<u>Chapter Two (pg. 25-45): The Macroscopic Character of Wood</u>

- This topic is of interest because **<u>macroscopic characteristics:</u>**
  - **<u>Give clues to conditions under which wood was grown</u>**
  - **<u>Provides an indication of the physical properties of wood</u>**
  - **<u>Serves as an aid to wood identification</u>**
- There are **<u>three distinct surfaces of wood</u>**:
  - Fig. 2.1 pg. 25 or pg. 3 in "Wood Identification…TN" pamphlet
  - **Radial**: perpendicular to growth rings; sides of ray cells visible
  - **Cross-sectional** or **transverse**
  - **Tangential**
- **Growth rings** (in temperate zones):
  - Growth rings are the result of new growth in the vascular cambium, a lateral meristem, and are synonymous with secondary growth
  - One growth ring occurs annually; distinct layers of early- and late-formed wood within each ring
  - Rapid growth in early spring, slowing in late summer before ceasing in fall
  - Many trees in temperate zones make one growth ring each year, with the newest adjacent to the bark. For the entire period of a tree's life, a year-by-year record or ring pattern is formed that reflects the climatic conditions in which the tree grew. Adequate moisture and a long growing season result in a wide ring. A drought year may result in a very narrow one. Alternating poor and favorable conditions, such as mid summer droughts, can result in several rings forming in a given year.
- Appearance:
  - Fig. 2.3 pg. 26
  - **Latewood** has greater density and is darker-colored
    - Cells have small radial diameter, thick walls, and small lumens (interior space of a tubular structure)
  - **Growth rings** do not always appear as distinct, alternating bands; some hardwoods form large-diameter pores early in a growing season and smaller-diameter pores later in the year (**ring-porous**); however, some do not (**diffuse-porous**). They exhibit little variation in cell structure across a growth increment and the pores are all about the same size (as in tropical trees).
- Formation:
  - Causes of the formation of early and late wood are unknown, but scientists believe that it is related to photosynthate availability and the presence of auxins.
- Characteristics of **latewood**:
  - Cells of relatively small radial diameter
  - Thick cell walls (depends on photosynthate supply)
- Effects on wood properties:
  - Strength of **latewood** is greater than **earlywood** in distinct-ring softwoods; it is two to three times the strength and stiffness of earlywood
  - Early and late wood have different mechanical properties

- **Discontinuous rings**:
  - Are a result of the cambium remaining dormant in one or more places around the stem, failing to form around the complete cross-section
  - Occasionally found in trees with one-sided crowns (as in borders), or in heavily defoliated, suppressed, or over-mature trees
- **False rings**:
  - Duplicate rings created by events such as drought, late frost, or defoliation, that cause terminal growth to slow or cease, reducing auxin production, within a season that are followed by favorable growth conditions
  - Exhibit a gradual change in cell character on both sides of the false latewood, resulting in double gradation; whereas, normal **growth rings** are characterized by an abrupt change in cell size and wall thickness from the last-formed latewood of one seasonal ring to the earlywood of the next
- Heartwood and sapwood:
  - Fig. 2.8 pg. 31
  - A stem cross-section shows a dark-colored center portion (heartwood) surrounded by a lighter-colored outer region (sapwood); sometimes there is not a color difference
- **Heartwood:**
  - Made up of dead cells
  - Usually begins to form around age 14-18
  - Heavier, stronger, more highly figured, more resistant to decay
  - **Factors in formation:**
    - **Age**
    - **Distance from cambium**
    - **Other unknown factors**
  - **Suspected factors**:
    - Accumulation of carbon dioxide or ethylene gas
    - Reduction of moisture content levels and/or cessation of water transport in the inner regions of the stem
    - Enzyme activity
    - Gradual reduction of starch, sugars, or lipid reserves from the cambium inwards and formation of compounds known as **extractives**, which are chemical components that give heartwood its distinctive properties and can be extracted from the heartwood
  - **Extractives** or **secondary metabolites** (formation of which accompanies death of cells):
    - are substances that do not participate directly in tree growth and development
    - Formed from transported metabolites (products of physical and chemical processes associated with the maintenance of life) by living parenchyma cells at the heartwood boundary (pg. 34)
    - Accumulate in cell walls and lumens
    - Usually polyphenolic in nature

            - a group of chemical substances found in plants, characterized by the presence of more than one phenol unit or building block per molecule
            - polyphenols that are commonly associated with heartwood include: oils, resins, gums, tannins, and aromatic and coloring materials
        - other compounds in heartwood include fats and waxes (pg. 34)
    - **Embolism**: an obstruction caused by the formation of air bubbles as liquid pressure is reduced (water columns in xylem are under tension); more likely to occur as height from the ground increases
    - **<u>Properties of Heartwood</u>**:
        - Darker color
        - Highly decay- or insect-resistant or both
        - Difficult to penetrate with liquids
        - Difficult to dry
        - Odiferous
        - Slightly higher weight-per-unit volume
        - No difference in strength except maybe to being crushed (pg. 37)
    - **Rays:**
        - Provide an avenue by which sap can travel horizontally either to or from the phloem layer; extend from the cambium toward the pith
        - Produced by division of ray initials in the cambium
    - **Grain orientation**:
        - The direction parallel to the long axis of most of the long tapered fibers of wood
        - Fig. 2.12 (pg. 41)
        - **Spiral grain:**
            - In trees in which fibers are spirally arranged about the stem axis
            - Caused by anticlinal division (production of new initials by radial partitioning, pg. 14) in which new cambial cell formation occurs in one direction only
            - Typically low in strength and stiffness and may tend to twist as it dries
            - fig. 2.13 (pg. 41)
        - **Interlocked grain:**
            - wood produced when grain spirals in one direction for several years and then reverses direction to spiral oppositely
            - genetically controlled
            - an example is elm
            - The wood is difficult to split, may shrink longitudinally upon drying, and can warp unpredictably, but is sometimes desirable from an appearance standpoint as alternating grain directions cause light to reflect in varying patterns

across radially cut wood, giving a "ribbon stripe" figure (as in veneer); fig. 2.14 (pg. 42)

- **Knots**:
    - Fig. 2.15 (pg. 43)
    - Branch bases become more and more deeply embedded in the trunk as diameter growth increases
    - Most branches originate from the pith
    - the base of the branch is cone-shaped
    - **intergrown** or **tight knots** result from living branches being incorporated into the main stem due to natural growth; these knots do not become loose or fall out upon drying
    - **Loose** or **encased knots** result when a dead branch is incorporated into the main stem as the cambial layer of the main stem continues to grow over where the branch died; knots formed this way may fall out as the lumber dries