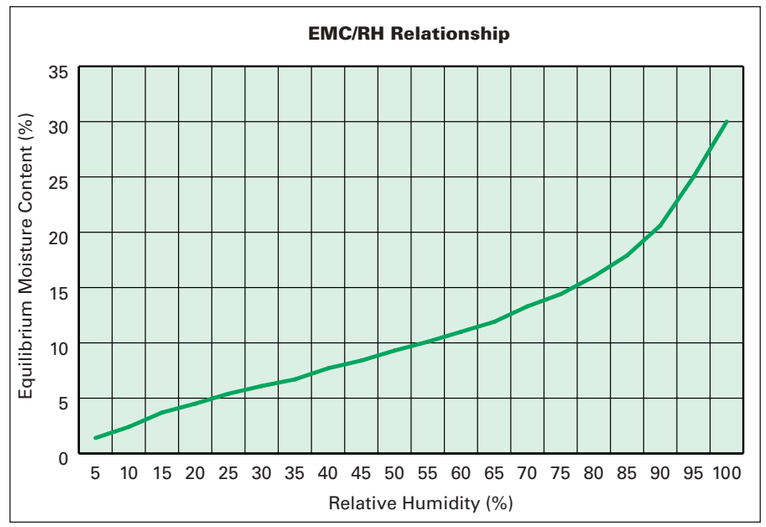
My father tells the story about when he built the family garage in Massachusetts. Building it with freshly sawn, full-size two-by material (2 x 4's, 6's, 8's, etc.), he quips that when nailing he would get "spit" in the face from the sap in the wood. Years later, the two-bys have dried out and were so hard that nailing was very difficult. This is because most of the moisture left the wood, making it extremely hard and somewhat brittle. The wood he used was Eastern hemlock (Tsuga canadensis), a native species found in the eastern part of the country. Its growing range is east of Wisconsin, north of Georgia and south of Ontario and Quebec in Canada.

TRUE OR FALSE:

This is a trick statement. Averaging a *green* moisture content of approximately 100 percent, the two-by material in my father's garage must have weighed twice as much when it was first built than when it dried out. Is this true?

If you took a sample from the dried two-by material, weighed it, put it in the oven and the weight stayed the same, then the answer would be true. If, after some time in the oven the sample weighed less, it showed that some additional moisture was driven out of the cellular structure. The answer, therefore, is false because moisture will be retained in the woods structure when left exposed to natural elements. Moisture from the atmosphere *(humidity)* can also be absorbed into wood, actually increasing the MC of wood. Due to woods hygroscopic properties, moisture is lost and regained based on the percentage of relative humidity in the surrounding air.

Wood dries from the outside in. Moisture will migrate from wet to dry areas in lumber. Moisture in the open cell cavity (*cell lumen*) is referred to as *free water*. The free water is the first moisture to leave the lumber as it dries. The reason there may be some moisture left in the two-by material is that water is retained in the cell walls, called *bound water*. The instant all the free water has left the wood, the wood is at its *Fiber Saturation Point* or FSP. The moisture content at FSP is generally about 30 percent MC. Until the wood has reached FSP, it has not yet shrunk in size. Once the bound water starts to leave the fiber or woody cellular material, wood will start to shrink, much like a wet sponge when left to dry.



The moisture content (MC) in wood will attain equilibrium with its atmospheric conditions. If these conditions are constant, wood will attain Equilibrium Moisture Content or EMC. By referring to the EMC/RH chart, one will be able to determine the EMC a piece of wood will attain when a constant RH is maintained. An EMC/RH chart is dependent on temperature and species. This chart reflects a temperature of 70 degrees F.

A dry kiln will control the rate of moisture loss during the entire drying process. A dry kiln is a large, well insulated building capable of controlling the atmospheric conditions, including temperature and humidity, within it. After lumber has reached FSP, the rate in which moisture is removed is a critical period in drying wood.

IN THE MARCH 2003 ISSUE OF WOOD DIGEST

In next months issue, we will cover the topic of wood drying, both naturally and in a *dry kiln*. In the years I have been in the wood industry, the topic of moisture removal from wood and its resulting shrinkage is by far the most important to understand. Drying wood by removing moisture has an effect on logs, lumber, furniture production, as well as the waste residue from these operations. The February and March issues have and will address many key points to help us further understand how and why wood dries.

TRY IT YOURSELF!

To all readers and students: To explore the discussion topics above, you can follow along at home or at work. Due to the nature of information presented, it may be difficult to relate to the subject matter. Try surfing the net using the keywords from this article. Gather more information about the subject. If you find some good articles, please let the class know about them on Blackboards Discussion Board or e-mail me at khanson@mwcc.mass.edu.

The keywords are:

Oven-dry method	Free Water
Sap	Bound Water
Hygroscopic	Fiber Saturation Point

For enrolled students: As part of your homework, January's homework and quiz questions are now due. A February '03 homework assignment and quiz is available for you on Blackboard. If you have any questions about Blackboard or the homework, contact me or review the help section available on the MWCC website. WD

All articles edited by David Damery, Building Materials and Wood Technology Department-UMASS-Amherst, MA

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