Modified Wood for New Product Opportunities

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Engineered Wood Products – from here to the future
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Modified Wood?

Wood that maintains its natural cellular structure, but changed by chemical, thermal, or mechanical methods to impart new properties.

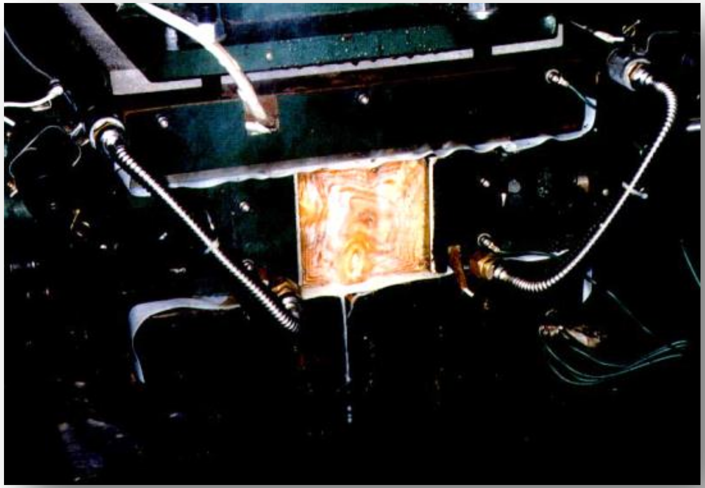
Examples:
Acetylated wood (chemical)
Thermo-wood (thermal)
Thermo-hydro-mechanical wood (thermal and mechanical)

~~MDF~~ ~~particleboard~~ ~~paper~~

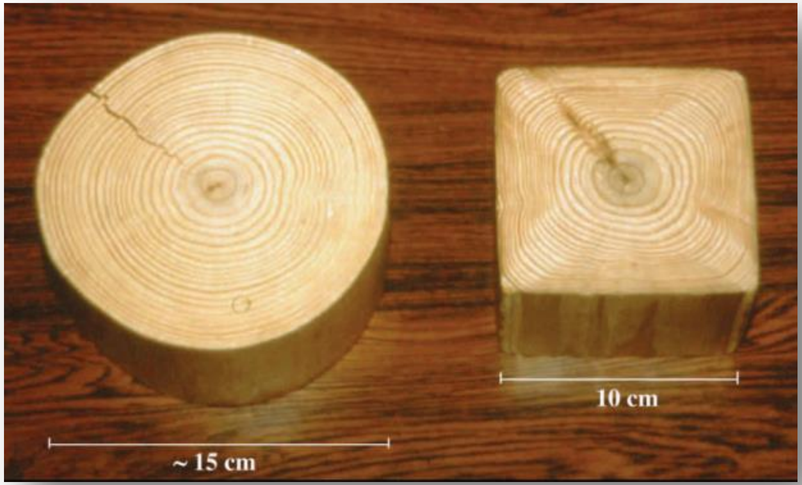
Focus today is THM wood

THM Wood

<u>THM</u>- Thermal-Hydro-Mechanical process that uses heat, moisture, and mechanical compression for the express purpose of increasing density of wood.



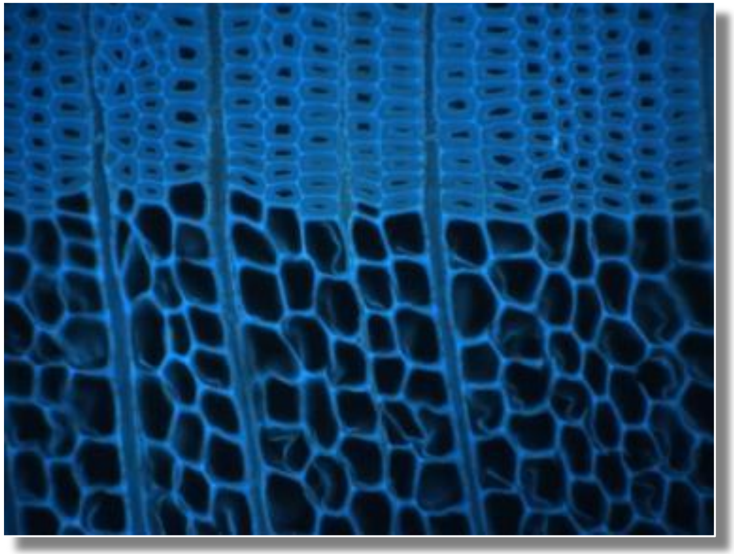
Morsing 2000



Ito et al. 1998

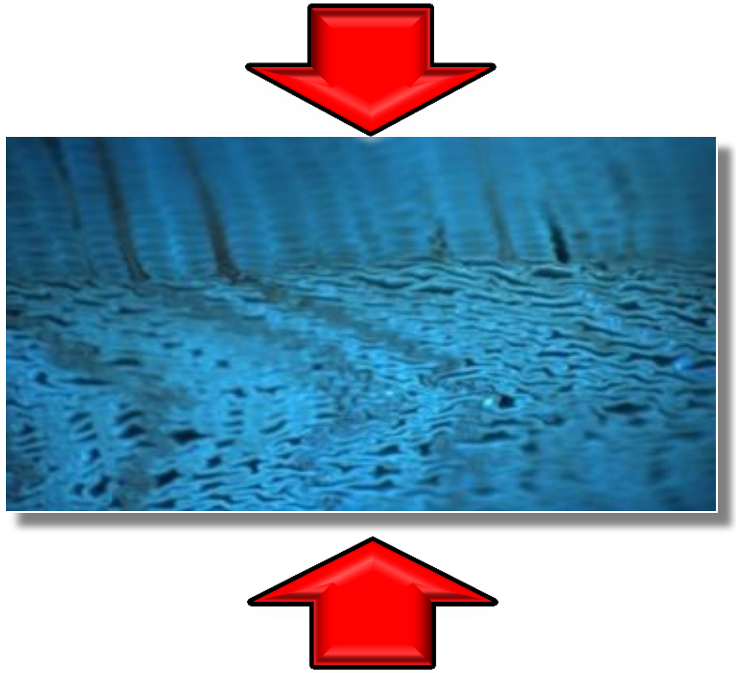
THM Wood

- Compression above yield strength
- Wood above glass transition temperature
- Minimal to no cell wall fracture



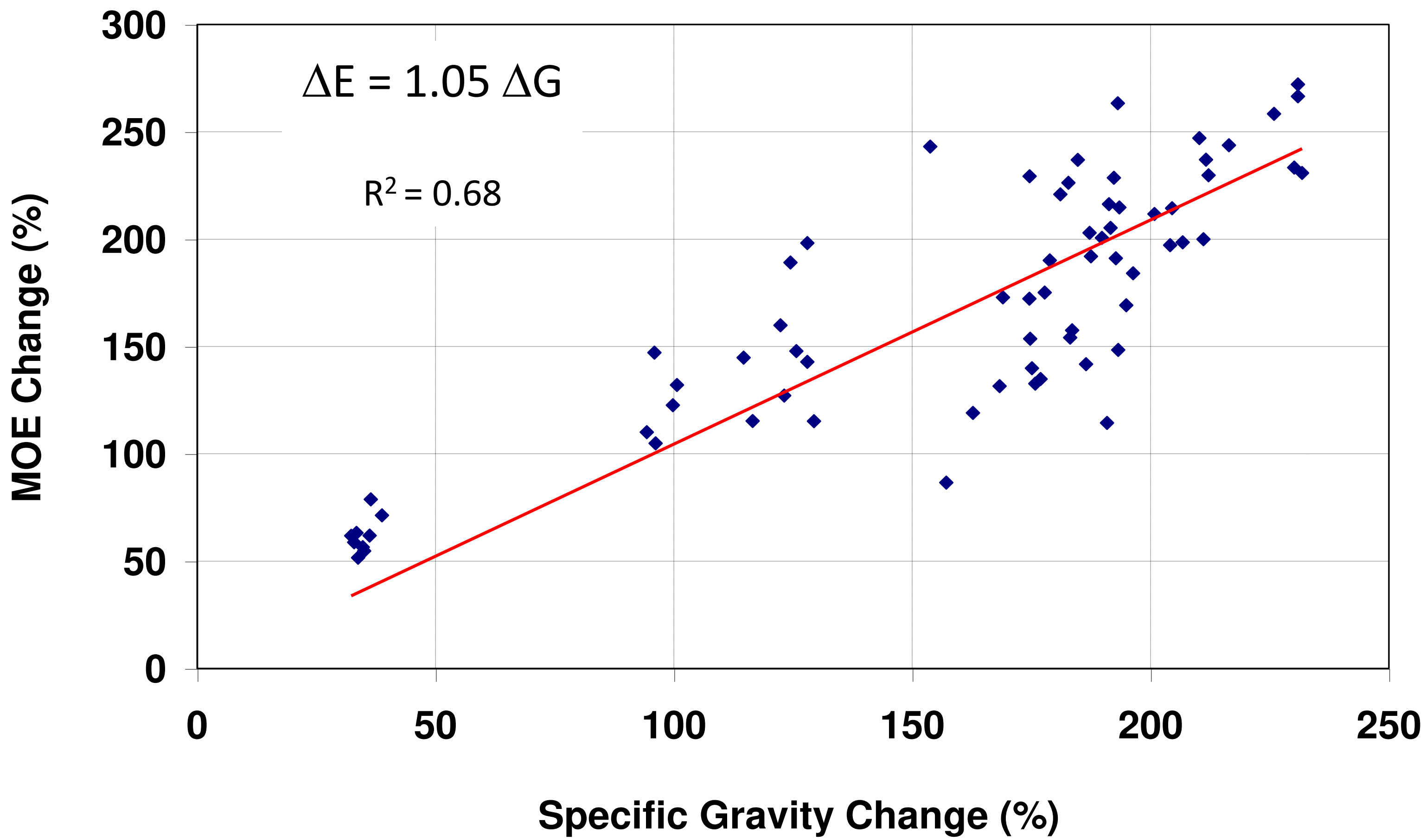
0.5 mm

Usually compression perpendicular to grain



THM Wood

If done properly, strength and stiffness increase in proportion to density



Outline

- Brief history of THM developments
- THM commercial products
- Challenges for THM commercialization
- Potential THM product applications
- Observations

Lignostone

Patent DE291945 (1915)

Fritz & Hermann Pfleumer

1919

Ludwig Roselius

Ter Apel, Netherlands

1924

Hermann Röchling

1935

Haren-Altenberge, Germany

www.lignostone.com

Staypak & Compreg

US Forest Products Laboratory
~1930 - 1960

Alfred Stamm

Ray Seborg

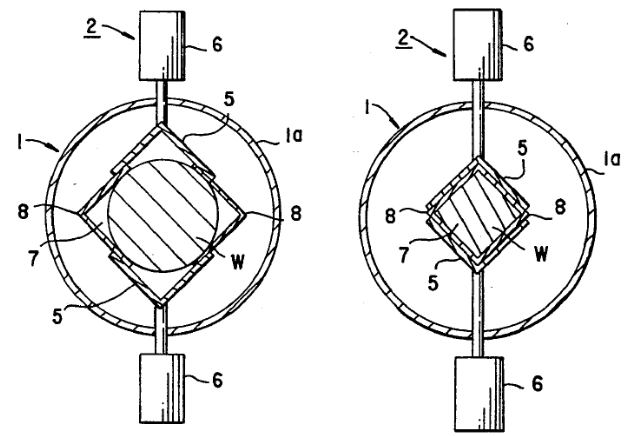
- Seborg, RM , Stamm AF. 1941. The Compression of Wood, Mech. Eng. 63(3):211-213.
- Stamm, AJ, Seborg, RM. 1944. Forest Products Laboratory Resin-Treated, Laminated, Compressed Wood (Compreg). Forest Prod. Lab. Rept. No. 1381.
- Stamm, AJ. 1936. US Patent 2060902

1943

1956 Australian Timber Handbook referred to these products as "Improved Wood".

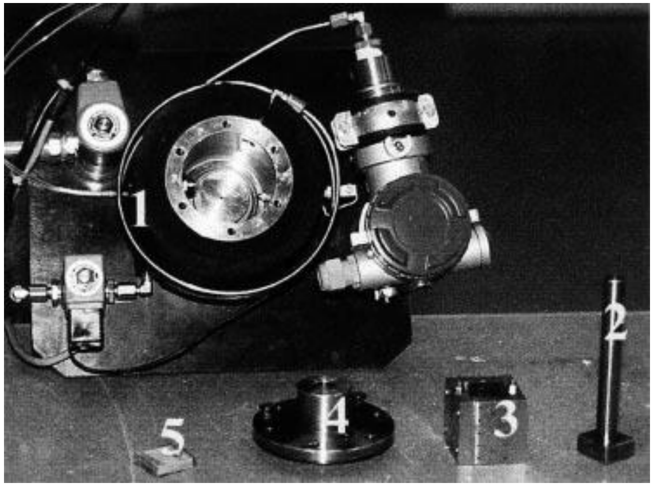
Japan (1990s)

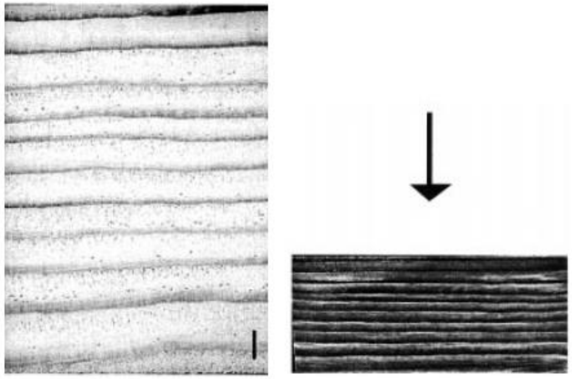
- Kyoto University & Gifu University
  - Inoue, M., Norimoto, M., Tanahashi, M., Ito, Y.M.
  - Tanahashi et al.1994. US Patent 5,343,913
  - Collaboration with Rowell (US FPL)
  - Dimensional stabilization with heat and steam treatments
  - Open & closed systems



Switzerland (1990s)

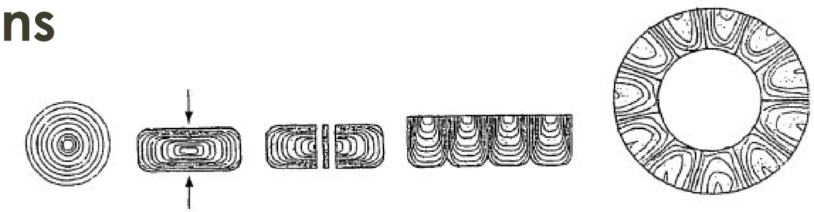
- Swiss Federal Institute of Technology
  - Navi, P., Girardet, F., Tomme, F-P.
  - Small scale, closed system
  - Dimensional stabilization with heat and steam treatments





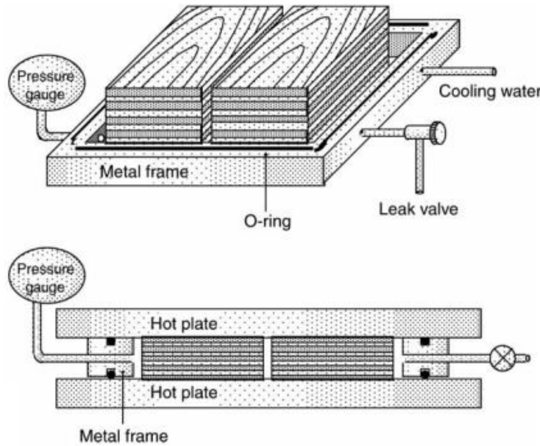
2000s

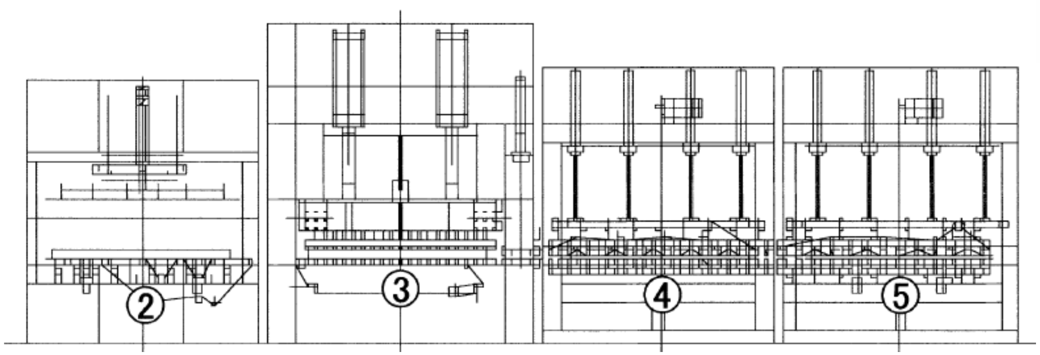
- Denmark - Morsing, N.
  - Used THM equipment at Kyoto University
- Sweden – Blomberg, J. Persson, B. , Sandberg, D., Nilsson, J. & others
  - Callignum process (isostatic)
- Canada – Fang, C-H. & others
  - Open system
- Switzerland – Navi, P., Heger, F. & others
  - Small scale, closed system
- Germany – Haller, P.
  - THM laminated columns



2000s

- Japan – Inoue, M., Kawai, S. and others
  - Collaboration with Rowell (USA) and Walinder (Sweden)
  - Veneer, closed system
  - High-frequency heating



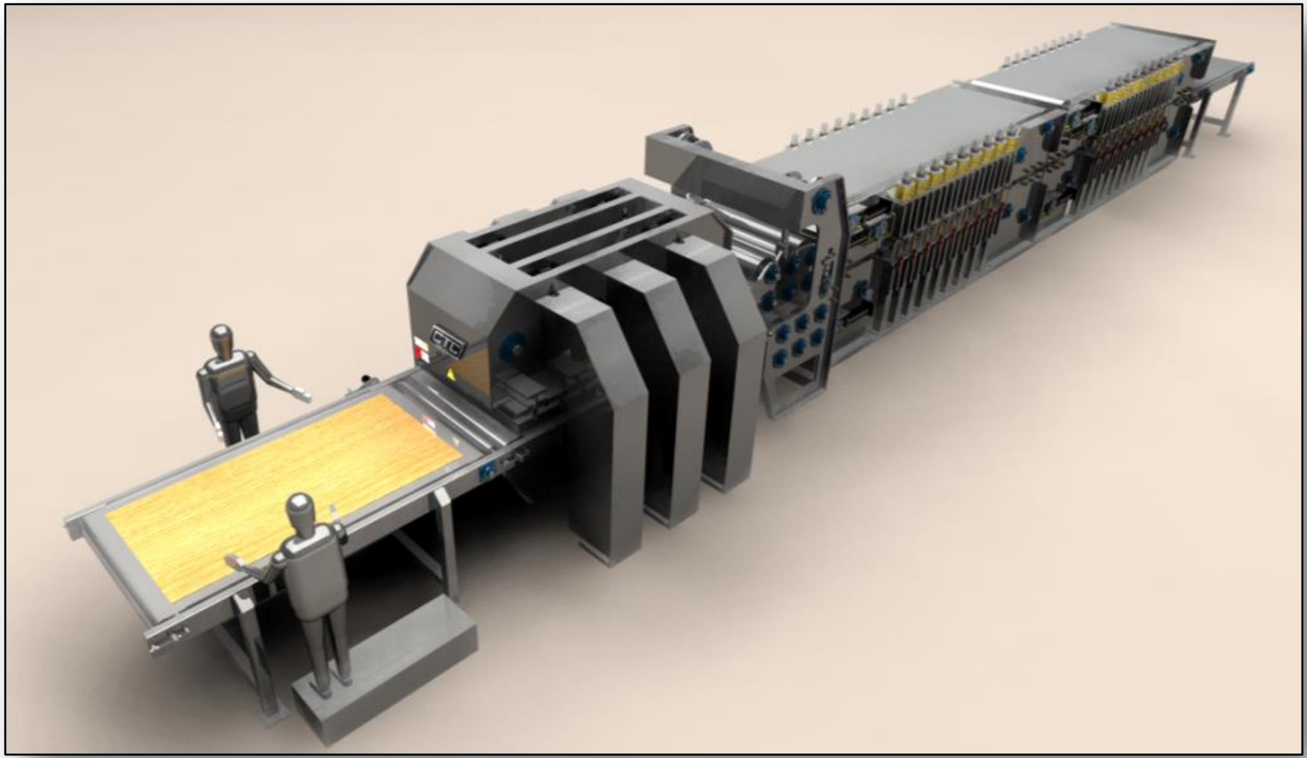


2000s

- USA – Kamke, F., Kutnar, A. and others
  - Closed system
  - Veneer and thin lamina
  - Engineered composites, rapid processing

2000s

- **USA – Kamke**
  - **Commercial scale continuous system**



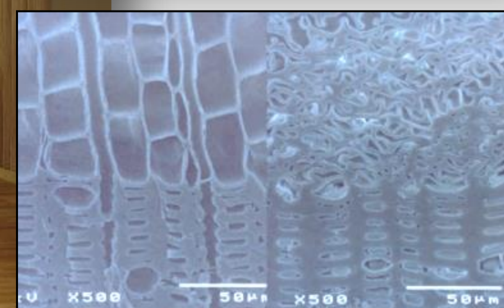
Examples of Commercial THM Products

- **Solid wood**
  - MyWood2 Corp., Iwakura, Aichi, Japan
- **Resin-impregnated & non-impregnated veneer composites**
  - Röchling, Harren, Gemany
  - Lignostone, Ter Apel, Netherlands
  - Deutsche Holzveredelung Schmeing, Kirchhundem/Würdinghausen, Germany
  - Several others

  (Röchling and Lignostone: Lignostone®)
- **Cold-bendable wood**
  - PureTimber, Gig Harbor, Washington, USA
  - Compwood Products, Szobor, Hungary

MyWood2 Corp.

THM Cedar with 50% compression



http://www.mywood2.co.jp

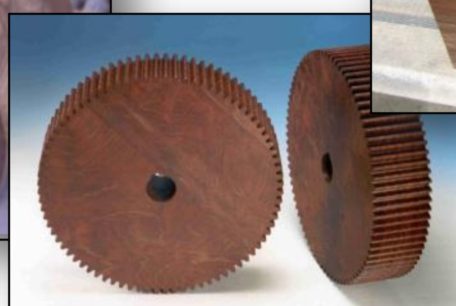
Deutsche Holzveredelung Schmeing GmbH & Co. KG

~ $4,200/m^3; €3,100/m^3

dehonit® - Permali® - Permawood® - Hydulignum® - Jabroc®


Beech veneer
Resin-impregnated or
Non-impregnated






PureTimber LLC (Gig Harbor, Washington USA)

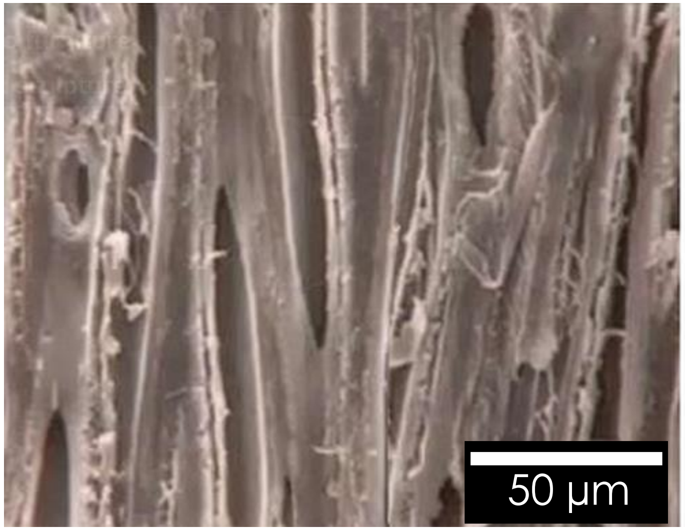
- THM with compression in longitudinal direction
- Cold bendable wood
- Ash, Red oak, White oak, Cherry, Maple, and 16 other species.
- Invented by Danish Technical Institute, Thomassen et al. 1991. US Patent 5,190,088

~$19,000/m^3; €14,000/m^3

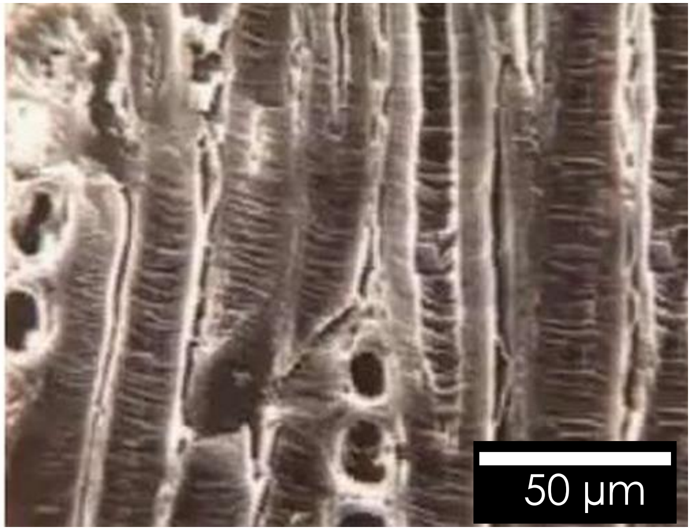
PURETIMBER LLC
THE EXTREME WOOD BENDING COMPANY

THM Products

- Cold Bendable Wood
  - Buckling of microfibril structure
  - After THM processing, must be bent when still wet (+25%)
  - Permanent reduction of stiffness in longitudinal direction



Before



After

Challenges

- Commercial Scale
- Loss of Volume
- Swelling Potential
- Profitability

Challenges

- Commercial Scale
  - Heat and mass transfer issues that are insignificant at laboratory scale may be technical barrier on large scale.
  - Low value application requires high volume capacity
    - Higher commercial risk
  - High value application
    - Low volume capacity may be adequate
    - Lower commercial risk

Challenges

- Loss of Volume
  - Most wood processing factories use the ratio of product volume to raw material volume as a measure of efficiency.
  - THM typically reduces volume by 50% in addition to other losses during production.
  - Product value must be very high, or alternative raw material must be very cheap.

Challenges

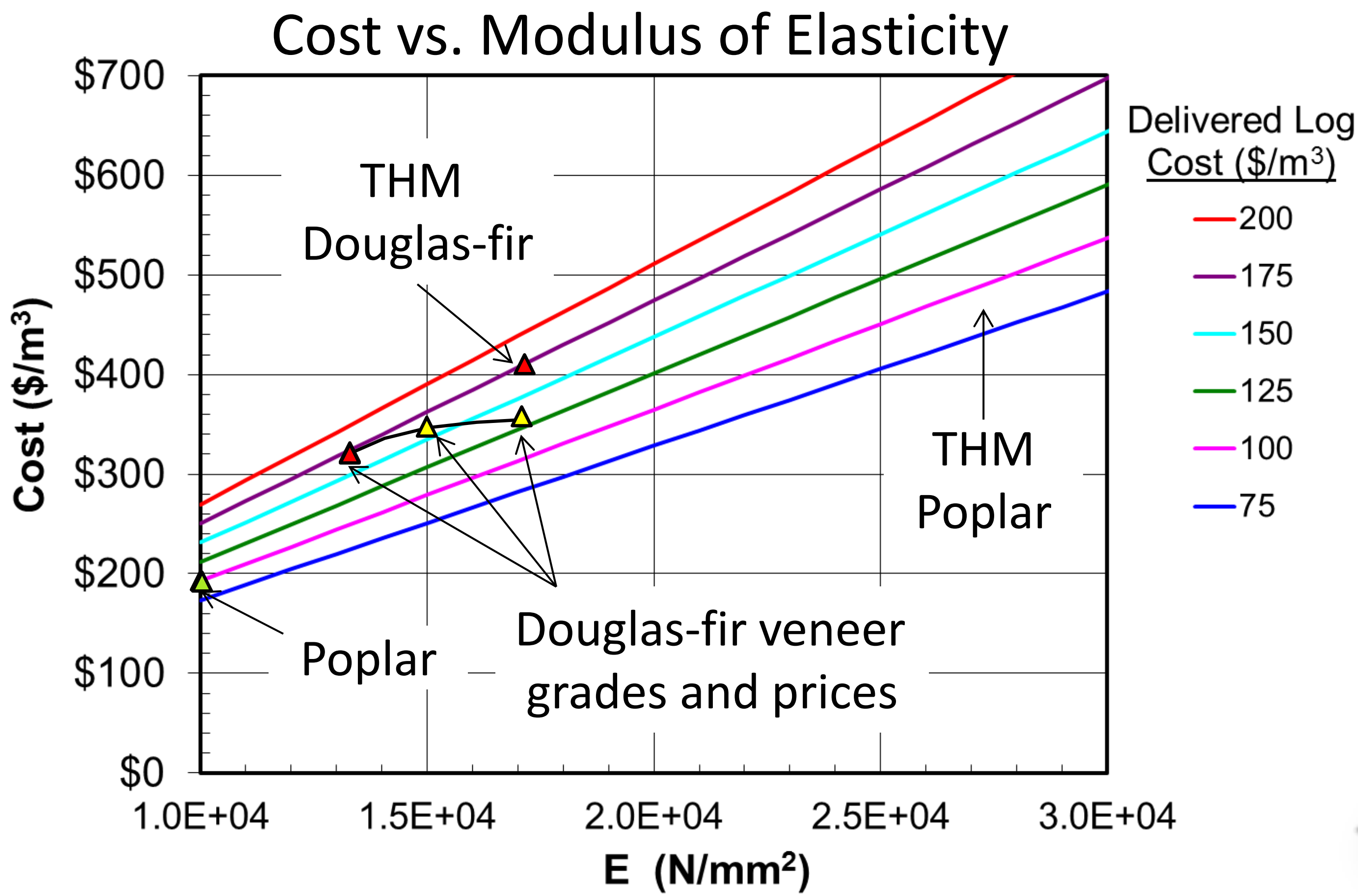
- Swelling Potential
  - Swelling of wood is proportional to density.
  - Heat and/or chemical treatment is needed to improve resistance to water.
  - Heat treatment or chemical treatment adds cost.
  - Chemical treatment has potential impact on environment and human health.
  - Find applications with low potential for exposure to water.

Challenges

- Profitability
  - The only absolute factor that must be achieved for a sustainable business enterprise.
  - Scientists should ignore profitability.
  - Investors and business managers always consider profitability.
  - Someone must fill the gap between scientific discovery and acceptance for commercial development.

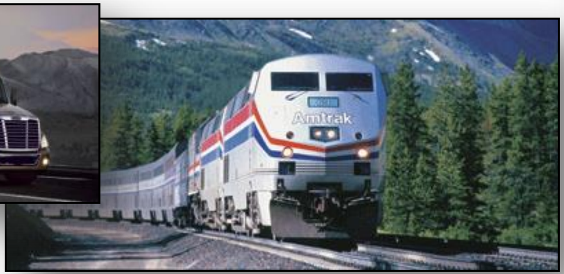
85 percent of technologies developed never see commercialization because they are lost in the so-called "Valley of Death" - the virtual chasm separating applied research from commercial development.

Example: THM poplar veneer cost comparison for use in structural laminated veneer lumber



Potential Applications

- Engineered flooring
- Building construction components
  - Engineered composites
  - Utilize low value wood in structural wood products
  - Replace steel in long spans & shallow beams
- Transportation vehicles
  - THM has good strength to weight ratio.
  - Bio-based products are desired even if cost is higher.



Morgan
Aero Coupe

Potential Applications

- Concrete forms
- Turbine blades for wind-powered generators

Thank you!

WBC
Wood-Based Composites Center

OSU
Oregon State
UNIVERSITY