Unit 4: Materials

Autor: Guillermo Gómez

Contents

Textos Marea Verde

Prior knowledge

Activity: Summarize your general knowledge on this topic.

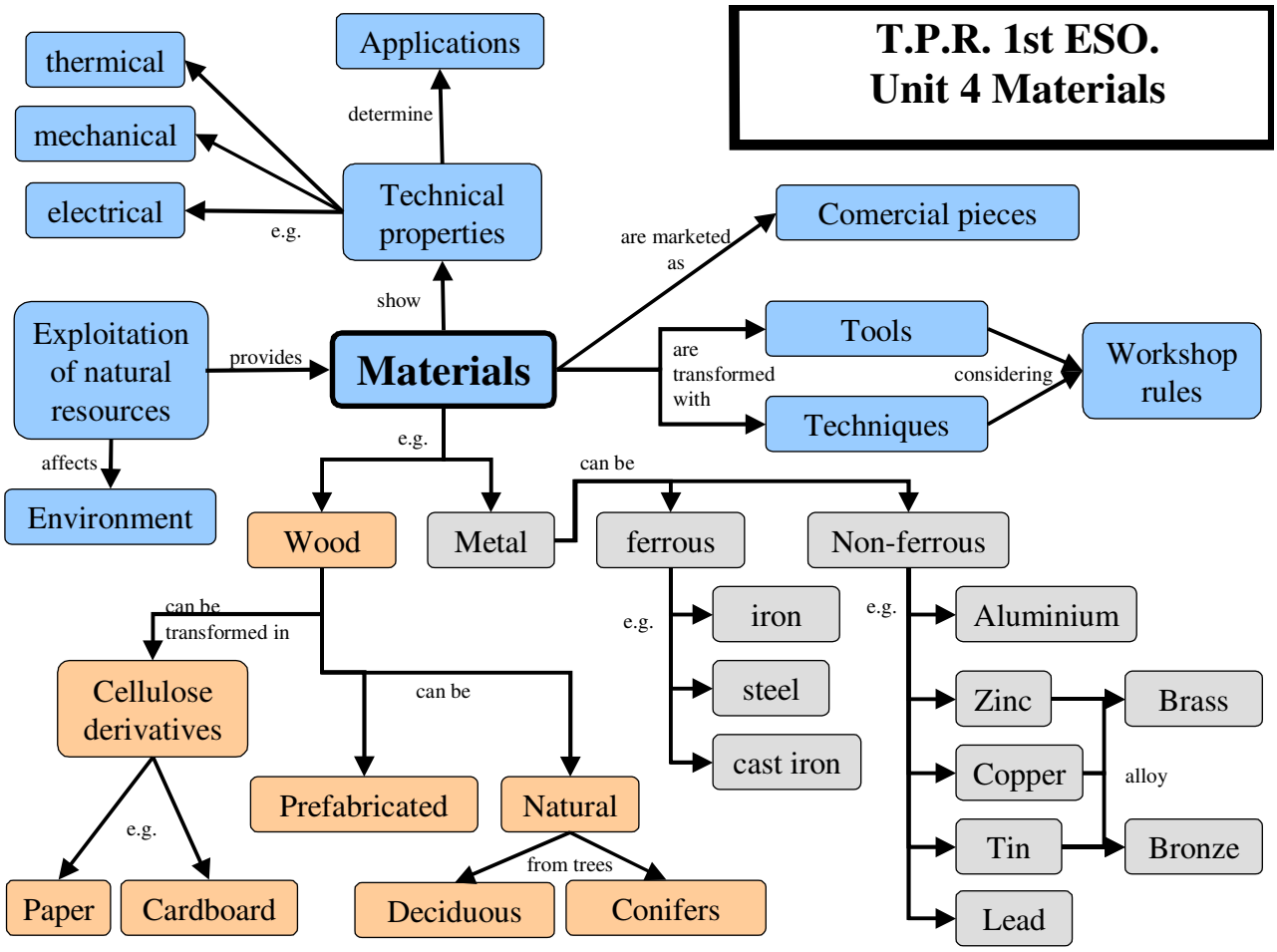
Keywords

Activity: Copy following keywords, explaining their meaning and translate them into Spanish.

material	board	blade	melt
ore	timber	steel	rustproof
quarry	bark	nail	layer
source	warp	screw	soldering
wire	humidity	bolt	
weld	deciduous	tighten	
strength	leftovers	pore	
raw material	bend	smooth	
trunk	mill	gangue	
grain	hardness	mining	

Mindmap of the unit

Activity: Analize and try to understand following mindmap



4.1. Classification of materials

Regarding their way of obtention, materials can be classified as:

Type of material	Origin	Observations	Examples
Natural	Renewable raw material (r.m.)	Vegetable	Cotton, wood, cork
		Animal	Wool, silk
	Not renewable r.m.	Mineral	Metal, marble, coal
Transformed	Natural materials	Simple[1] processes	Paper, prefabicated wood
Synthetic		Complex[2] processes	Plastic, synthetic textil

1: mainly physical; 2: mainly chemical

4.2. Properties of materials

The technical properties of the materials determine their application.

Type of properties	Examples
Electrical	Conductivity / insulation
Thermal	Conductivity, Expansion / Contraction, Fusibility
Mechanical	Strenght, hardness, elasticity, plasticity, malleability, ductility
Optical	Opaque / Translucent / Transparent
Ecological	Recyclable, toxic, biodegradable
Other	Density, Permeability, Magnetism, Acoustic conductivity, etc

Activity: Copy following exercises and solve them in your notebook

1) Fill in the table with following materials: wool, marble, cotton, clay, cork, sand, silk

Animal origin	Vegetable origin	Mineral origin

2) Which raw material do these materials come from? Glass, steel, plastic, porcelain, planks, concrete

3) Complete the table with the information of objects made of various materials

Object	Element	Material	Element	Material	Element	Material
Window	frame	wood	glass	glass	handle	plastic

4) Find out if following textile material are synthetic, transformed or natural: polyester, cotton, polyamide, wool, jute, nylon, rayon, silk, linen, cardboard

5) Which materials are electrical conductors or insulators? plastic, aluminium, wood, iron, copper.

6) Choose the correct option

a) If touching a material it becomes *cold / warm*, it's a thermal conductor.
b) *Metal / Wood* is the most sensitive to thermal expansion.
c) A characteristic of materials used for welding is *fusibility / conductivity*

7) Fill with *yes* or *no*

Object	Optical properties of the material		
	Transparent	Translucent	Opaque
Window			
Door			
Gook (potingue)			
Light bulb			

8) Write a list of five manufactured goods made with elastic materials.

9) Order from greater to lesser hardness: plastiline, glass, plaster, ceramics, diamond, talc

10) Can a hard material be brittle? Explain your answer with an example.

11) Fill the table with following words regarding waste products: newspaper, milk carton, potato peelings, paper bag, ice cream box, plastic bag, shampoo boottle, chicken pieces

Yellow container	**Blue container**	**Dark green container (Glass)**	**Light green container (Household)**

12) Complete the table with following materials according to their properties: marble, PVC, porcelain, aluminium, methacrylate, glass and wood.

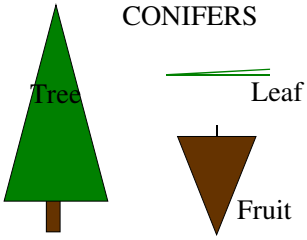
Properties	**Materials**
Electrical conductivity	
Thermal conductivity	
Acoustic conductivity	
Transparency	
Malleability	
Ductility	
Toughness	
Fragility	
Ecological	

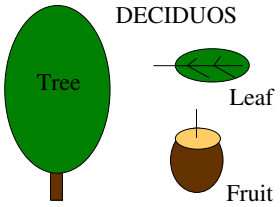
4.3. Wood

Wood is made of cellulose fibres.The most important properties of wood are, hardness, mechanical resistance, flexibility, electrical and thermal insulation, colour and grain and ecological properties.

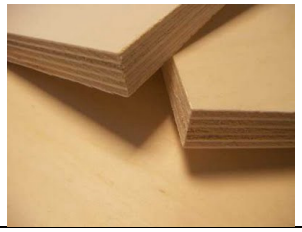
4.3.1. Classification

<table>
<tr><th>Type of wood</th><th>Remarks</th><th>Types</th><th>Examples</th></tr>
<tr><td rowspan="2">Natural Wood</td><td rowspan="2"> 
No transformation in the structure.

<u>Commercial pieces:</u>
• Plank (Tablón)
• Board (tablero)
• Strip (listón)</td><td>Softwood
• fast growth
• low resistance
• light colours
• cheap</td><td>CONIFERS
 

Conífers
Pine (pino)
Fir (abeto)</td></tr>
<tr><td><u>Hardwood</u>
• slow growth
• high resistance
• dark colours
• expensive</td><td>DECIDUOS
 

<u>Deciduos</u>
Beech (haya)
Oak (roble)
Cherry (cerezo)</td></tr>
<tr><td rowspan="2">Prefabricated</td><td rowspan="2">Transformation in the structure in order to improve properties and reduce cost (less waste material).

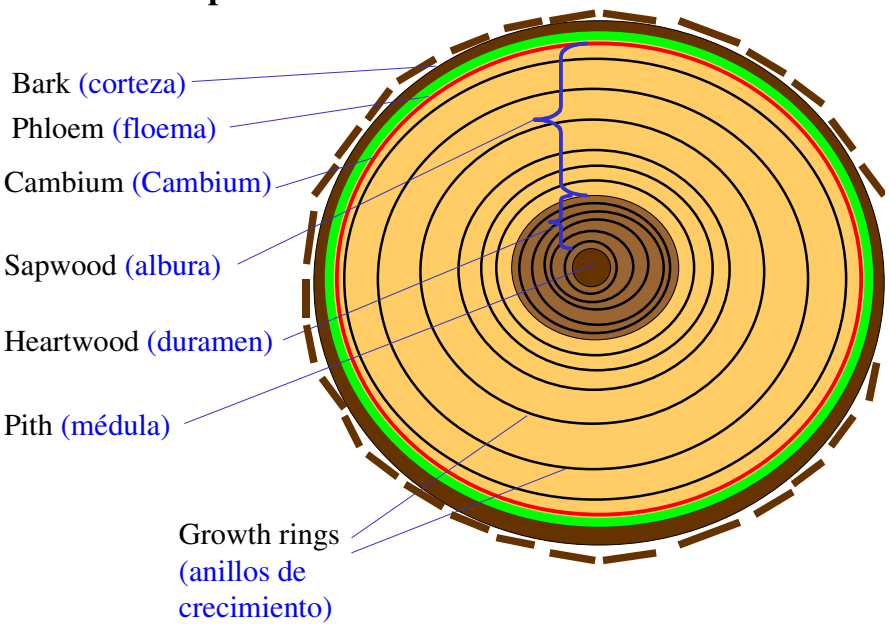
<u>Commercial pieces:</u>
• Panel (tablero)</td><td>Made from a mixture of shavings and synthetic glue, subjected to pressure and heat</td><td>Particleboard (aglomerado)
  </td></tr>
<tr><td>Formed by an odd number of wood plies, glued together with alternating grain direction.</td><td>Plywood (contrachapado)
  </td></tr>
<tr><td>Cellulose materials</td><td>Cellulose from wood</td><td>-</td><td>Paper, carton, Cardboard</td></tr>
<tr><td rowspan="2">Others</td><td>cork</td><td>From cork bark</td><td>-</td></tr>
<tr><td>Rubber</td><td>From sap of tropical trees</td><td>-</td></tr>
</table>

4.3.2. Constitution

The cambium is a layer of living cells that each year produces outwards a new ring of phloem (transport of sugars) and inwards a new ring of sapwood (transport of sap). The bark is formed by the rings of dead phloem of each year. The sapwood becomes after years into heartwood.

Activity: Make a sketch of a piece of trunk your teacher will give you and label the different parts.

Tree trunk parts



4.3.3. Process

The process consists in four steps (see image).

For the extraction of timber from the forest chainsaws are used.

Once at the sawmill, the logs are:

- washed (to extract fluid as tannins),
- sawn longitudinally with special saws in different ways and
- dried (naturally or artificially).

1.) Cutting and pruning

2.) Transport to the sawmill

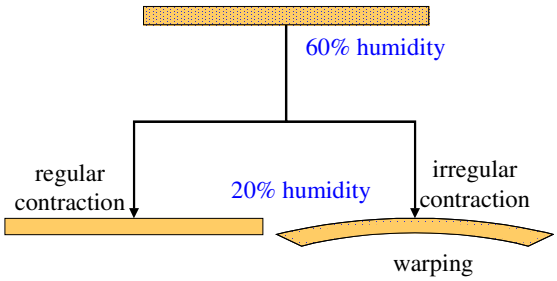
3.) Removing of bark and sawing in the sawmill

4.) Drying

During the drying humidity is reduced from 60% to less than 20% and the wood contracts. If this contraction is irregular the wood deforms (warping = alabeo) , which is considered a defect.

Wood defects can also appear during the growing period: knots, wounds and fissures.

Warping of wood during drying



Autor: Guillermo Gómez

Activity: Watch the videos about how to get plywood, timber, furniture and paper. Summarize each of them in your notebook, identifying the different steps of the process.
Plywood (spanish video) https://www.youtube.com/watch?v=9vsAXiM1Bxw
Natural wood (english video) https://www.youtube.com/watch?v=SwxinbpQ9B4
Particle wood (english video) https://www.youtube.com/watch?v=GBrgZihZhjs
Paper https://www.youtube.com/watch?v=fZ3HQ9lBHuA

Currently logging is based on sustainability, that means, that logging cannot exceed the production of wood from the forest.

We need to care for forests because of their three major functions:

1) Utility (oxygen, climate, wood, work ...)
2) Protection (fauna, flora, water, air, noise, erosion ...)
3) Relax and recovery (walking, hiking, watching, sports ...)

Activity: Copy following exercises and solve them in your notebook

13) True or false?
a) Wood is denser than water,
b) Wood provides good thermal insulation,
c) Wood is used to conduct electricity

14) Choose the correct option:
a) When wood is not correctly dried, it may *warp / die*
b) *Spaces / piles* are needed between the pieces of wood to help air circulate
c) Artificial drying takes place *outside/inside*
d) Natural drying of wood can be very *fast / slow*

15) Choose the correct option:
a) Hardwoods grow more *quickly / slowly* than softwoods
b) Hardwoods have *more / less* resin than softwoods
c) Hardwoods are *more / less* resistant than softwoods

16) Complete using the words: plywood, fibreboard, sheets, fibres.
a) _____is made of _____ of wood that are glued together and compressed
b) _____is made of wood _____ that are compressed and joined using a synthetic resin.

17) Complete the table with the information of objects made of wood

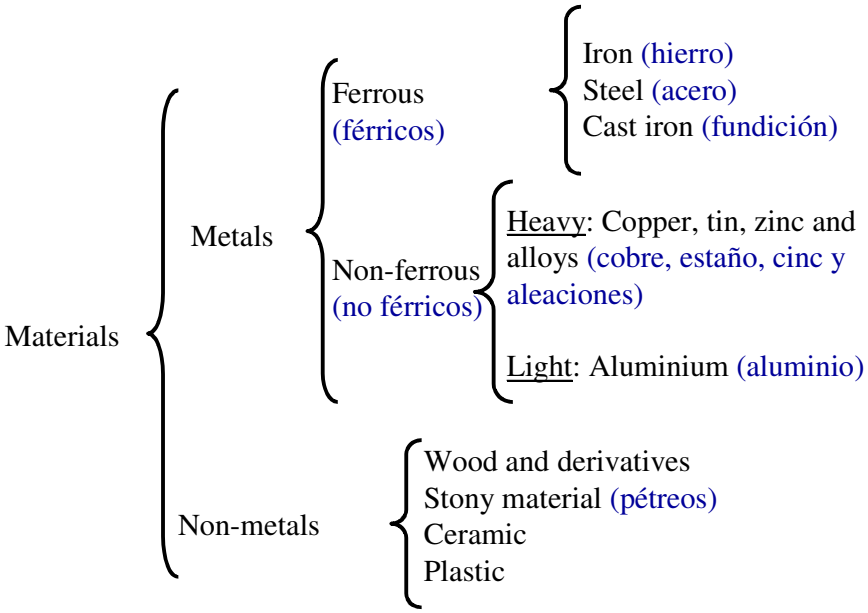
Object	Draft (label the different parts)	Type of wood	Reasons why it is made of wood.	Alternative material to wood
1				
2				
3				
4				

4.4. Metals

Metals are extremely important in industry due to their mechanical resistance and conductivity. Other characteristic properties of metals are: metallic sheen, hardness, density, tenacity (opposite of fragility), malleability (transforms into sheets if pressured), ductility (transforms into strands if streched) and fusibility.

4.4.1. Classification

An other way to classify materials is following (compare with 4.1):



4.4.2. Ferrous metals

Ferrous metals are those whose main component is iron. Iron is an abundant metal (5% of the earth's crust is iron ore), but pure iron has few industrial applications. As an alloy (mixture of two chemical elements, being the main one a metal) it is the most used metal.

Type	% carbon
Pure Iron	< 0,03
Steel	0,03 -1,8
Cast iron	1,8 - 6,8

Iron alloys are created by adding carbon, which improves very much the properties (hardness, resistance, easier to melt). There are three types (see image).

Steel is used to manufacture wire, sheets, beams, screws, etc. Steel's properties can be improved by adding other elements (i.e. Chrome to make it rustproof).

Cast iron is more resistant to corrosion and are used to obtain pieces through moulds into which the molten metal is poured (e.g. sewerage).

PROCESS FOR OBTAINING STEEL AND CAST IRON

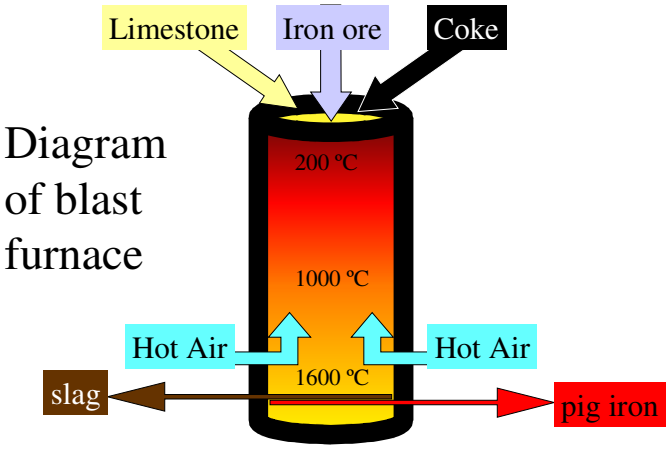
1) Mining: Metals are extracted from natural accumulations (deposit), through surface mining (a cielo abierto) or underground mining, with explosives and heavy machinery.

2) Separation: The useful mineral (ore) has to be separated from the useless material (gangue).

3) Blast furnaces (altos hornos): The iron ore is introduced into the blast furnaces together with coke (coal - fuel) and limestone (caliza - fundente) in order to be smelted (1600 ºC). The smelted iron (pig iron = arrabio) is denser and separates from the impurities (slag = escoria).

4) Refinery furnaces: Carbon and other elements are added and homogeneously mixed.

5) Obtention of commercial pieces.



Activity: Watch the videos about the steel obtention process. Summarize each of them in your notebook, identifying the different steps of the process.
Blast furnace (english video) https://www.youtube.com/watch?v=8s8rcnxqLIw
Steel obtention process (english v.) https://www.youtube.com/watch?v=9l7JqonyoKA

4.4.3. Non-ferrous metals

Non-ferrous metals are classified by density (see 4.4.1.).

Material	Properties	Uses
COPPER	✓ brownish-red metal ✓ ductil, malleable ✓ very good conductor ✓ resistant to corrosion	Electrical wire, telephone lines, pipes, radators, etc.
BRASS (LATÓN) (COPPER and ZINC alloy)	✓ attractive yellow ✓ easy to mold ✓ good conductor ✓ resistant to corrosion	Handicrafts, imitation jewellery, taps, handles and hinges, screws, etc.
BRONZE (BRONCE) (COPPER and TIN alloy)	✓ attractive appearence ✓ easy to mold. ✓ wear and tear resistant ✓ resistant to corrosion	Boat propellers, church bells, sculptures, taps, etc.
ALUMINIUM	✓ silvery white ✓ very light ✓ ductil and malleable ✓ good conductor	Planes, cars, bicycles, power lines, kitchen tools, kitchen foil, cans, etc.
OTHER METALS	Lead (plomo), zinc, tin, are mainly used as alloy materials	
	Gold, silver and platinum are used in jewellery because of its attractive appearance which remains unaltered.	

Activities: Copy following exercises and solve them in your notebook

18) Match the properties of metals to their definitions

elastic	can be made into thin wires
fusible	can be melted to join with other pieces of metal
oxidation	bends and then returns to its original shape
ductile	reacts with oxygen and corrodes

19) What are the similarities and differences between underground mining and surface mining?

20) Indicate the property which is important when manufacturing following objects

Object	Important property
anvil (yunque)	
electrical wire	
metal bridge	
water pipes	

21) Complete the sentence:

Metal such as ____ that have high thermal conductivity are useful because we can make _____ with them.

22) Choose the correct option.

- ✓ Cast iron is *hard / soft*.
- ✓ Ferrous materials are *inexpensive / expensive* to extract, but they need processing to extract the iron.
- ✓ *Non-ferrous metals / alloys* are a mixture of two or more chemical elements.
- ✓ Steel is a mixture of iron and *carbon / tin*.

23) What are the differences between bronze and brass. Name two objects made of each alloy.

24) Match the object with the material it is made of.

electric wire	steel
plane	rustproof steel
sewerage	cast iron
frying pan	aluminium
car	copper
sculpture	brass
handle	bronze
ring	gold

25) Complete the table with samples of metals and their information

Metal collection: Uses and properties			
Metal	**Sample**	**Use**	**Properties**
1	Fix here a sample of the metal		
2	Fix here a sample of the metal		
3	Fix here a sample of the metal		
4	Fix here a sample of the metal		
5	Fix here a sample of the metal		

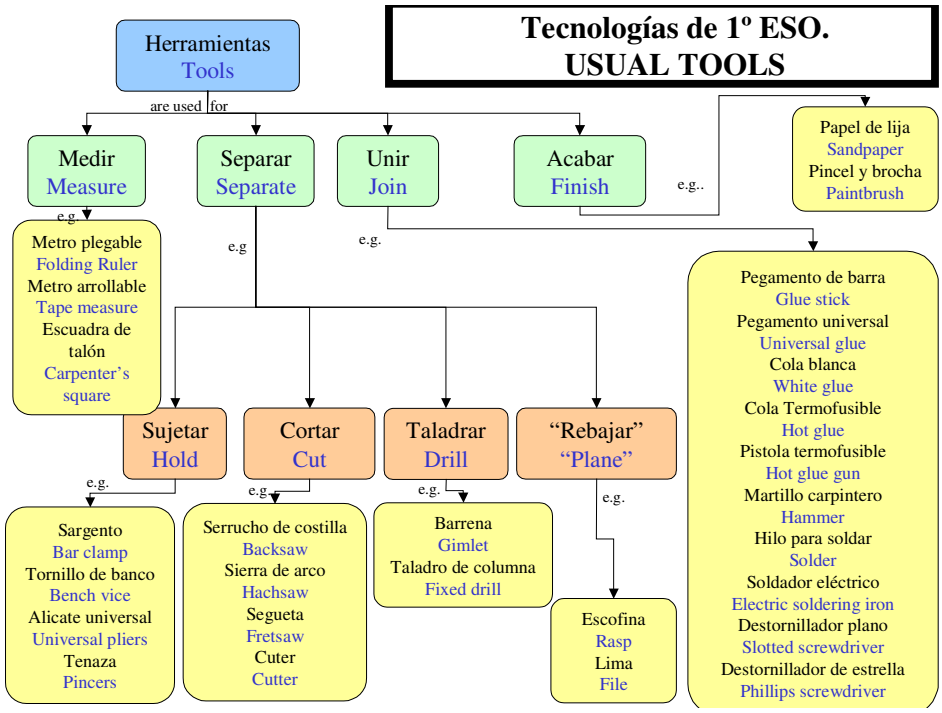
4.5. Techniques and tools

To make an object we use different tools (see image) following these steps:

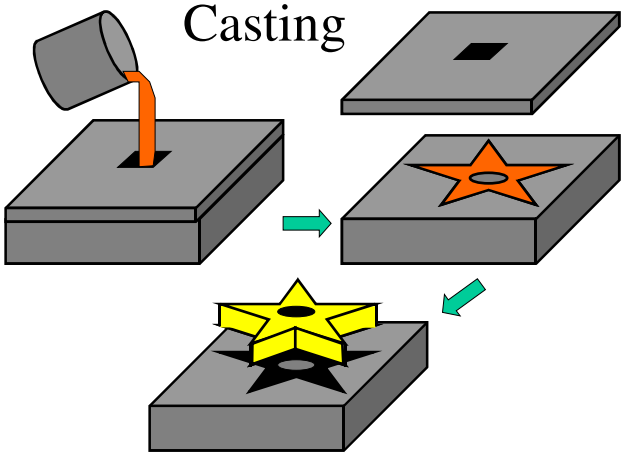
1. Measure and mark
2. Separate (hold, cut, drill, plane)
3. Join
4. Finish

Pieces can be joined with nails, screws, bolts and nuts, rivets (remaches), glue, hinges, etc..

Metal can also be joined by welding or soldering.



Activity: Practise in the workshop the different techniques used with each tool; e.g. building an wooden calendar or a Soma cube (see projects).

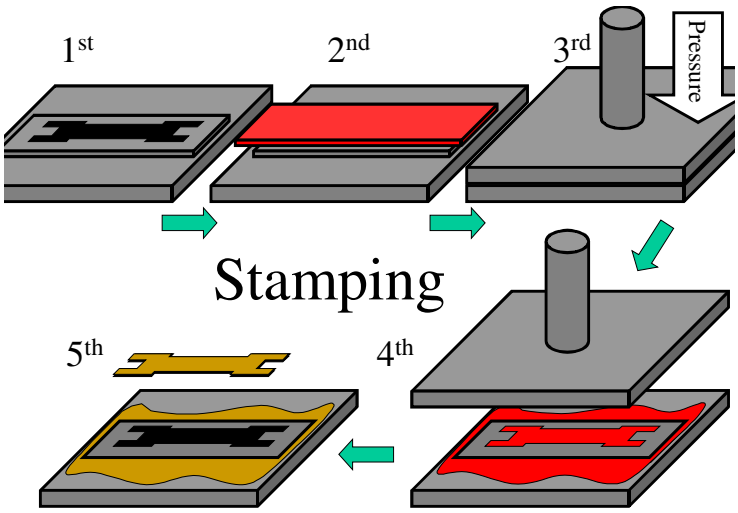


<u>Specific techniques for metals</u>

FORGING (forja; ancient technique):
1st Heating of the metal until red hot.
2nd Beating until desired deformation

CASTING (moldeo; for complicated shapes):
1st Pouring of melted metal into the mold
2nd Extraction of the piece after solidification

STAMPING:
1st Pressing of laminated sheets (red hot) with moulds (stamps)
2nd Extraction



Activity: Watch the videos about techniques used in different processes. Summarize each of them in your notebook, identifying the different steps followed.
Axe making and lodge construction (english video) https://www.youtube.com/watch?v=dbCpDsxUHVc
Bronze sculptures (spanish video) http://www.youtube.com/watch?v=rIaUOBqcACA
Aluminium foil (spanish video) http://www.youtube.com/watch?v=VaUqeDFfAcs

Activities: Copy following exercises and solve them in your notebook

26) Find the most economical way to cut a wood board of 30 cm x 30 cm into following shapes (draw them; scale = 1: 2).
- ✓ one circle (5 cm radius)
- ✓ one square (10 cm x 10 cm),
- ✓ three isosceles square triangles: two of (10 cm x 10 cm) + one of (8 cm x 8 cm)
- ✓ one rectangle (24 cm x 6 cm)

27) Look on internet the spanish translation and draw following objects explaining what for are they used.

Object	Translation	Rough draft	Use
Awl			To make a small mark in a piece of wood
Gimlet			
Chisel			

28) Complete following table

Task you want to do	Type of saw
To cut a wooden puzzle	
To cut a branch off a tree	

29) Match the tools with the correct definition

Chisel (cincel / escoplo)	A tool to make grooves in wood
Drill bits (brocas)	A tool to make wood smooth
Plane (cepillo de carpintero)	Cilindrical pieces of metal used with a drill

30)Fill in the table with: plane, file, pliers, spanner (llave), sandpaper, screwdriver

Planning / Sanding	
Tightening	

31) Fill in following table

Situation	Tool you should use
The srew in the door has come out	
I put a nail in the wrong place in the wall	
The corner of the table is cracked (astillada)	

32) Fill in the table with following words: metal cutters (tijeras de chapa), guillotine, punch press (prensa troqueladora), drill, hacksaw

Task	Tool you should use
To cut a curve in thin sheet metal	
To cut large sheets of metal	
To cut out small metal shapes in very thin metal sheets	
To cut a metal bar	
To make holes in metal	

33) Complete the sentences with following words: hard, lengths, grooves, soft, diameters, cylindrical.

Drill bits have_____ and are _____.
They are _____ or _____ depending on the material we want to drill.
They are made of different materials and can be different_____ and _____.

34) Draw following objects: nut, bolt, screw, nail.

35) Fill in the following table.

Object	Type of joint used
Metal box	
Metal glasses frames	
Tap (grifo)	

36) Why should metal objects be painted or varnished?

37) Order the sentences to explain the casting process:

a) The liquid metal is poured into the mould
b) The solidified piece is extracted from the mould
c) The metal is heated to melting point
d) The mould and metal are left to cool until the metal has solidified