The Relevance of Surface Properties & Wood Finishes to the Wood Science & Technology Research Community

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SOCIETY OF WOOD SCIENCE AND TECHNOLOGY

SWST

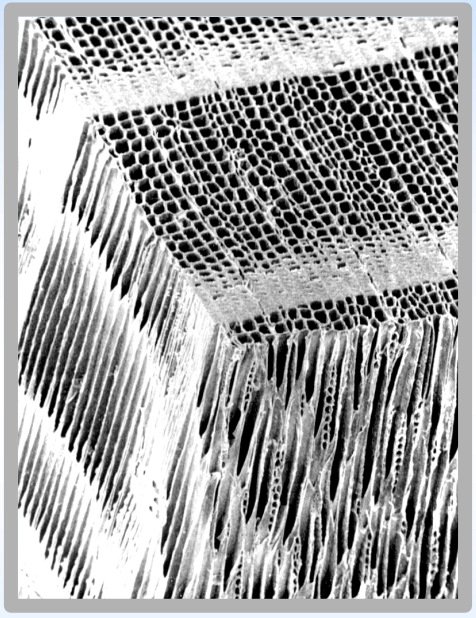
THE 2nd ANNUAL FUNDAMENTAL DISCIPLINES SESSION

Outline

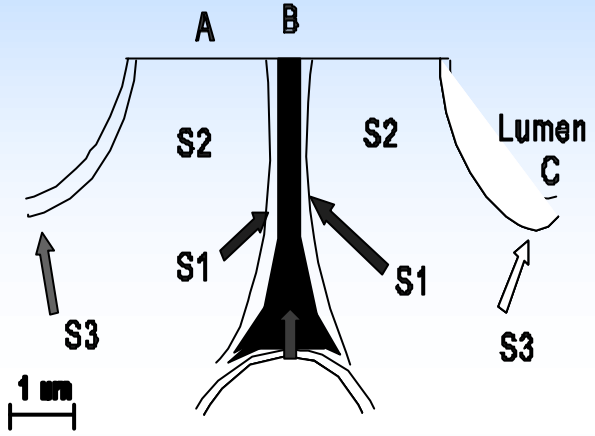
- Overview –Wood Surface Properties
- Where is research being done?
  - Survey University Programs In North America
  - Federal Labs (USDA and Forintek)
- Panelization (A practical finishing challenge)
- Opportunities

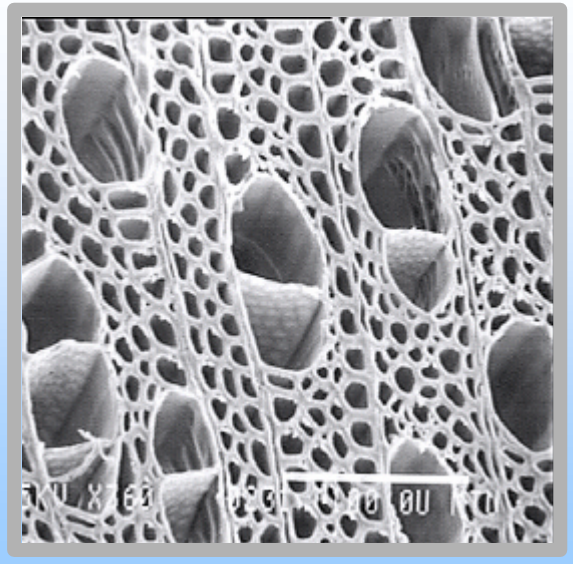
Wood Finishing Considerations

- Wood is a porous material
- Wood is also an anisotropic material
- Wood surface chemistry is heterogeneous
- Wood swells and shrinks as a function of moisture content



SEM - Softwood

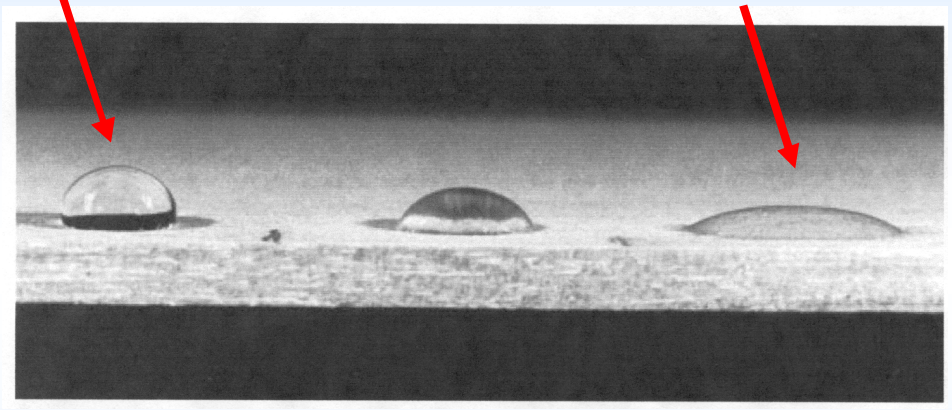


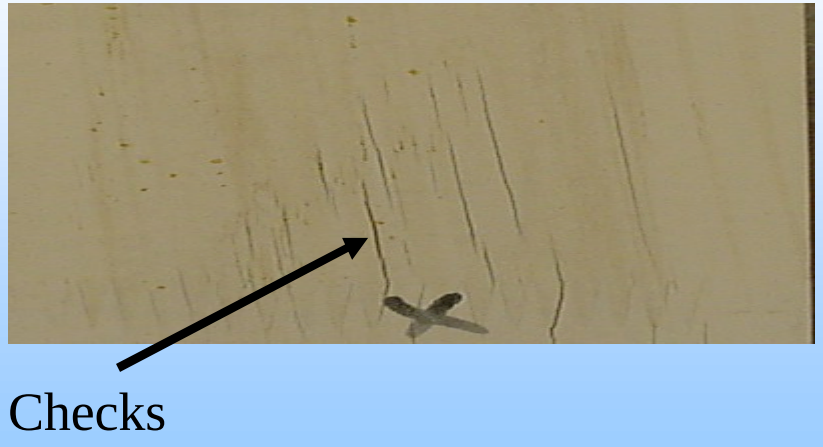


SEM -Hardwood

Wood Surface Property Issues

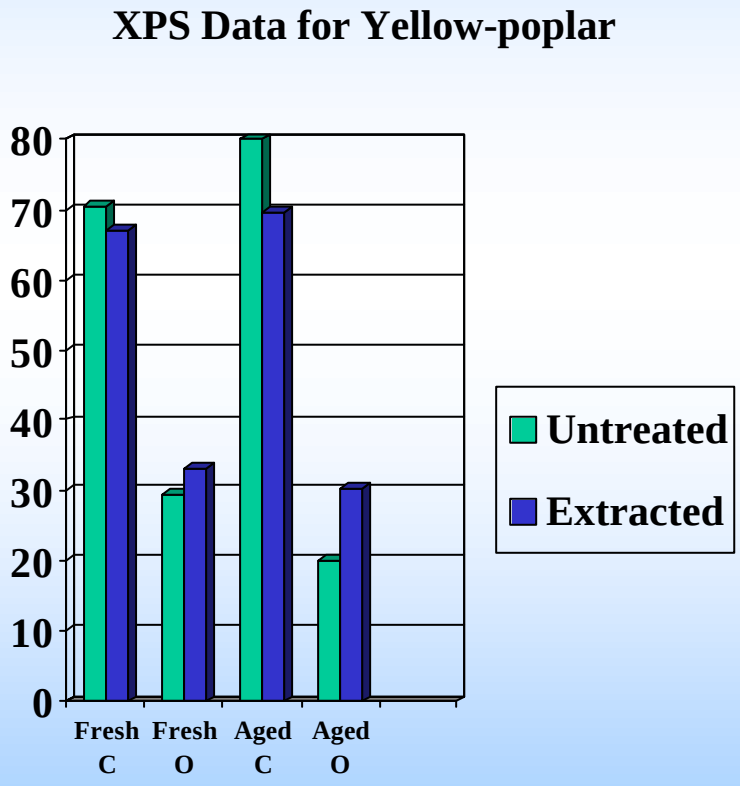
- Impact of Processing
  - Machining
  - Drying
  - Aging
- Weak Boundary Layers
  - Chemical (extractives)
  - Mechanical
- Application Environment
  - Temperature
  - Relative humidity





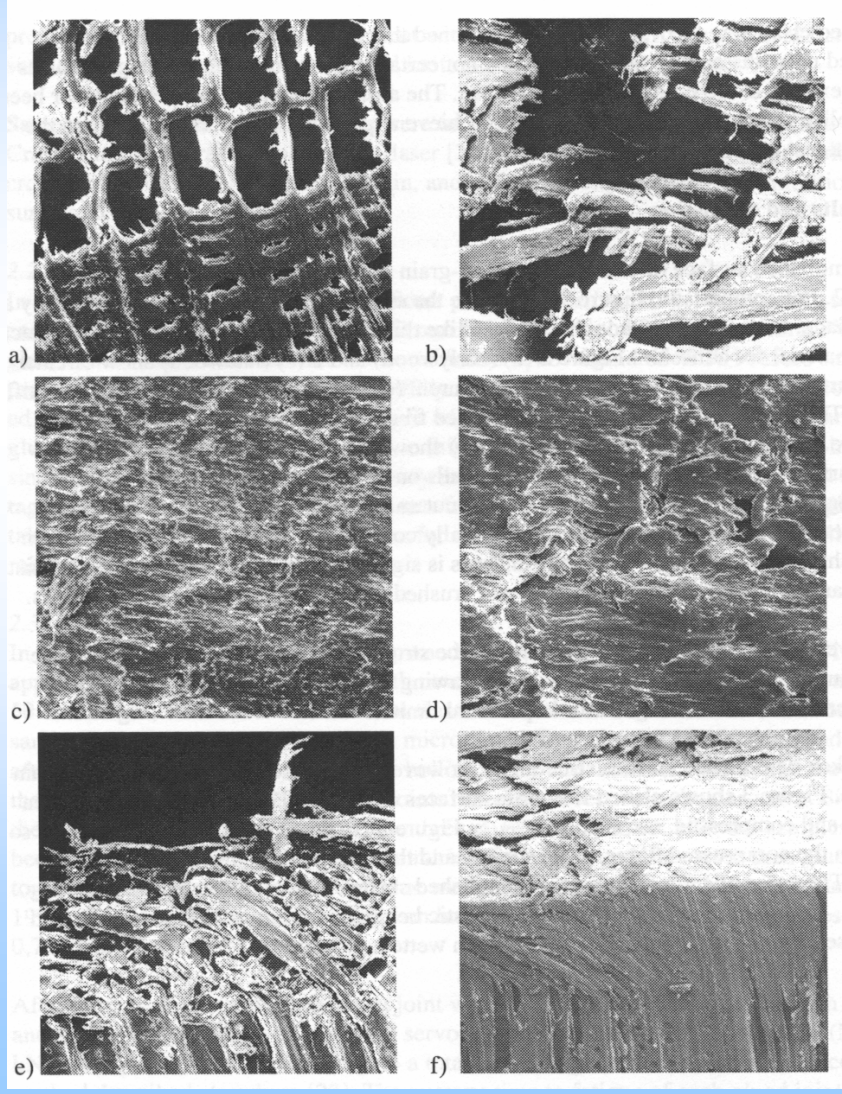
Wood Surface Chemistry

- **Elemental composition**
- Functional groups
- Surface thermodynamics
  - Acid-base character
  - Non polar character
- Molecular reorientation of surface functional groups
- Extractives dominate wood surface chemistry



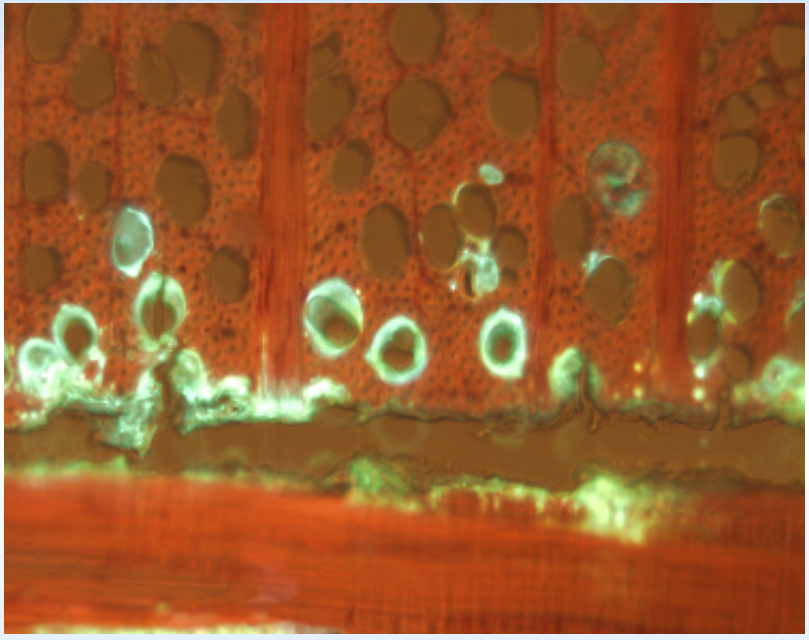
Wood Surface Morphology

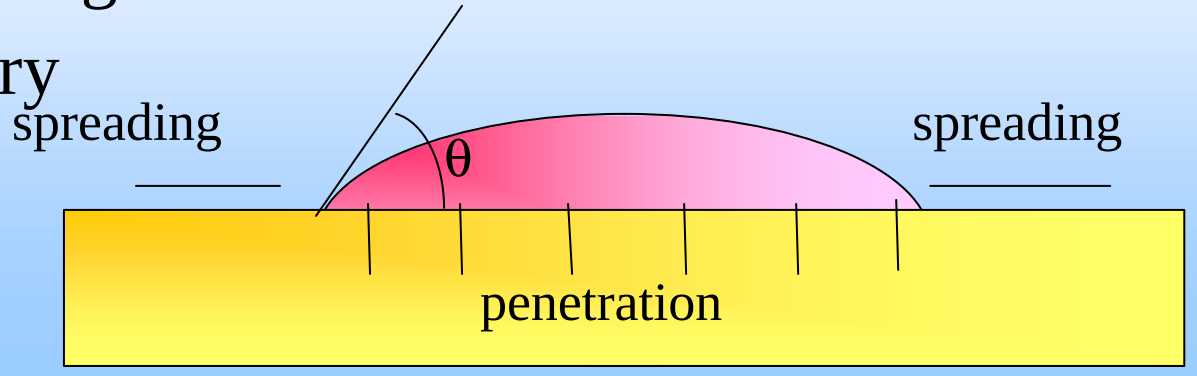
- Surface roughness
  - Improved mechanical interlocking
  - Changes in wettability due to capillary forces
- Mechanical weak boundary layer
  - Damaged fibers from machining processes
  - Cracks or splits



Adhesion Bonding Mechanisms

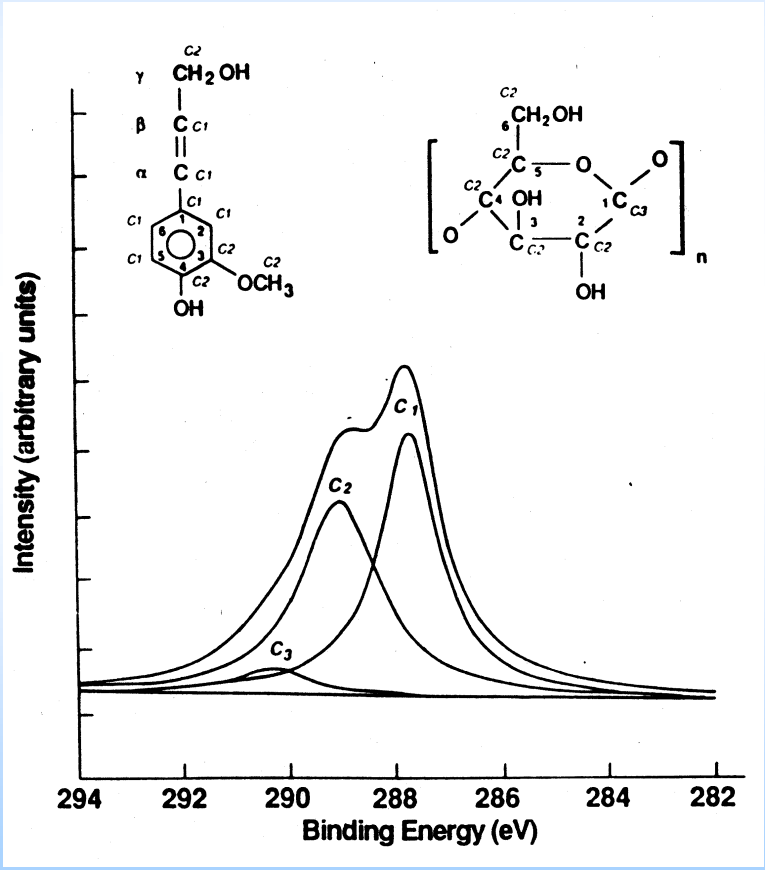
1. Mechanical Interlock
2. Diffusion Theory
   - Interpenetrating Network
3. Wettability Theory
4. Electrostatic
5. Covalent Bonding
6. Weak Boundary Layers





Measuring Surface Properties

- Contact angle analysis
- Inverse gas chromatography
- X-ray photoelectron spectroscopy
- Infrared/Raman spectroscopy
- Microscopy
  - Electron
  - Optical
  - AFM



Wood-Orders of Scale

FRP Laminate

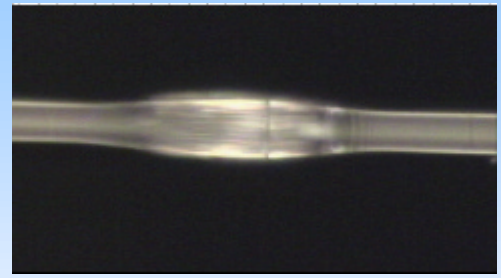
1 meter

Glulam-FRP

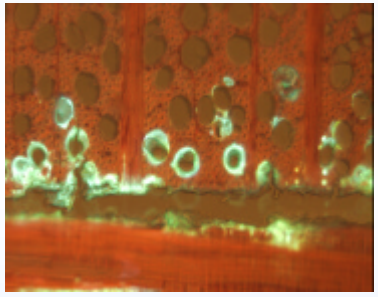
10 centimeters

Shear specimen

1 centimeter

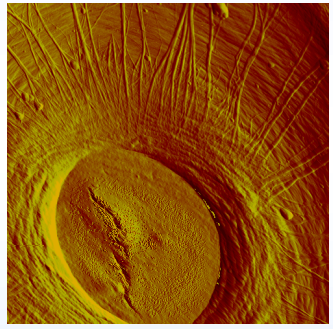


Microdroplet on Fiber, 1 millimeter



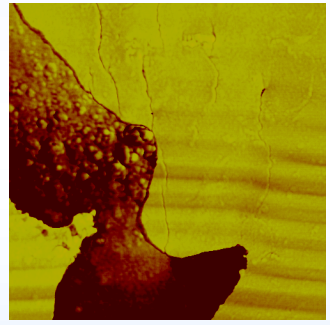
Bond line micrograph

100 microns



Bordered Pit

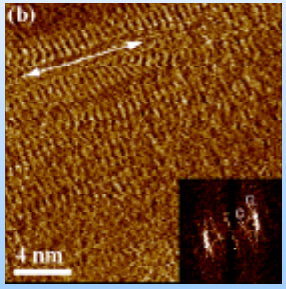
10 microns



UF Resin on loblolly fiber (2 micron scan)

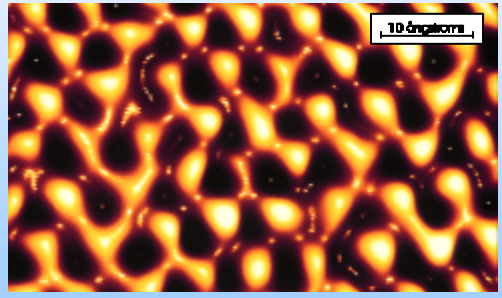
Cellulose nanocrystals

200 nm long, 10 nm wide



Valonia

10 nanometers



1 nanometer

Survey of Wood Science Programs

Number	Institution	Fundamental	Applied
1	Laval University	No (Planned)	No (Planned)
2	North Carolina State University	No	No
3	Louisiana State University	No	No
4	Mississippi State University	No	No
5	Oregon State University	No	No
6	Washington State University	No	Planned (Coatings for wpcs)
7	Virginia Tech	No	Yes (Product Analysis)
8	University of Maine	Yes (Coating diffusion)	No
9	University of British Columbia	Yes	Yes
10	University of Tennessee	No	No

Panelization

- Two studies sponsored by the Maple Flooring Manufacturers Association (MFMA)
  - 1997
  - 1998
- 2002 Deposition in front of a legislative committee in Delaware

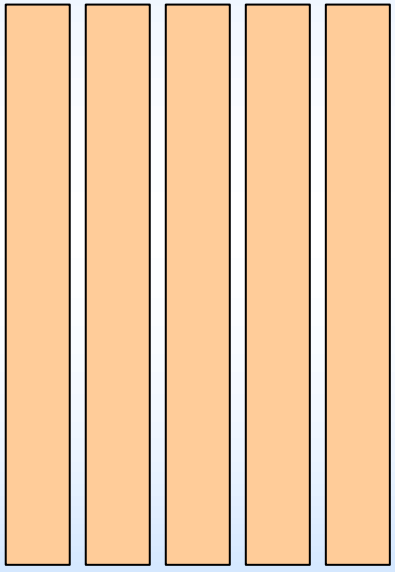
What is “Panelization”?

- “Panelization” or edge-bonding is a condition where localized excessive cracks develop between some strip flooring boards while adjacent boards remain tightly bonded together with no apparent separations.

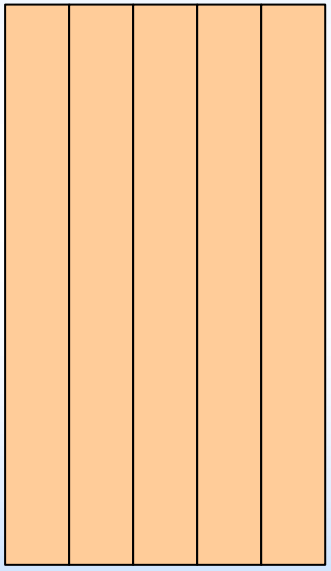
History of the Problem

- Not a new problem
  - Reports have been made over the past decade
  - Impact of VOC regulations
- Contributing Factors
  - Water-based sealers
  - Seasonal moisture fluctuations

Causes of Panelization



- Apply water-borne finish
- Some finish gets between the cracks
- Wood Swells
- Conditions to form an adhesive bond are met

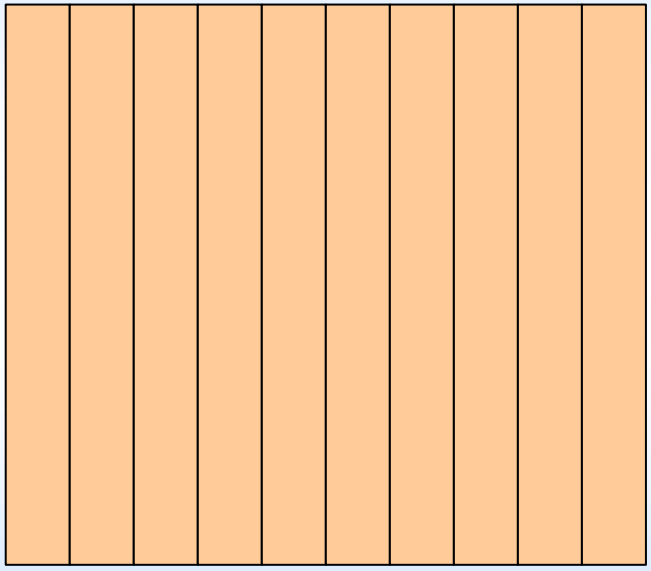


Unfinished Flooring

Panelized floor

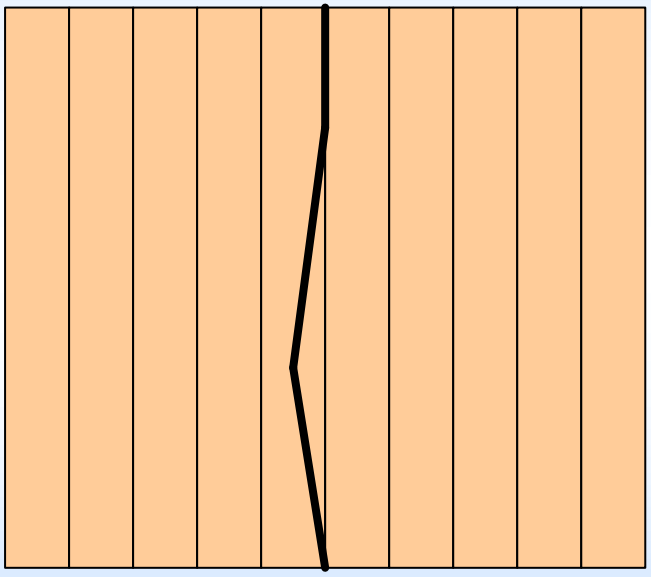
Note: Oil-borne finish will not swell the wood

Causes of Panelization



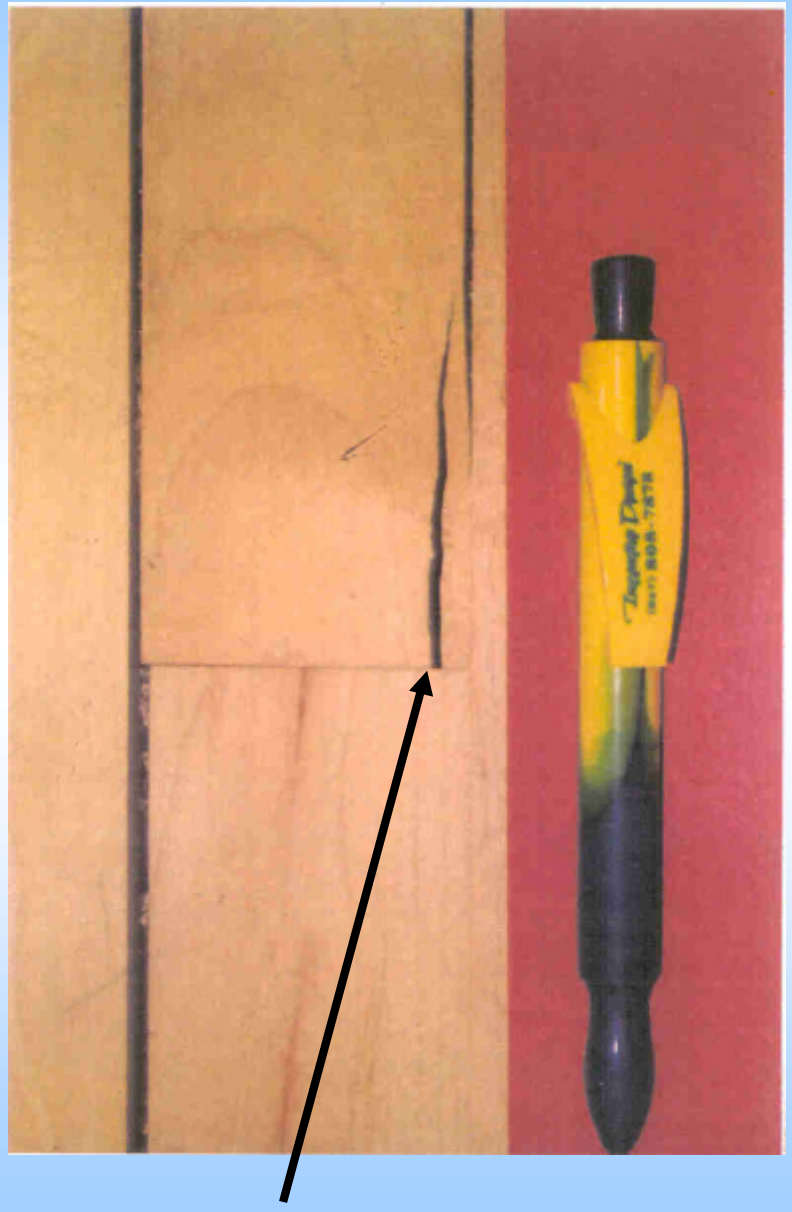
Panelized floor

- Summer to winter
- Wood Shrinks
- Splits and Cracks develop



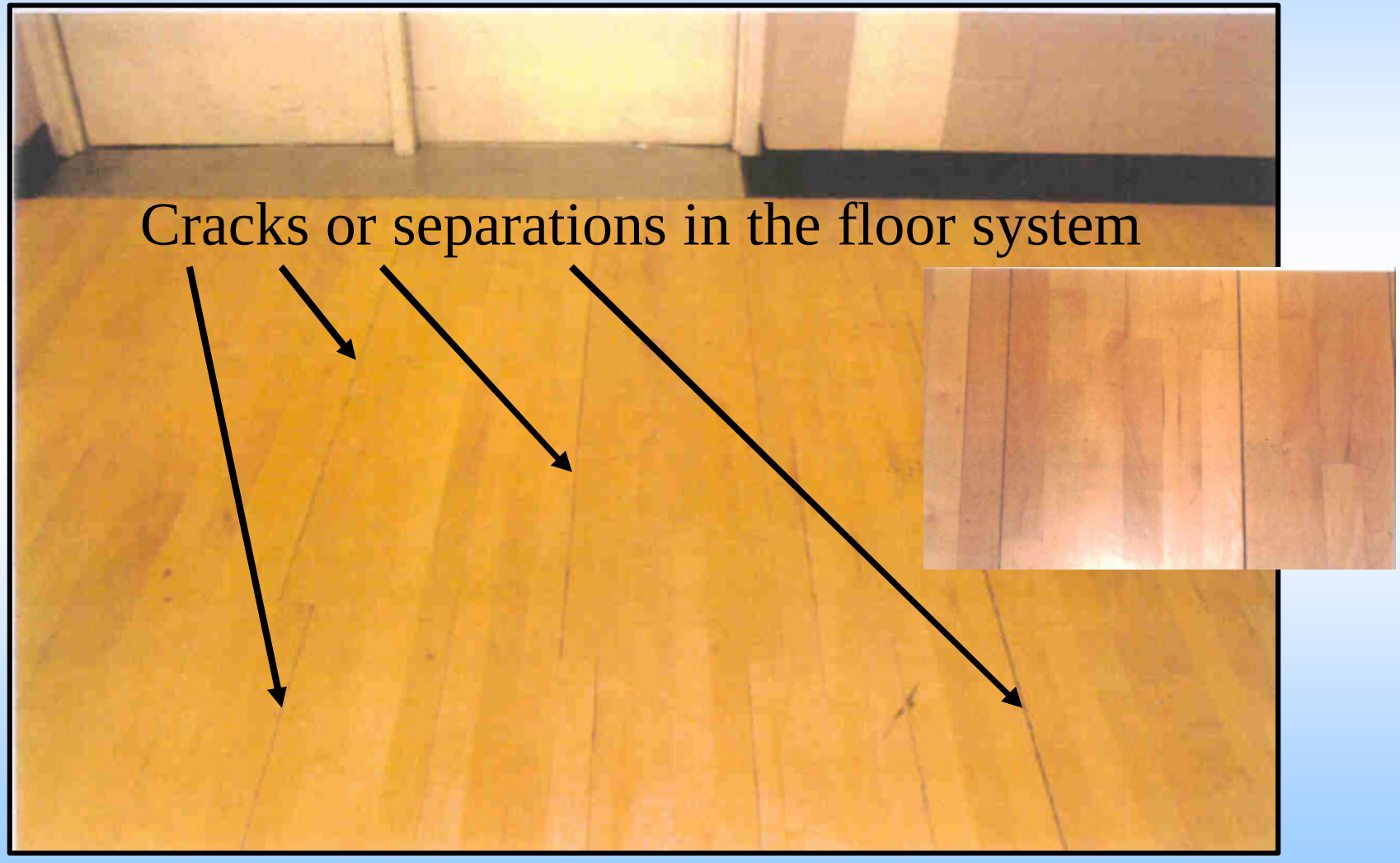
Panelized floor response to seasonal climate change

Results of Panelization Occurrence



Splits in the Wood

Panelization



Opportunities

- Academic interest (wood scientists) in North America is minimal (Potential for a research niche?)
- Research Areas
  - Architectural Coatings
  - Furniture finishes
- Funding potential?
  - Government programs (USDA, NSF, DOE)
  - Coatings and Finishing Manufacturers