

ADDA4001: MATERIALS AND MANUFACTURING

LECTURE 07: WOOD



Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

Swansea
College of Art
Founded 1853

Outline: Wood

- What makes woods invaluable?
- Softwood and Hardwood
- Examples
- Quiz
- Sustainability
- Future

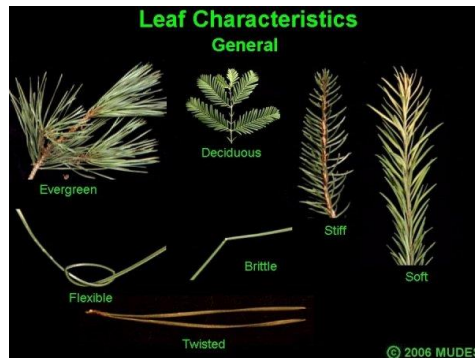
What makes woods invaluable?

1. Sustainable (reforestation projects)
2. Reusable
3. Relatively easy to grow
4. Easy to work with
5. Natural

Softwoods and Hardwoods

Softwood

- Gymnosperm trees which usually have needles and cones (Conifers)
- Generally Low Density
- Relatively inexpensive



Hardwood

- Angiosperm trees are usually broad-leaved.
- Generally high Density
- Relatively expensive



Softwoods and Hardwoods

Softwoods

Red Cedar
Pine
Douglas Fir
Poplar
Yew

Hardwoods

Oak
European Beech
Teak
Walnut
Birch
Ash
Balsa

Softwood - Pine

Key Features

- 390 – 690kg/m³
- Straight even grain
- Easy to work
- Finishes well
- Low shrinkage
- Low strength

- Grows relatively fast
30cm – 60cm/year
- 45m – 80m tall
- 15 – 20 years until ready for harvest



Advantages

- Easy to work
- Good dimensional stability
- Accepts finishes well
- Sustainable

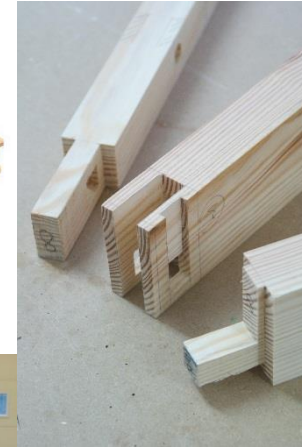
Disadvantages

- Not especially strong
- Dead knots can drop out of the wood



Applications - Pine

By-products
Resins
Tar
Turpentine



<https://inhabitat.com/the-oree-board-is-a-wireless-wooden-computer-keyboard-that-mixes-tradition-with-technology/>

Softwood – Douglas Fir

Key Features

- 530kg/m³
- High Stiffness
- High crushing strength
- High bending strength (with the grain)
- High Resin Content
- One of the biggest sources of plywood
- Growth rate – 60cm/year
- 60 – 90 meters high
- Relatively inexpensive

Advantages

- Fairly knot-free
- Easy to work
- High stiffness and bending strength
- Renewable

Disadvantages

- Prone to splitting if cut across the grain
- Requires more finishing than other timbers



Applications – Douglas Fir



Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

**Swansea
College of Art**
Founded 1853

*Trawsnewid Addysg; Trawsnewid Bywydau
Transforming Education; Transforming Lives*

Softwood – Yew

Key Features

- 670kg/m³
- Extremely hard
- Excellent elasticity
- High density
- Good stability
- Finishes well

- Growth rate: 20 - 40cm/year
- 10m – 20m in height
- Relatively expensive



Advantages

- Excellent strength and elasticity
- Good stability
- Very good steam bending
- Highly decorative

Disadvantages

- Difficult to work



Applications – Yew



Softwood – European Lime

Key Features

- 535kg/m³
- Soft and easy to carve
- Excellent resistance to splitting
- Easy to work
- Low stiffness
- Straight, uniform and fine grain

Advantages

- Easy to work, being particularly good for carving
- Glues and finishes well
- Straight, even grain
- Sustainable

- Growth rate: 20 - 40cm/year
- 20m – 40m in height
- Relatively inexpensive

Disadvantages

- It's softness can result in a fuzzy surface
- Poor steam bending



Application – European Lime



Hardwood - Oak

Key Properties

- 720kg/m³
- Course texture
- Straight grained
- Good workability
- Good finishing
- Rich grain
- Good water resistance

Advantages

- Extremely versatile
- Easy to work
- Strong and hard
- Finishes well
- Distinctive patterns

- Growth rate – 3.5 – 5cm/year
- 60 years to grow
- 30 - 40m high
- 3 meters diameter

Disadvantages

- Coarse Texture
- Some sustainability issues



Application - Oak



Hardwood – Rock Maple

Key Properties

- 720kg/m³
- High resistance to abrasion and wear
- Reasonable staining and finishing
- Fine and even nature
- Medium Density
- Steam bends extremely well
- Growth rate 30 – 60cm/year
- 15 years to fully grow
- ‘The timber of hardness and resilience’



Advantages

- Extremely hard and resilient
- High wear resistance
- Steam bends well
- Sustainable

Disadvantages

- Can cause allergies
- Susceptible to insect attack



Application – Rock Maple



Hardwood - Teak

Key Properties

- 630 – 720kg/cm³
- Good hardness
- Good steam bending
- Excellent dimensional stability in a wide range of temperatures
- Good resistance to chemicals
- Relatively brittle
- Fast growth rate – 4m/year
- Expensive
- 5x more expensive than Oak
- 100 years to mature
- 25 years harvested

Advantages

- Good hardness
- Steam bends well
- Good chemical resistance

Disadvantages

- Relatively brittle
- Sustainability issues in India and Indonesia (illegal logging)
- Does not accept finishes well



Application - Teak



Hardwood - Balsa

Key Properties

- 40kg/m³
 - Good shock and vibration absorption
 - Can be easily glued and cut
 - Poor steam bending
 - Extremely easy to work
- Growth rate – 2.7m/year
 - Fast growing
 - 6 – 10 years to grow

Advantages

- Very good strength-to-weight ratio
- Extremely buoyant
- Easy to work
- Good shock absorbency
- Sustainable

Disadvantages

- Poor steam bending
- Extremely porous so tends to soak up stain



Application - Balsa



Hardwood – European Ash

Key Properties

- 680kg/m³
- Distinct colouring – pale and creamy
- Outstanding flexibility and toughness-
- Straight grained
- Course texture
- Steam-bends well
- Growth Rate – 70cm/year
- Approx. 24m in height
- 16 – 60 years to grow full height
- Lasts 170 – 260 years



Advantages

- Very tough and flexible
- Easy to work
- Steam bends well
- Excellent shock absorbency
- Sustainable

Disadvantages

- Perishable and susceptible to insect attack
- Low stiffness



Application – European Ash



Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

Swansea
College of Art
Founded 1853

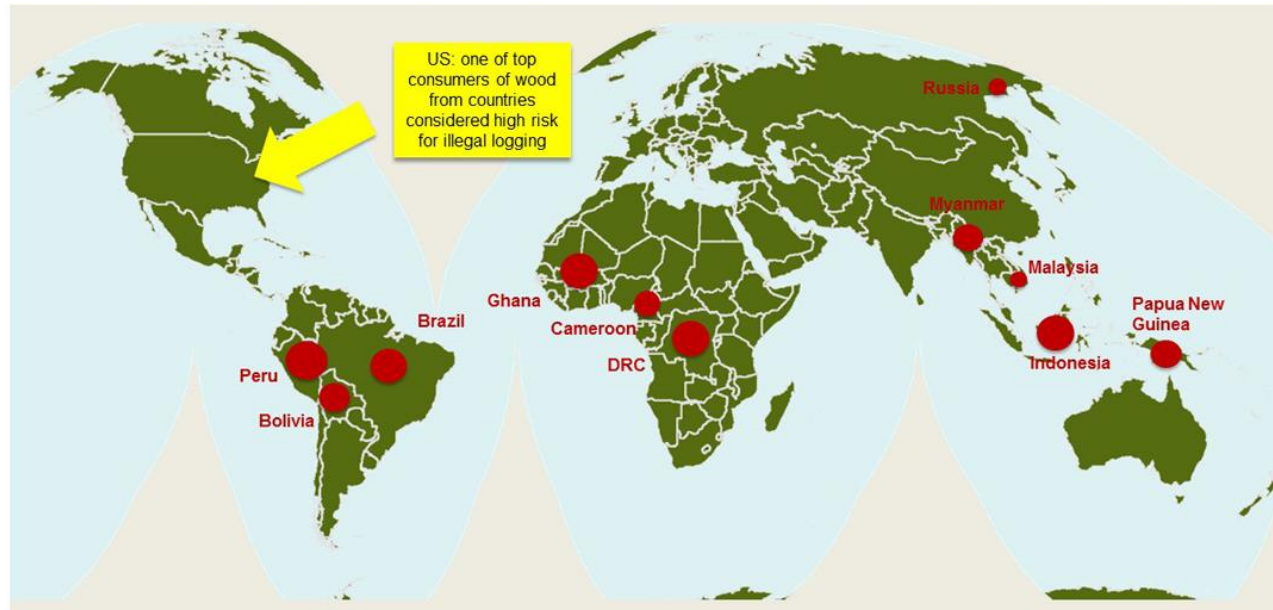
Trawsnewid Addysg; Trawsnewid Bywydau
Transforming Education; Transforming Lives

Sustainability Issues: Illegal Logging

Illegal Logging

- Brazil – 80%
- Indonesia – 73%
- Cameroon – 50%
- Malaysia – 35%
- 80% of ancient forests removed
- Deforestation for cattle ranches
- Climate Impact

Countries with higher rates of illegal logging.



WWF - http://wwf.panda.org/about_our_earth/deforestation/deforestation_causes/illegal_logging/
Illegal Logging - http://www.fern.org/sites/fern.org/files/media/documents/document_851_862.pdf

Sustainability Issues: Illegal Logging / Deforestation

- 60 million indigenous people affected
- 1.6 billion rely on forests for their livelihood
- £10 billion/year



<http://www.greenpeace.org/international/en/campaigns/forests/threats/illegal-logging/>

Sustainability Issues: Impact

- Forests cover approximately 30% of the earth
- 24% of greenhouse gas emissions caused by forestry and agriculture
- Biodiversity – 80% of land animals live in forests
- 4000 – 6000 species go extinct per year

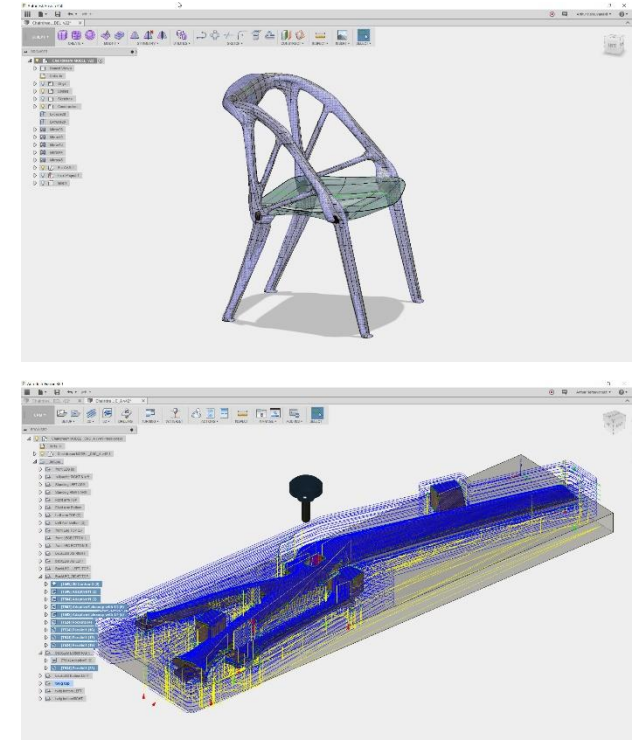


<https://www.nationalgeographic.com/environment/global-warming/deforestation/>

Interesting Uses - Maple Wood / Walnut - Orée



Interesting Uses – Generative Design



<https://www.youtube.com/watch?v=YeP8TT5POYE>

<https://gallery.autodesk.com/fusion360/projects/elbo-chair--generated-in-project-dreamcatcher-made-with-fusion-360>

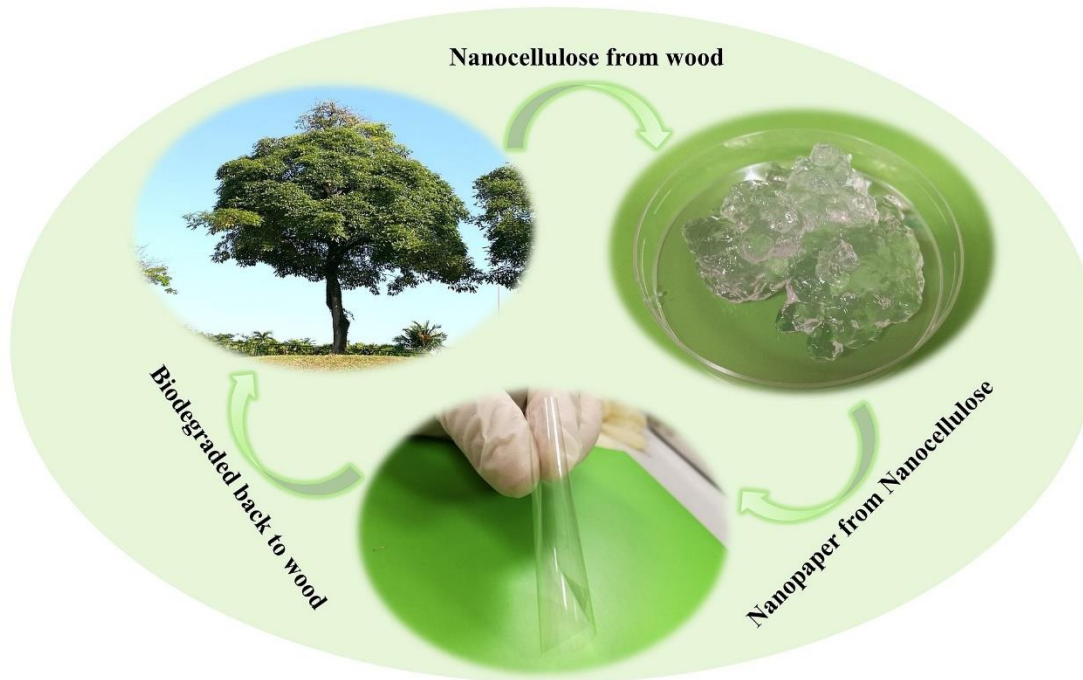


Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

**Swansea
College of Art**
Founded 1853

*Trawsnewid Addysg; Trawsnewid Bywydau
Transforming Education; Transforming Lives*

Interesting Uses – Nanocrystalline Cellulose (NCC)



<https://www.sciencedirect.com/science/article/pii/S0958166916000045#fig0015>

Sources

<http://www.wood-database.com/>



Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

Swansea
College of Art
Founded 1853

Trawsnewid Addysg; Trawsnewid Bywydau
Transforming Education; Transforming Lives