An introduction to papermaking fibres
What holds a sheet of paper together?

- Cellulose fibers, are the main component of the raw material “pulp”. The individual fibers are present in a network of fibres. This can easily be seen by looking at the torn edge of a piece of paper. The more softwood is used, the longer will be the prominent fibres at the torn edge of a sheet.
- Each cellulose fiber is bonded to its neighbouring fibers by thousands of relatively weak hydrogen bonds. Mechanical entanglement of the fibers makes only a small contribution to holding fibers together in a sheet.
- Textiles use similar fibres, but rely on entanglement.
Types of Pulp

- In the tree or plant, the papermaking fibers are embedded in a natural glue, lignin. To release these fibers, the raw material has to be broken down by a combination of:
  - Chemical action. The chemical combines with the lignin, makes it soluble, and thus removes the 'adhesive' holding the fibers together. Yields are low (<50%), purity is high
  - Mechanical action. Heat softens lignin at about 140°C (its glass transition temperature), thus allowing fibers to be separated with less fiber breakage. In practice, temperatures in the range 120-140°C (248-284°F) are employed. Yields are high (>50%), purity is low
Softwood or hardwood?

- **Hardwood provides:**
  - Printability
  - Bulk/Stiffness
  - Opacity
  - Dimensional stability

- **Softwood provides:**
  - Reinforcement/tensile
  - Wet runnability
  - Tear strength
  - Internal bond

Many paper grades don’t really need much dry mechanical strength, so they can be made without any softwood. Modern papermachines with closed draws, and good hardwood refining produce these grades “softwood free”.

These grade include many printing & writings, photocopier, etc.
Cross section of one annual ring
HW versus SW

- Softwoods are the more primitive plants
  - fibre is used for mechanical support and to conduct food (sap).
  - 90% fibres, 10% parenchyma cells
- Hardwoods are the more evolved plants
  - fibres only provide mechanical support, food is conducted by the vessels.
  - 65% fibres, 25% vessels, 10% parenchyma
**HW versus SW**

- Hardwoods can be denser, hence the name, i.e.
  - HW 0.3 - 0.7 g/cm²
  - SW 0.3 - 0.5 g/cm²

- Softwood fibres (tracheids) are long with relatively wide lumens.
  - 2.5 - 4 mm long, 16 - 35 mg/100m coarseness

- Hardwood fibres are short, and thick walled
  - 0.8 - 1.5 mm long, 9-15 mg/100m coarseness
Major Paper Grades

- **Newsprint:**
  mostly from mechanical pulps and recovered paper. May have a small level of filler

- **Uncoated mechanical:**
  suitable for graphical printing. Contains varying amounts of chemical pulp, but always more than 12% mechanical pulp - ie SC paper in TV guide

- **Coated mechanical:**
  suitable for high quality colour reproductions. Often 33% chemical softwood, 33% coatings/filler and 33% mechanical pulp - ie LWC for magazine covers
Major Paper Grades (cont’d)

- Printing and Writing paper:
  used for office purposes, photocopy papers etc. Uses mainly hardwood chemical pulp, strengthened with a little chemical softwood pulp. 30% of the sheet is often filler such as clay or calcium carbonate. Often contains recovered fibre, and may contain up to 10% of mechanical fibre.

- Coated Freesheet:
  similar furnish to P&W, but with more softwood. These papers are coated to provide the best surface for printing - ie glossy brochures
A dense, well bonded sheet (tape base)
Speciality creped papers - masking tapes
An unbonded, bulky sheet (tissue)

(Same magnification as tape base)
Liquid Filters  (SW fibre + diatomaceous earth)

Filter cross-section: Canfor
Electrical Capacitors
All the components of a cigarette use fibres

Wood fibre is sometimes even added to the tobacco!
Products from sap

- rubber
- radial tires
- hose pipes
- maple syrup
Products from bark

- cork
- drugs (i.e Taxol, aspirin)
- pharmaceutical products
- cosmetics
- shoe polish
- animal bedding
- garden mulch
- spill control agents
Products from wood

- wood alcohol
  - colognes
  - solvents
- wood sugars
  - baby foods
  - cereals
  - food flavourings
Products from cellulose

- rayon
- toothpaste
- viscosity modifiers in food
  (ketchup, ice cream, peanut butter)
- plastic products (safety helmets, tool handles)
- cling films
- plastic bags
- photographic papers/films
- sausage casings
- explosives
Products from lignosulphonates

- insecticides
- hair sprays
- laundry stain removers
- ceramics