WEEK 2 – THE ROMANS, CONSTRUCTION MACHINE & DESIGN AUTOMATION

WHAT IS A MACHINE?

→ Any device that helps you do work

→ Use machine to:

- Transform energy - Generator
- Transfer energy/Increase the magnitude of force - Hammer
- Change direction of force - Crane
- Increase the speed/distance of a force - Bicycle

WHAT IS A SIMPLE MACHINE?

→ The simplest mechanisms that use mechanical advantage to multiply force

→ 6 principles:

- Lever
- Inclined plane
- Block and tackle
- Wheel and axle
- Screw
- Gear

*Complex machines are combinations of 2 or more simple machines

1) LEVERS

→ 3 main classes

→ Elements:

- Weight/resistance, fulcrum, effort

→ Mechanical advantage = Weight ÷ Effort

→ FIRST CLASS

- Pliers
- Positive MA
- Effort < Motion

→ SECOND CLASS

- Nutcracker
- Positive MA
- Effort ≤ Motion

→ THIRD CLASS

- Tongs
- Fractional MA (Disadvantage)
- Effort > Motion

2) INCLINE PLANE

→ A flat surface that is higher on one end
→ Allows you to overcome a longer resistance, by applying a small force through a longer distance when raising the load
→ Mechanical advantage = Length of slope ÷ Height of inclined plane
→ The wedge (knife) is a special application of 2 inclined planes set base to base:
    - Mechanical advantage of WEDGE = Depth of penetration ÷ Distance between wedged surface

3) BLOCK AND TACKLE

→ A block/pulley is a grooved wheel that turns by the action of a rope in the groove
→ Blocks are either fixed or movable
→ Fixed pulley: No mechanical advantage
→ Movable pulley: Positive mechanical advantage
→ Block and tackle is a system of 2 or more pulleys with a rope or cable threaded between them, usually used to lift/pull heavy loads
→ Mechanical advantage = Number if parts of the rope that act on the load (Count the number of parts of rope going to and from the movable blocks)

4) WHEEL AND AXLE

→ A wheel attached to an axle so that these two parts rotate together in which a force is transferred from one to another
→ A hinge supports the rotation of the axle
→ Mechanical advantage = Ratio of radius of the wheel to radius of axle

5) SCREW

→ Inclined plane wound around a central cylinder
→ Converts rotational motion into linear motion
→ Mechanical advantage = Circumference of screw ÷ Pitch of screw
→ Highly used in wall systems, skyscrapers and glass facades (Cables used to stabilise)

6) GEAR

→ Rotating machine part having cut teeth, or cogs, which mesh with another toothed part to transmit torque
→ Can change direction of force, vary rotational speed and produce a mechanical advantage

CONSTRUCTION MACHINE

→ Innovation in construction
→ Construction of shells and gridshells (Dante Bini's patent)
→ Principle of hyperbolic paraboloids

INNOVATION IN CONSTRUCTION

→ Innovation is usually in design, not construction

→ Simplifying construction
→ Reduce cost
→ Reduce environmental impact

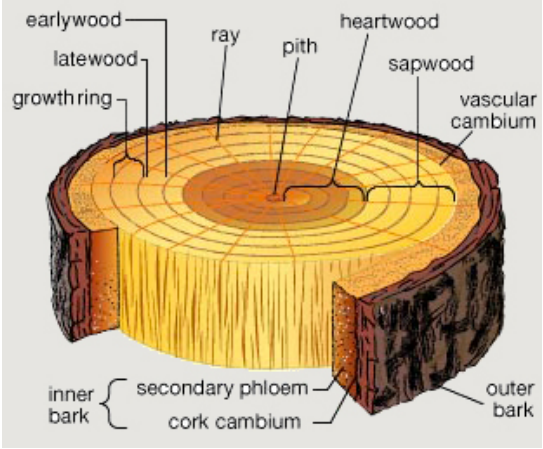
CONSTRUCTION OF SHELLS AND GRIDSHELLS
→ Bini's patent

DESIGN AUTOMATION
→ Additive/Subtractive manufacturing techniques
→ Parametric design

WEEK 3 – TIMBER

WOOD PROPERTIES

→ Timber for construction purposes are obtained by converting fallen tree trunks into geometrically elements
→ Inner part of log (heartwood) is most appropriate for timber
→ Outer part (sapwood) is too moist to be converted into timber



→ Hollow cellular microscopic structure of wood accounts for the light weight of timber
→ Grained surface of trunks created by different seasonal growth rates

TIMBER RESOURCES IN AUSTRALIA

→ Managed native forests (hardwoods)
    - <10% available + suitable for harvesting, only 1% harvested
→ Plantations (soft and hardwoods)
    - Normally only of 1 species
→ Imports
→ Timber takes time and space to grow to the size of millable logs:
    - Native forests: 60 – more than 100 years
    - Plantations: 30 – 50 years

SOFTWOOD AND HARDWOOD

SOFTWOOD	HARDWOOD
→ Structural purposes	→ Flooring and cladding
→ Less dense	→ Denser (Except for balsa)
→ One type of cell and appear more regular	→ Pores surrounded by support fibres
→ Coniferous	→ Broad-leaved
→ Eg. Pine	→ Eg. Oak

MANUFACTURING

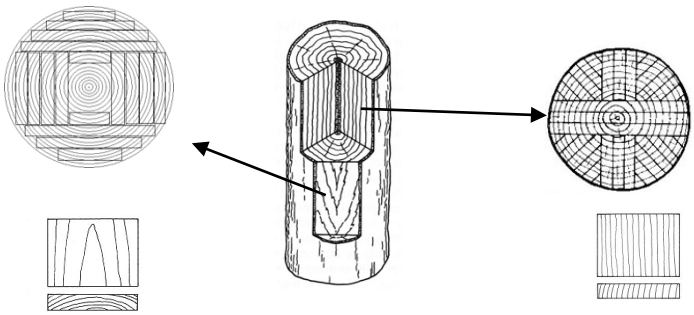
→ Process: GAHTTM (Get A Husband To Travel More)
    - Growth

- Assessment
- Harvesting
- Trimming
- Transport
- Milling

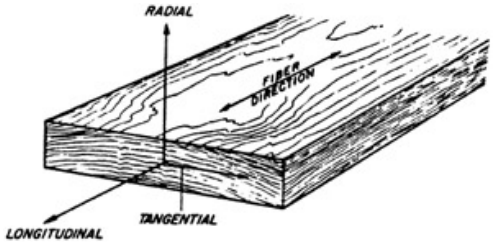
→ Timber conversion

- Sawing of logs into boards at timber mill
- Affects strength, durability and quality of the sawn properties
- Turning the log as sawing proceeds will result in cuts made in different planes and shapes are optimised to obtain timber with better strength while wastage is minimised
- Back-sawing VS Quarter-sawing

BACK-SAWING	QUARTER-SAWING
→ Structural purposes → Highly flexible method of construction → Higher recovery from log, less/no wastage → Simpler and faster to produce → Separation of sapwood and knotty areas is often more effective → Rapid seasoning with less shrinkage → Some softwoods reveal figure only with back saw → Less prone to splitting when nails are driven in	→ Cladding, flooring → Has aesthetic qualities, showcases grains → Many decorative hardwood reveal their rich figure with the interlocking grains only by quarter-sawing → Flooring and joinery timber often quarter-sawn to produce boards with 'edge-grain' that wears better → Dries more slowly but less prone to develop defects in season (Eg. Cupping and warping)



→ Timber grains



→ Seasoning

- Freshly cut timber has a high water content