

# 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 fourth in the series.

By Ken Hanson

**T**HE 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.edu/HTML/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](mailto: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, 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.

## HARDWOOD AND SOFTWOOD IDENTIFICATION — MONTH 4 OF 12

### A SHORT REVIEW OF THE PREVIOUS THREE MONTHS

In the September and October issues of *Wood Digest*, the articles outlined the main structural components of softwoods and hardwoods. Their structural components were described beginning with scientific classification of the initial structural difference, the encapsulation of their seeds. In November, additional gross features used in identifying wood were introduced, i.e., grain figure, color and end grain. Please refer to these three issues to familiarize yourself with these features of wood. An archive of these and other articles are posted on the *Wood Digest* website <http://www.woodworkingpro.com/>.

## MICROSCOPIC IDENTIFICATION FEATURES — LETS LOOK AT THE SMALL PICTURE!!

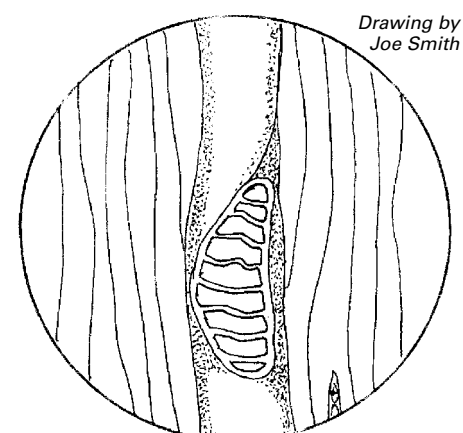
### Vessels, Rays, Fibers — What are their individual features?

Color and texture are examples of grain characteristics that are seen with the naked eye or in some cases easier with a hand lens. From a chemical perspective, woody material or fiber is composed of *cellulose*, *hemicelluloses*, *lignin* and *extractives*. In addition, extractives are organic compounds found in the heartwood structure of a log. Extractives reduce the ability of sapwood to conduct nutrients, by affecting the *hygroscopic* nature and *permeability* of the cellular material. Extractives may affect the odor, specific gravity and decay resistance of a particular species. In addition, the color of heartwood will be different than sapwood. As a general rule, a dark color may represent heartwood in a wood sample. Conversely, as in black walnut, the sapwood may be difficult to identify because it is a creamy light color, radically different than the dark brown heartwood color.

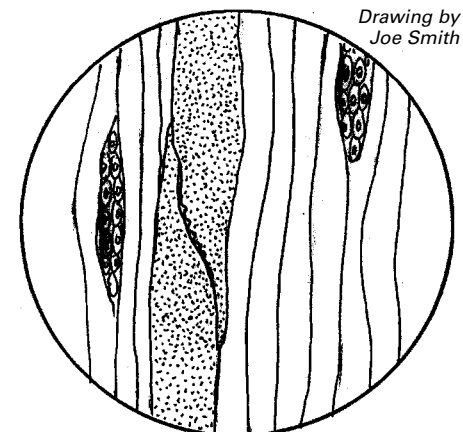
Many features can be used to identify a wood species from a microscopic level. The more common features used are *perforation plates*, *pits*, *parenchyma cells*, *epithelial cells*, *spiral thickenings*, and *oil cells*. These features are discussed in greater detail below. A microscope will provide to the wood identifier a finer view of the thickness of the *cell wall*, relative size of pores and rays, *multiple pore arrangements*, and *resin canals*.

**Perforation Plates:** Hardwood vessel elements are tubular structures with tapered ends. Perforation plates, which

occur only in hardwoods, connect these tapered ends of the vessel elements. Some species feature *Scalariform* perforation plates which are ladder-like structures with varying quantities of "rungs" dependent on species. Most tree species have either *simple* or *scalariform* plates. (See drawing of two views of a scalariform perforation plate).



Scalariform perforation plate-view showing rungs



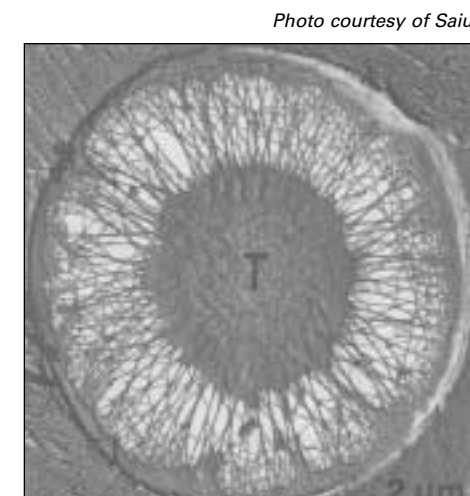
Scalariform perforation plate-side view

A simple perforation plate has one large hole with no connecting bars. Water and other fluids easily flow through either perforation plate, enabling these life-giving fluids the pathway to flow in an unimpeded manner. In some hardwood species, both simple and scalariform plates exist.

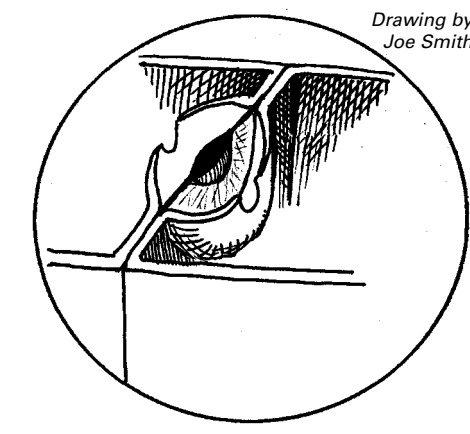
In contrast, softwood tracheids (although less efficient) have pits in their walls, but no perforation plates. Used as an identification tool, perforation plate types may be used to group the sample into a hardwood or softwood subdivision (refer to September article in *Wood Digest* magazine).

**Pits:** An opening allowing intercellular transfer of fluids. A pit is located on the sides of wood cell walls. These are designated as either *simple* or *bordered pits* (see drawing). Pits separated by a *pit membrane* always occur in pairs and are called *pit pairs*; however, combinations of simple and bordered pits exist. In softwoods, the pit membrane will thicken into a disk shape called a *torus*. Tori are not found in hardwoods; however, a flat cell membrane does exist.

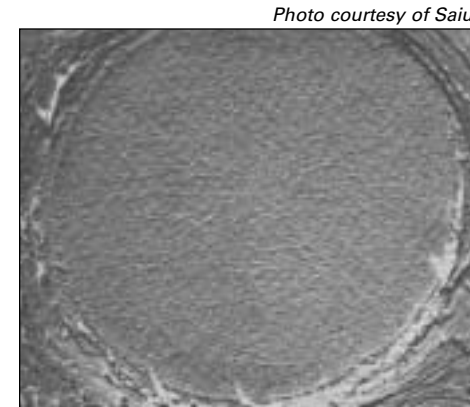
Many of the pines (having resin canals) exhibit slight variances in their pits. Microscopes will aide the viewer in



Bordered pit in softwood with torus



Bordered pit with torus



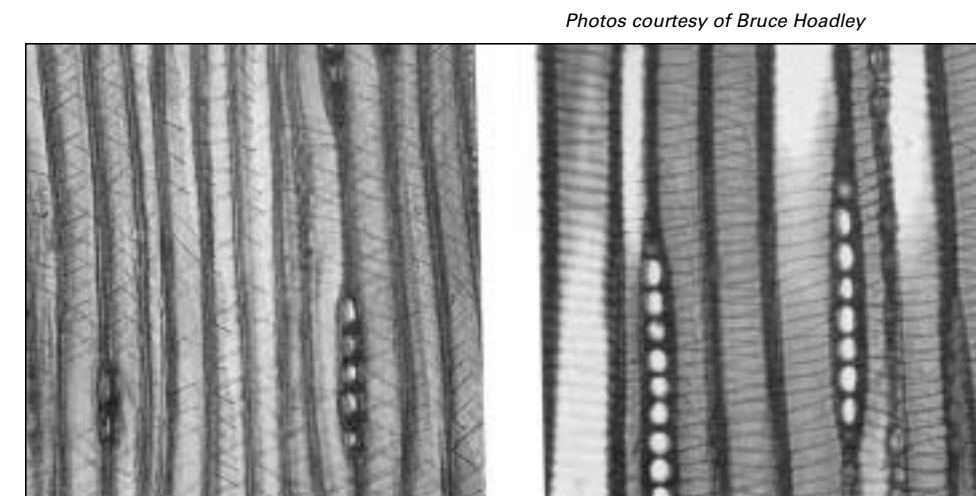
Bordered pit in hardwoods

determining the size and shape of intracellular pitting.

**Oil cells:** Many woods exhibit similar gross features. For example, black ash (*Fraxinus nigra*) and sassafras (*Sassafras albidum*) are both ring-porous and show similar color tones and tyloses. In this case, a microscope will assist in locating yellow-colored oil cells in sassafras, never found in black ash. In softwoods and hardwoods, a microscope may be used to define one species from another within the same family.

**Spiral thickenings:** Spiral thickenings occur only in the vessels of some species of hardwoods and the tracheids of Douglas fir and yew. In these similar conifer species, spiral thickenings are an effective identification feature. In the case of yew, resin canals are not found. Conversely, resin canals are found in the Douglas fir species.

Spiral thickenings in hardwoods are more common than in conifers. Use of spiral thickenings in conjunction with other features such as porosity, inclusion of tyloses, pit pair and perforation



Spiral thickenings

plate type will provide many of the clues to identify a hardwood.

A microscope may be used to identify a wood species when the only material available is fiber, e.g., paper pulp or newsprint. Soaking in water and gently pulling apart the fibers will allow the wood identifier to locate tracheids or vessels, their size, shape of pits, etc.

## WHAT TO LOOK FOR IN JANUARY 2003 . . .

The January issue of *Wood Digest* outlines many of the strength characteristics of wood as it relates to the grain direction and weight. We will define those words like tension and compression, elasticity and stiffness, and stress and strain. Good Luck!

## 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, the reader must have access to a microscope in order to view and explore the features discussed above.

If you do not have access to a microscope, try surfing the net using the keywords from this article to view these features.

- The keywords are:
- Perforation plates
  - Spiral thickenings
  - Simple pit
  - Bordered pit
  - Pit membrane
  - Torus
  - Epithelial Cells
  - Extractives

**For enrolled students:** Locate the best picture of each keyword and e-mail ([khanson@mwcc.mass.edu](mailto:khanson@mwcc.mass.edu)) to me. By hand, draw a vessel member, a vessel and three pit pair types and send them to me.

November's homework and quiz questions are now due. A December homework assignment 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.

Photos courtesy of Bruce Hoadley

## Definitions

**Cellulose** – Strong, long chain C<sub>6</sub>H<sub>12</sub>O<sub>6</sub> polymers comprising 40 to 50 percent of wood's cell wall weight.

**Hemi-cellulose** – Comprising 20 to 40 percent of woods cell wall weight. A polysaccharide, lower in molecular weights than cellulose, has a weak undifferentiated structure compared to crystalline cellulose.

**Lignin** – Lignin is nature's cement and along with hemicelluloses, exploit the strength of cellulose while conferring flexibility. Comprises 25 to 35 percent of wood's cell wall weight.

**Extractives** – Comprises up to 25 percent of the cell wall weight.

**Spiral thickenings** – Located on the cell walls and helically arranged, spiral thickenings are thickened ridges resembling coil springs or reinforcement fiber in garden hoses.

**Resin canals** – a transportation system of resin, secreted from epithelial cells located within the canals.

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