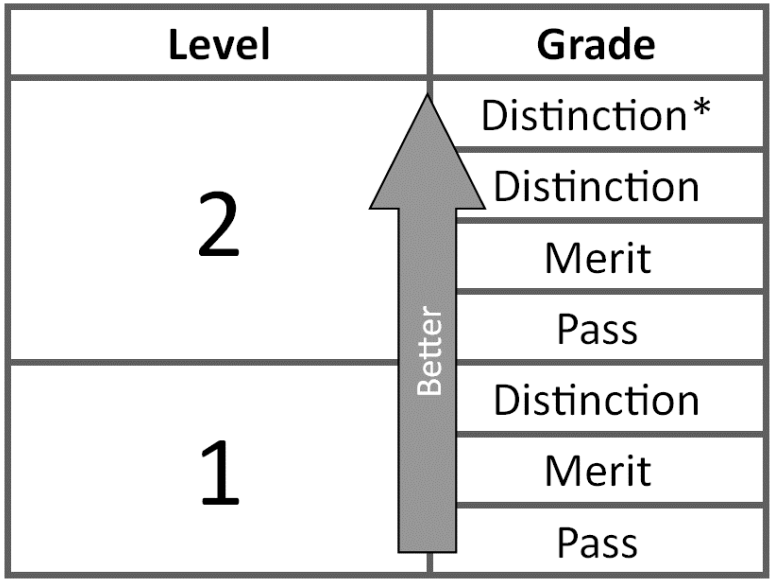
OCR Engineering Design J822
Course overview

Unit	Contribution to final grade
R038 Exam	40%
R039 Coursework	30%
R040 Coursework	30%

Grade scale



Updated Summer ‘23

Contents

Unit R038:

Principles of engineering design

Examined.

Worth 40% of your final grade.

R038 Topic Area 1:

Designing processes

Unit R038 Principles of engineering design.

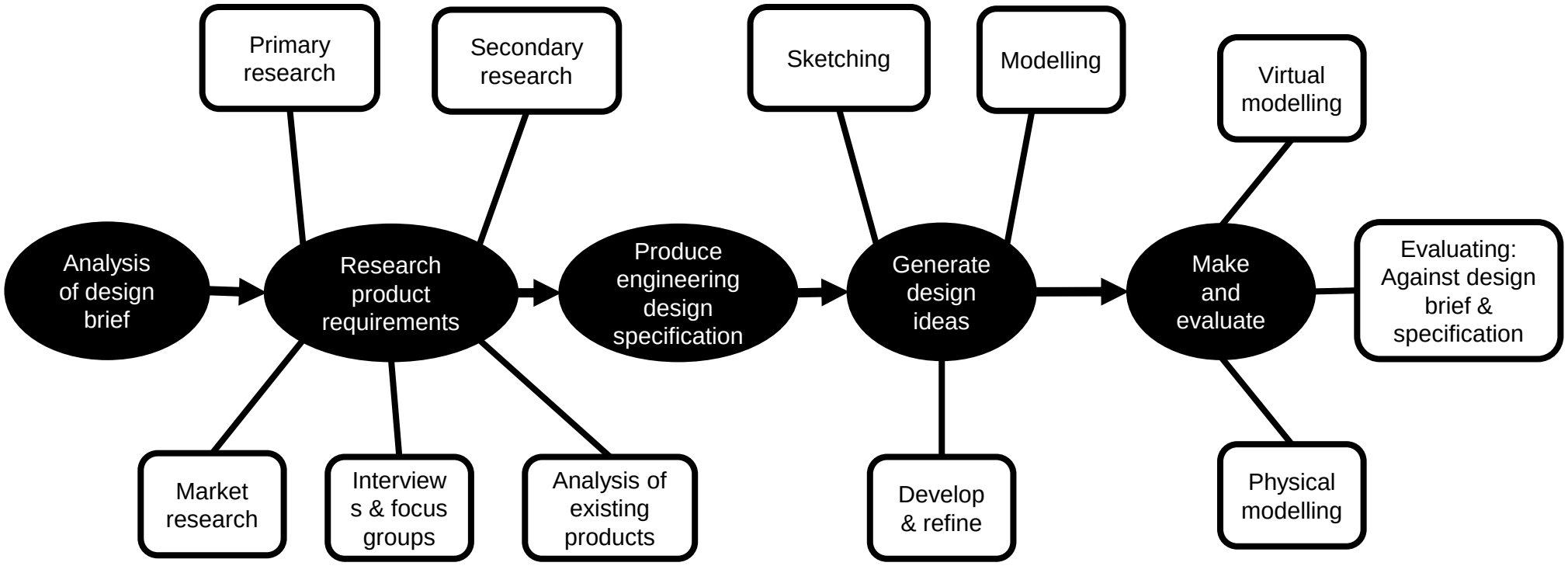
TA1.1 The stages involved in design strategies

These strategies can often be used in combination:

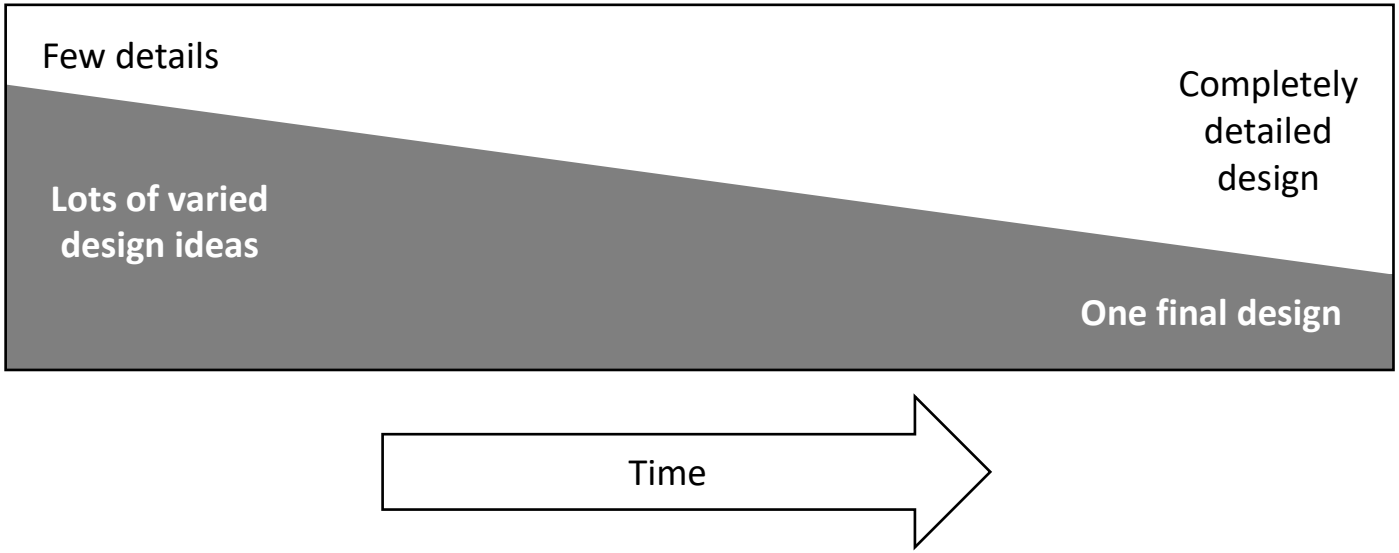
Linear design	One stage leads to another resulting in a final product.
Iterative design	A prototype is made quickly; then the design is evaluated, improved and another prototype made. This continues until all design issues are resolved.
Inclusive design	Creating designs that can be used by everyone.
User-centred design	Design based on the needs of the user.
Sustainable design	Design centred on sustainability.
Ergonomic design	Design for comfort and ease of use.

TA1.2 Stages of the iterative design process

Iterative design means testing each version of a design and using that information to help make an improved version.



How Designs Are Developed



TA1.2.1 Design (Research Techniques)

Things you need to know:

Primary or secondary research?

You should show that you can use both approaches in your work.

Choose methods based on the information you want to find out.

Secondary research must be referenced; you need to show where you got the information. Failure to do this may be cheating.

Types of Data

Quantitative data is measurements. E.g. the amount of memory in a phone or the capacity of a battery.

Qualitative data is opinions, impressions and points of view. E.g. how comfortable a handle is or how attractive a bath tap is.

Sample Size

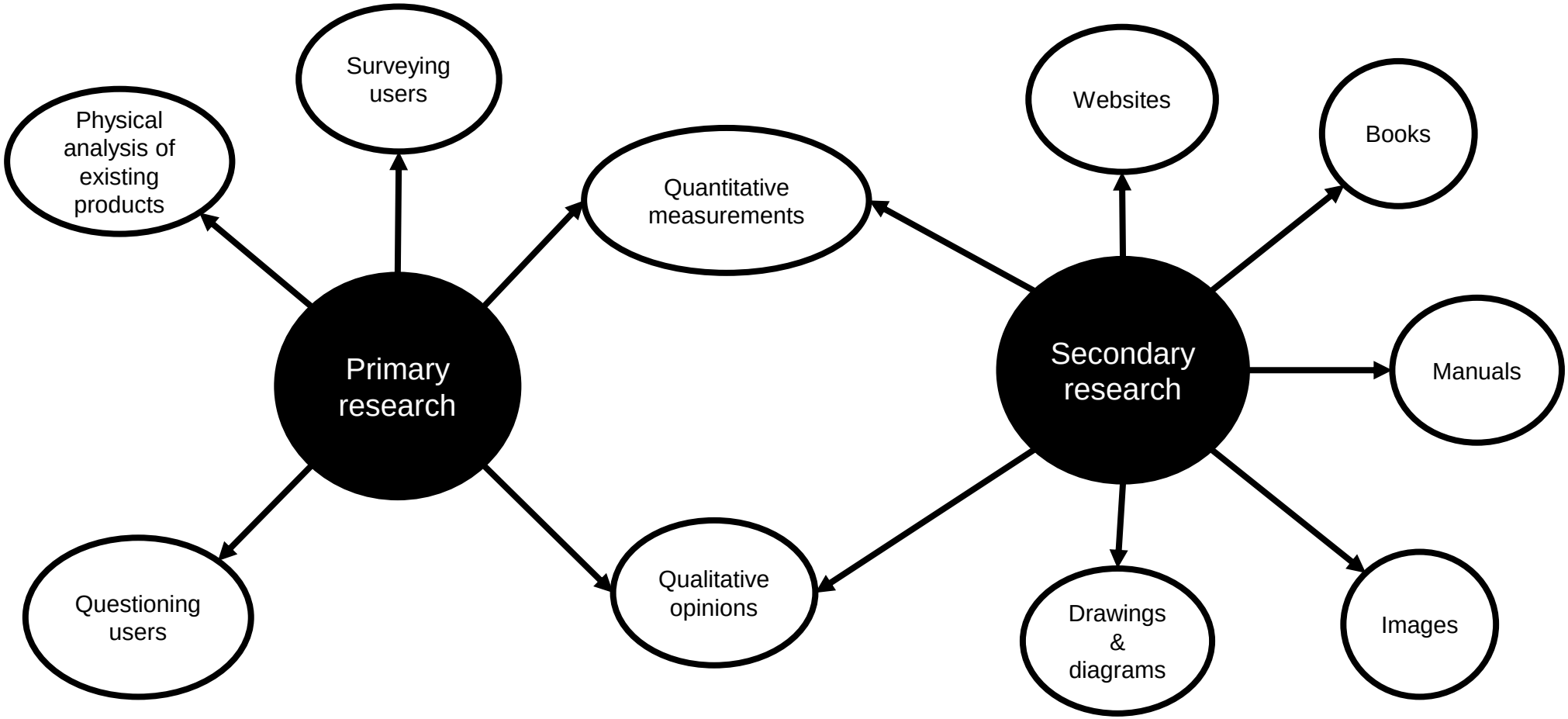
When we research products, we are usually comparing them. We might also get information from more than one person. How many we compare is the sample size.

TA1.2.1 Design (Research Techniques)

Researchers need to use a range of techniques.

Primary research : You do the actual research.

Secondary research : Identify and summarise relevant information that has been compiled by others**.**



TA1.2.1 Comparison of <u>Primary</u> Research Methods

How do you know which methods to choose?

	Method	Type of Data Available	Sample Size	Example of Use
Primary Research	**Physical analysis of products** Disassembling, examining and testing real life products. Usually they are compared using criteria.	**Qualitative** information about products according **to criteria that you decide.**	A **few** (as many examples as you can find).	Comparing bike saddles for comfort. Comparing phone chargers for speed of charging.
	Questioning Users Users are interviewed usually with a pre-prepared set of questions.	**Qualitative** information about user needs according **to criteria that you decide.**	A **few** (as many people as you can interview).	Finding user needs for a refrigerator. Understanding the impact of someone's disability.
	Surveying Users Many users are asked straightforward questions and the results are then analysed e.g. using graphs.	**Quantitative** information **from lots of people.**	**Many** (as many as will complete your survey).	Asking 40 people how much they would pay for a school bag. Asking a class about their favourite leisure activities.

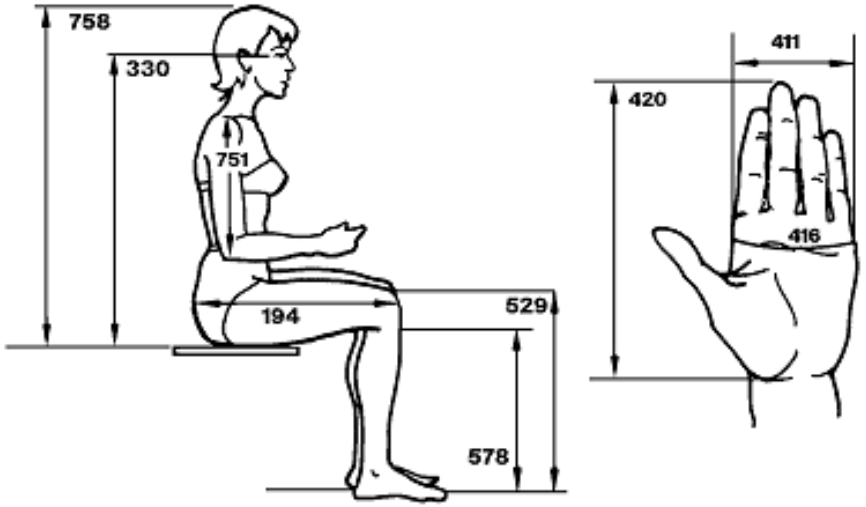
TA1.2.1 Comparison of <u>Secondary</u> Research Methods

How do you know which methods to choose?

	Method	Type of Data Available	Sample Size	Example of Use
Secondary Research	**Web sites** Finding information you need on the internet needs care – be clear about what information you need and watch out for bias.	**Images**. **Opinions** (qualitative). **Reviews** (qualitative). **Technical data** (quantitative). **Comparisons** (quantitative). **Prices** (quantitative).	**Several** (as many as you can find on websites).	Finding out what sizes of paper different printers use. Researching different solutions to bike security.
	Books & other literature Similar to web sites but books tend to be more accurate if they're not out of date.	**Magazines** sometimes have qualitative **reviews of products.**	A **few**.	Gaining opinions about current hair straighteners.
	Manuals Manuals can show you technical details of a product.	**Maintenance manuals** can show how things work and how to repair them.	**One product per manual** usually.	Finding out how food mixers work.
	Images, Drawings & Diagrams Images can help you judge aesthetic appeal and might give clues about ease of use etc.	The **parts that make up a product.** How a product is **operated**.	As many as you can find.	Making judgements about the aesthetic appeal of headphones. Identifying all the parts that make up a power drill.

TA1.2.1 Anthropometric Data

Measurements of the human body.



What is anthropometric data?	Anthropometric data are measurements of human bodies.
How do designers use it?	Designers use anthropometric data to design products that fit the human body. This is especially important for user-centred and ergonomic design strategies.
Are averages sizes used?	No human is average in all ways so designers usually create designs that work for the middle 90% in the variation of sizes.
Where does anthropometric data come from?	Data tables are available for a huge variety of measurements. Different tables are available for male and female and different age groups. Better ones show the range of measurements as well as the average.

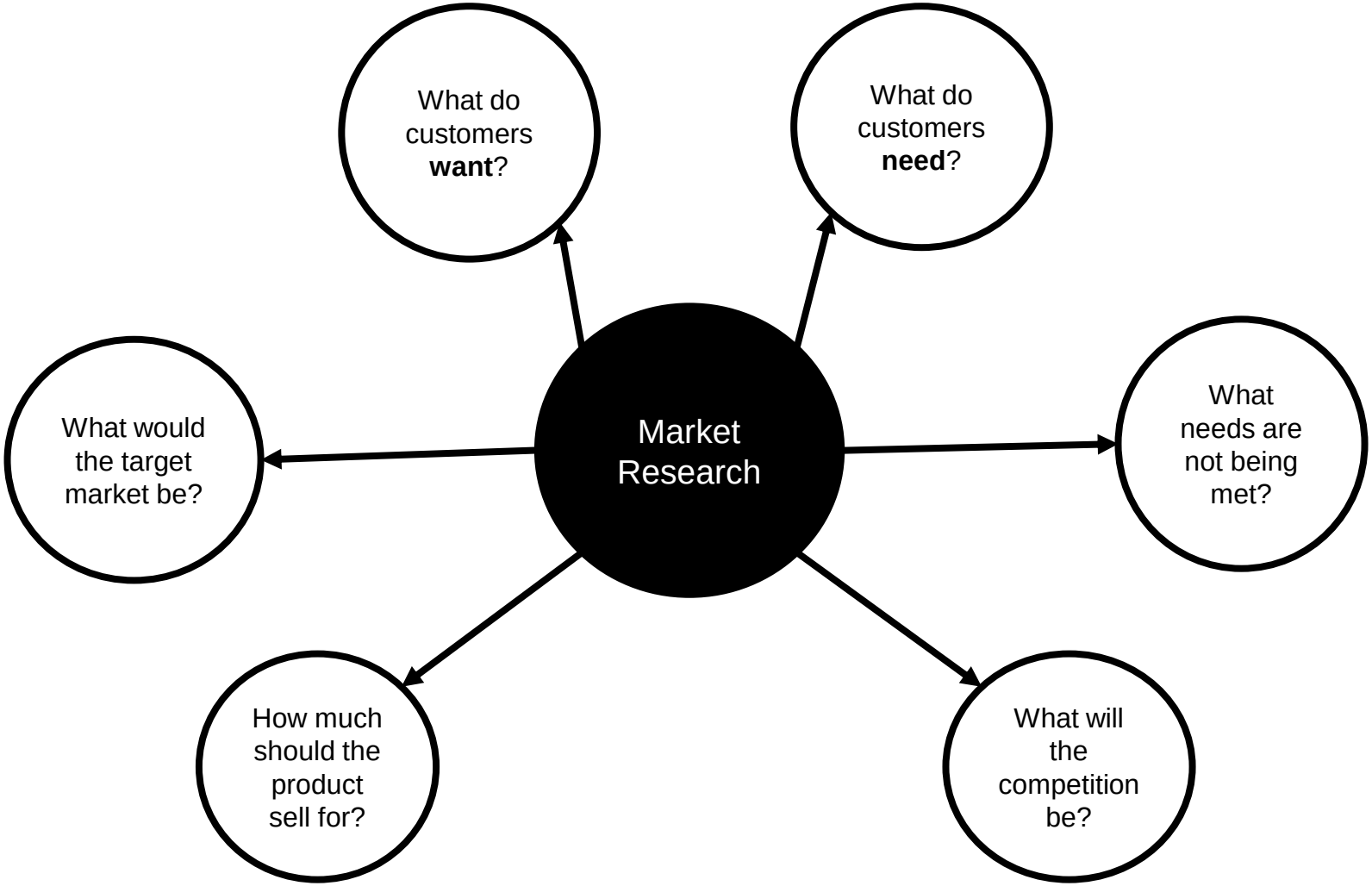
TA1.2.1 ACCESS FM

A way of remembering criteria with which to evaluate designs, or to include in a design specification.

	Issue	Quick question	Thinking hard for top marks
A	**Aesthetics**	How nice is it to look at and feel?	How could you make another one even better?
C	**Cost**	How much do you think it would sell for?	How much profit could be made? Take into account the time to make it at about £6 per hour for your time.
C	**Consumer**	Who would use it? Who would buy it?	What makes it suitable for that consumer? How could the design be improved?
E	**Environment** (sustainability)	How sustainable are the materials? If it uses power, how much does it use?	Are the materials renewable? Degradable? Can they be recycled?
	Environment (of use)	Where is the product designed to be used? Is it suitable for use there?	What makes it suitable for use in that environment?
S	**Safety**	What have you done to make your product safe to use?	How could another one be made safer still?
S	**Size**	How big is it?	Is it the optimum size for its purpose? Why is that?
F	**Function**	What does it do?	Are there any ways in which it could be redesigned to work better?
M	**Materials**	What are the parts made from?	Why were these materials suitable for the project?

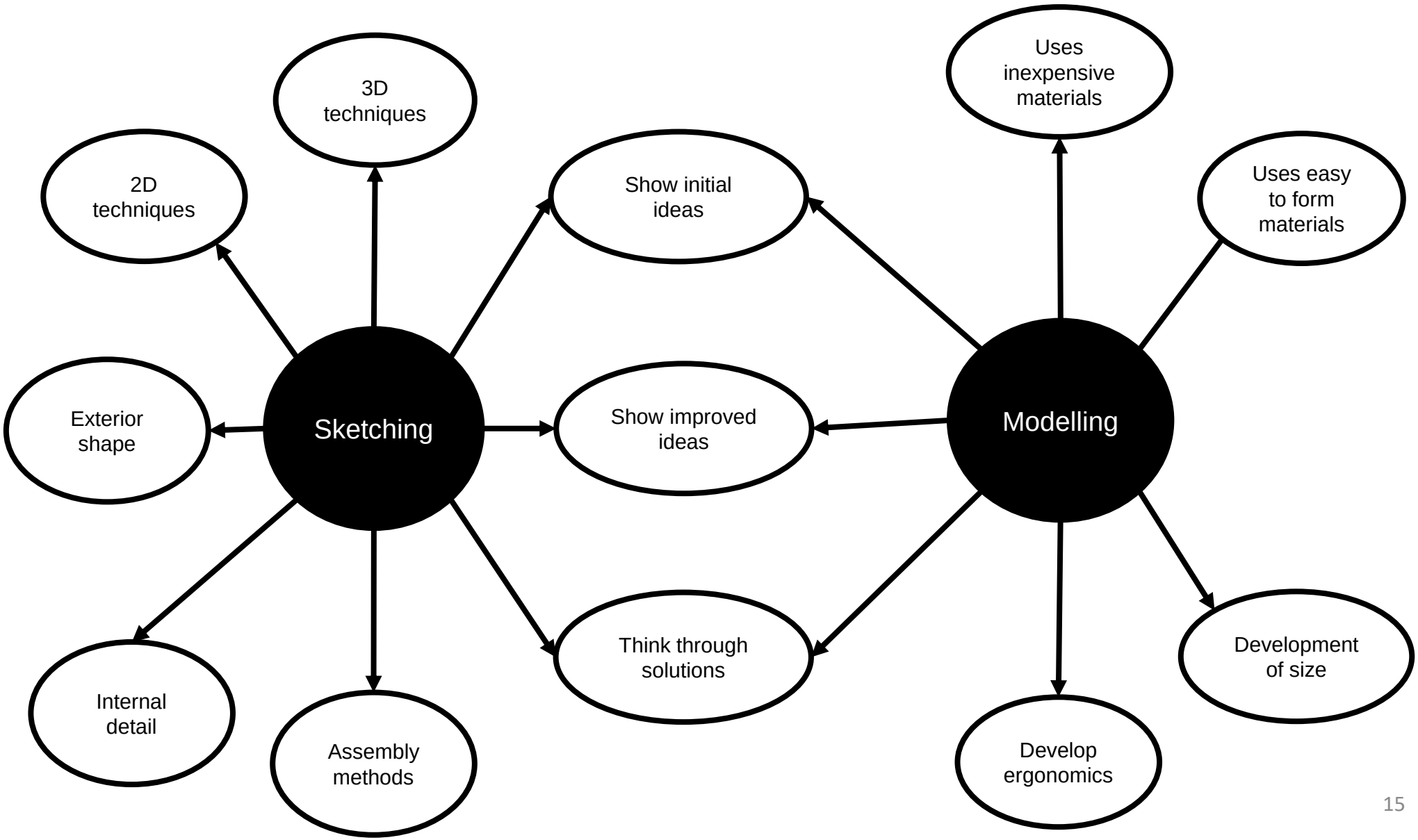
TA1.2.1 Market Research

Market research is the process of collecting information about the market or what customers want that might help a business to be more successful and spot gaps in the market.



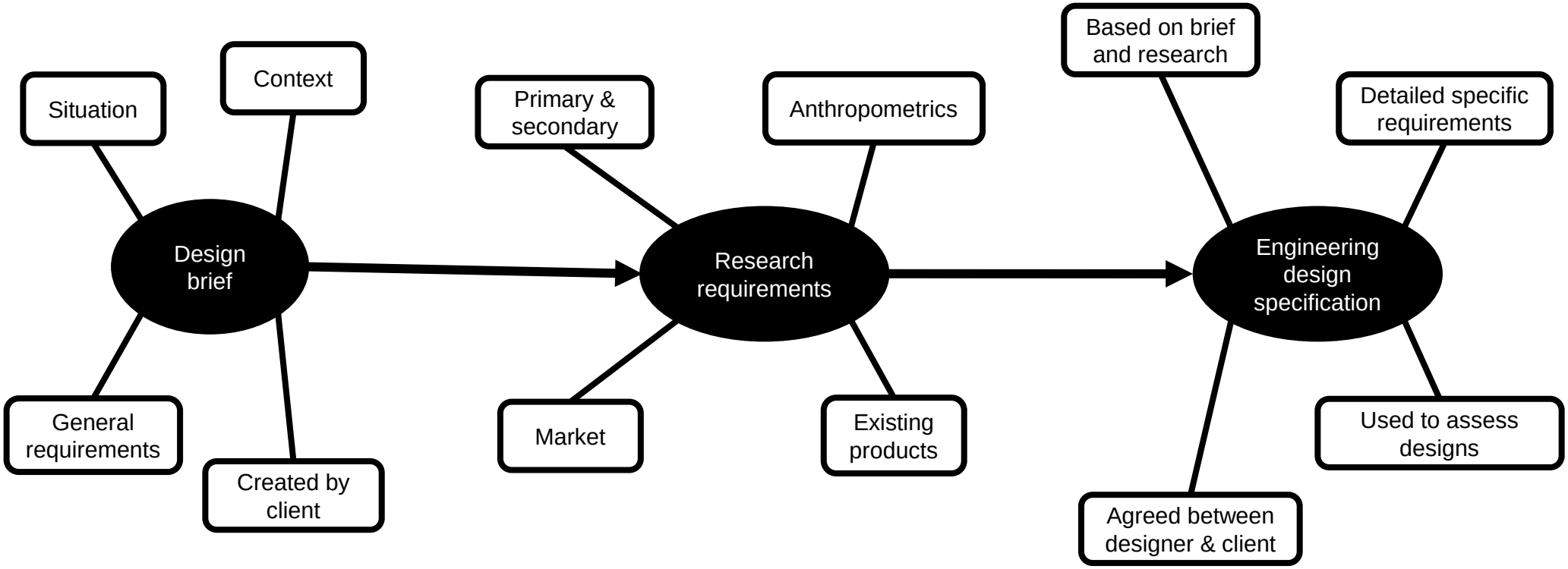
TA1.2.1 Generating design ideas

Exploring ideas for solving the brief.



TA1.2.1 The brief and engineering design specification

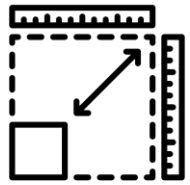
Before anything is designed, the design engineer needs to be clear about what is required.



TA1.2.2 Make and Evaluate

Towards the end of the design process, the best design(s) are modelled as prototypes.

Modelling is used to test:



Scale

Proportion

Created by WEBTECHOPS LLP from the Noun Project

Function

Created by Adrien Coquet from the Noun Project

Types of modelling

Virtual

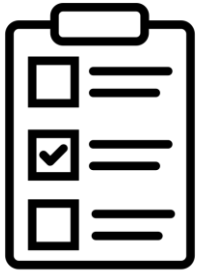
Created by Azam Ishaq from the Noun Project

Physical

Evaluation of model

All models or prototypes are compared with the design **brief** and **specification**.

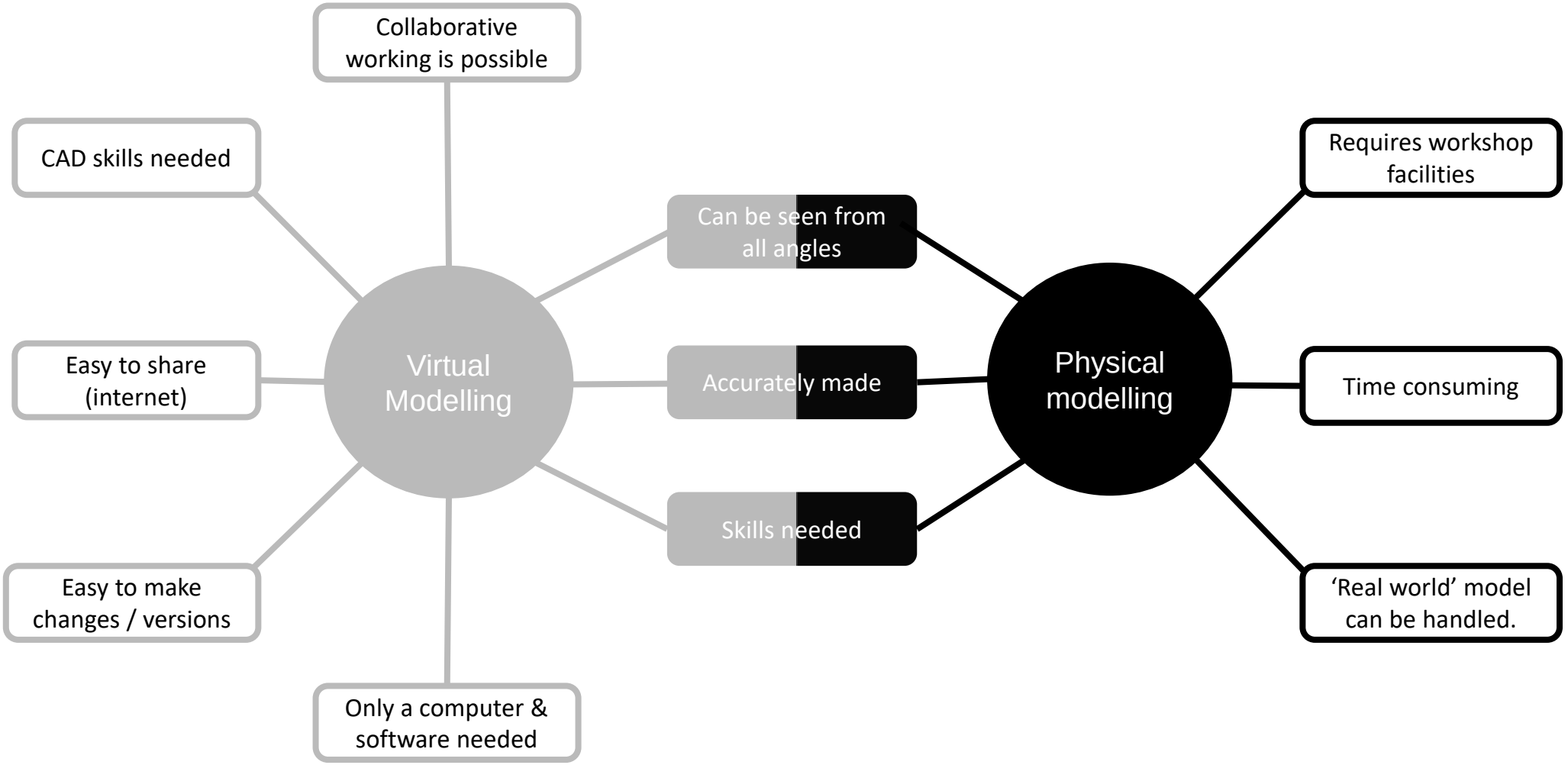
In **iterative** design, this leads to an **improved design** which is then modelled.



Created by Shocho from the Noun Project

TA1.2.2 Virtual and physical modelling

Modelling on computer or in real life



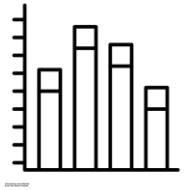
R038 Topic Area 2:

Design Requirements

Unit R038 Principles of engineering design.

TA2.1 Quantitative and qualitative criteria

Can we measure our findings on a scale?



Quantitative criteria are measurements. E.g. the amount of memory in a phone or the capacity of a battery.

Qualitative data are based on opinions, impressions and points of view. E.g. how comfortable a handle should be or how attractive a bath tap must be.

See also:
ACCESS FM from TA1

TA2.1 Needs and Wants

Both of these appear in engineering design specifications.

Created by Vector Portal

Needs criteria are essential and must be included in a design. E.g. an emergency stop button on a machine.

Created by Stanislav Levin from the Noun Project

Wants are criteria that are not essential but desirable. E.g. 1950s aesthetic styling on a food mixer.

TA2.2 Scale of Manufacture

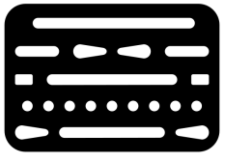
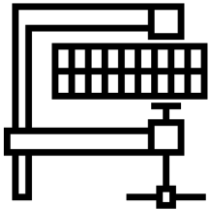
How many copies will be made at once?
Note: Not all manufacturing processes work at all scales!

	One-off production	**Batch production**	**Mass production**
Quantity	One	Fixed number. Typically 20-100	High volume. Typically 1000s
Tools used	Standard workshop tools.	Manufacturing aids: • Jigs • Templates • Fixtures	Automated machines.
Time per copy	High	Medium	Low
Employment	Highly skilled. Able to do all tasks. High job satisfaction. Labour intensive.	Skilled in limited number of processes. Repetitive. Lower job satisfaction.	Skilled engineers to set up and maintain machines. Low skilled jobs to supply machines / transport products.
Setup cost	Low	Medium	High
Cost per copy	High	Medium	Low
Time per copy	High	Medium	Low
Examples	Prototype. Theatre set.	Garden bench. Traffic light.	‘Phones. Cars.

TA2.2 Manufacturing Aids

These make batch production:

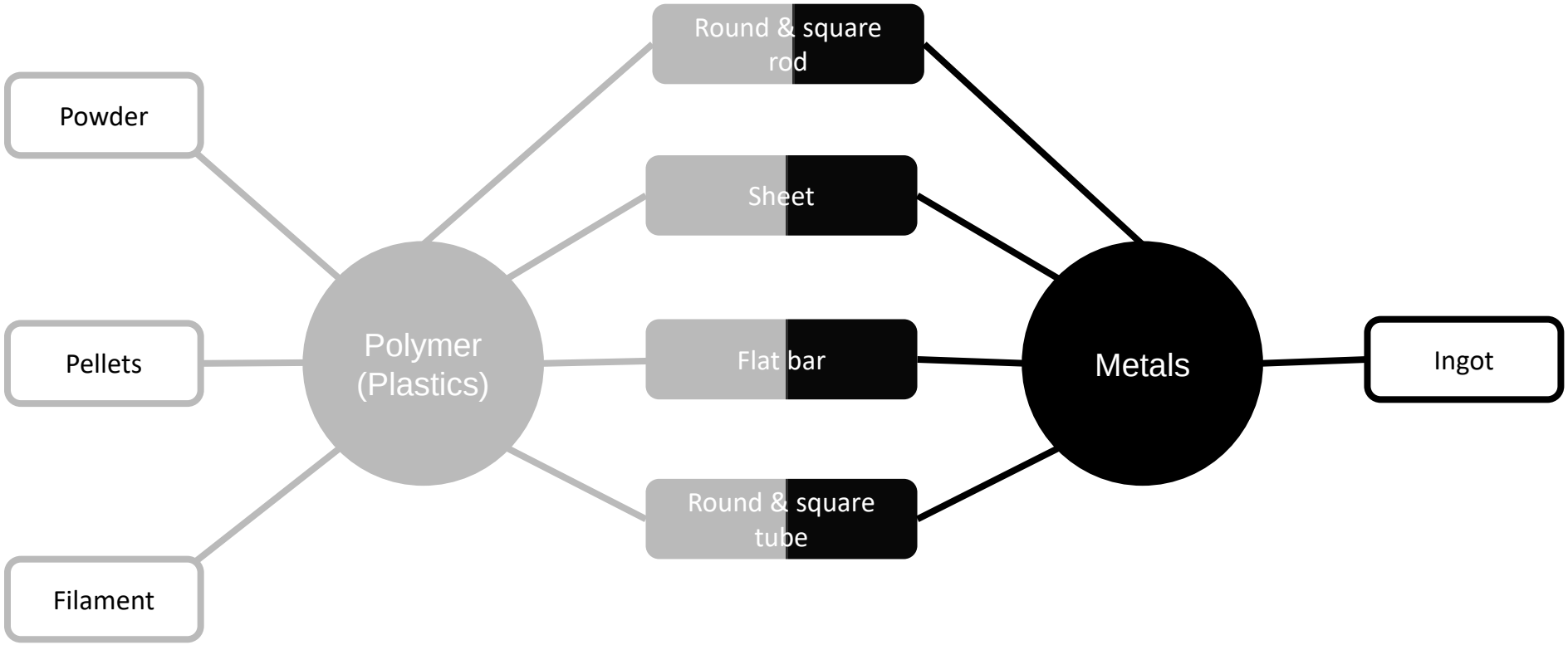
- More accurate
- Quicker
- More consistent
- Less reliant on worker skill

Jig	Guides a tool into the work without need for marking out first.	 Created by Marie Van den Broeck from the Noun Project
Template	A pattern that is drawn around to make marking out quicker.	 Created by Amethyst Studio from the Noun Project
Fixture	Holds components firmly in place whilst the worker works on them.	 Created by Kokota from the Noun Project

TA2.2 Material Availability and Form

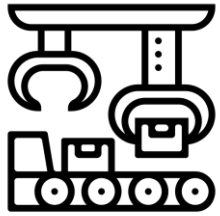
Materials are available in standard ‘stock’ forms and sizes.

Polymers and metals have some stock forms in common.
Other materials have their own standard stock forms.



TA2.2 Types of manufacturing process

How components can be made.

Wasting	Shaping	Forming	Joining	Finishing	Assembly
					
Changing shape by removing material	Forming a shape by moulding or laying up composites.	Changing shape by deformation.	Permenant or temporary fixing.	Creating a surface finish for technical or aesthetic reasons.	Adding components together into a single product.

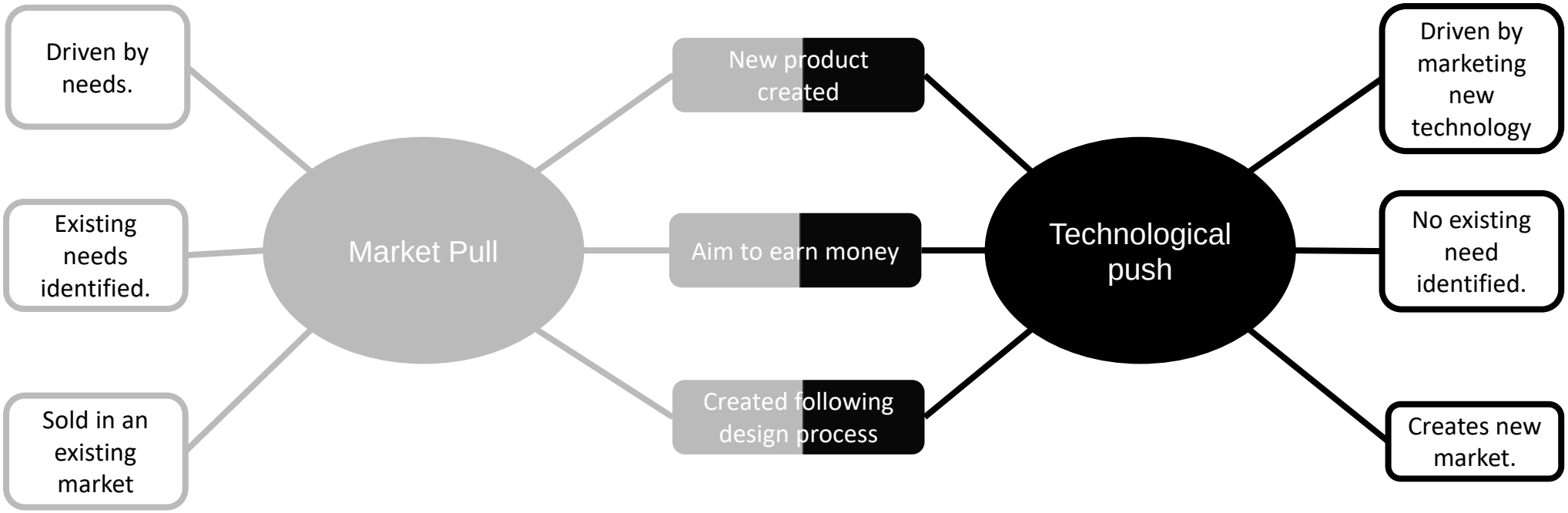
TA2.2 Production Costs

Where does the money go?

 Created by iconsphere from the Noun Project	Buildings	Capital cost
 Created by iconcheese from the Noun Project	Equipment	
 Created by Kokota from the Noun Project	Workers	Labour cost

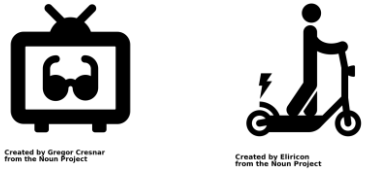
TA2.3 Market Pull and Technological Push

This is to do with why new designs are created.



Reusable water bottles and digital cameras were designed because of **market pull**.

3D TV and electric scooters were designed because of **technological push.**



TA2.3 British and International Standards

Showing that a product is of good quality.

British Standards		Independently tested and assessed.	Meets the British Standards Institution's standards. These are tougher than those required my law.
United Kingdom Conformity Assessed		Self-declared by manufacturer.	Meets all relevant UK legislation.
Conformité Européene		Self-declared by manufacturer.	Meets all relevant European Union legislation.

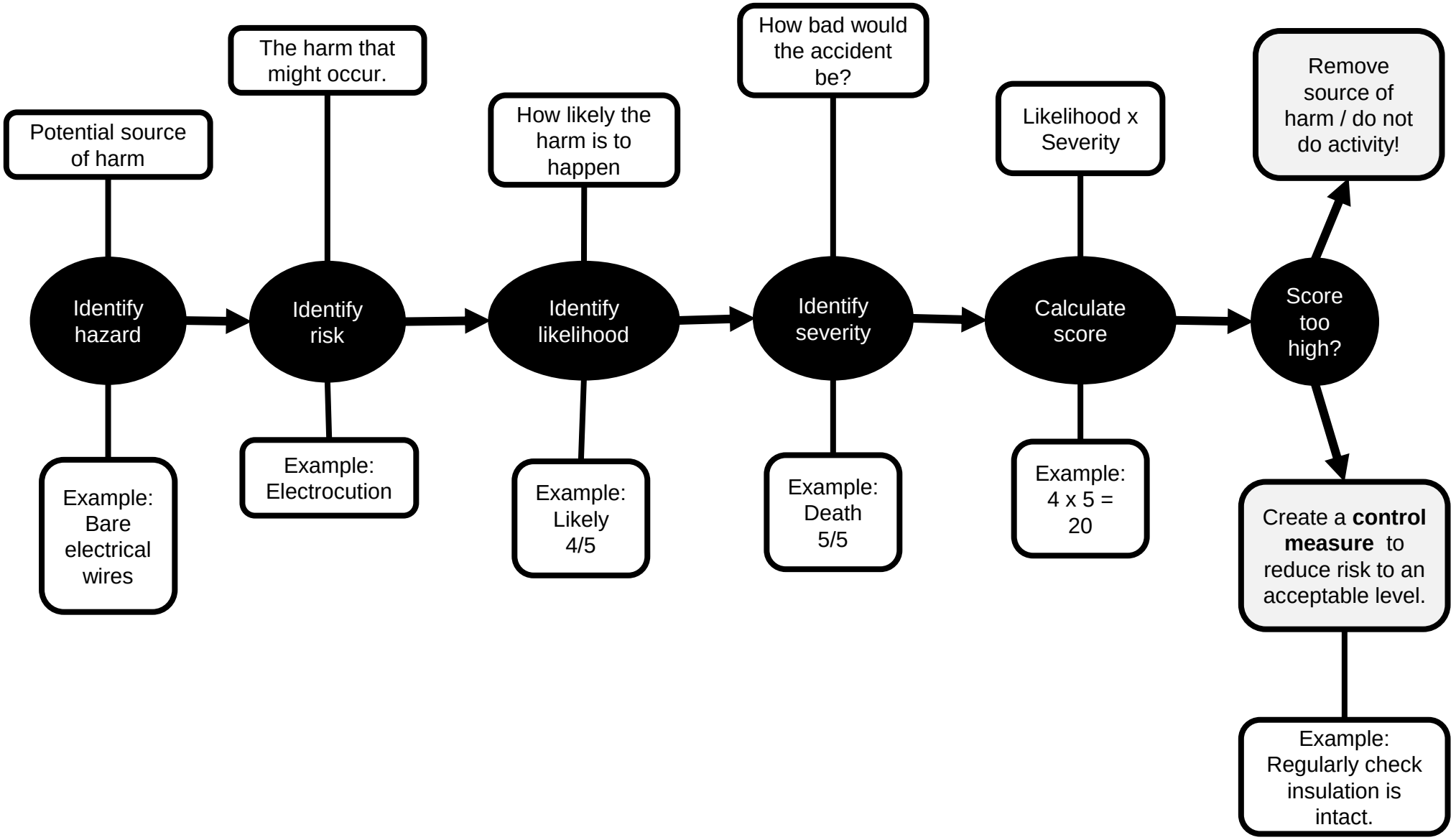
TA2.3 Legislation for Health & Safety

Applies to manufacture and also sometimes to a product in use.

Health and Safety at Work etc Act	Employees must ensure that employees are kept: • Kept safe from accidents. • Health is not affected negatively by their work. Employees must cooperate and look after each other's health & safety.	
The Management of Health and Safety at Work Regulations	A standard process called risk assessment must be used to identify hazards and reduce the risk to an acceptable level. See separate section.	
COSHH	**C**ontrol of **S**ubstances **H**azardous to **H**ealth	Is about how potentially dangerous substances should be labelled, stored and used.
RIDDOR	**R**eporting of **I**njuries, **D**iseases and **D**angerous **O**ccu**r**rences	Is a requirement for employees to record and report accidents or 'near misses'.

TA2.3 Risk Assessment

Identifying risks and reducing them with control measures.



TA2.3 Planned Obsolescence

Designing products that have a deliberately limited life.

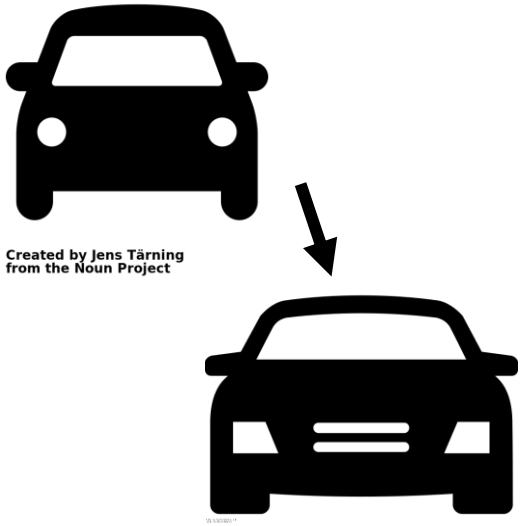
- More profit for manufacturers
- More expense for consumers
- More materials used, waste & environmental damage.

Definition: Obsolete

Ob-so-leat

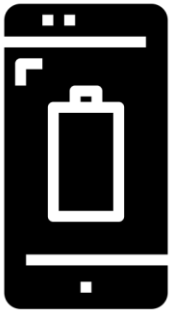
No longer of any use

Updated car models



Old model still works well but a ‘facelift’ encourages people to replace their car.

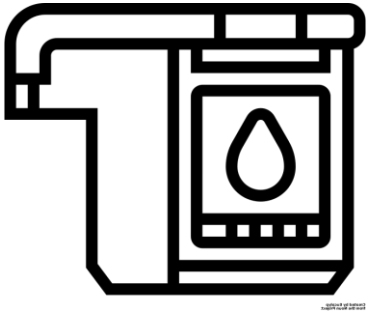
Non-replacable batteries



Created by Komkrit Noen

After a few years, battery capacity drops but the owner cannot replace the battery cheaply so they buy a new one.

Non-refillable printer cartridges



The cartridge cannot be refilled so must be thrown away and a new one bought with new ink.

TA2.3 Sustainable Design: The 6 ‘R’s

Six ways to create more sustainable design.
The biggest impacts are in reducing consumption and waste.

	Quick question	Example
Rethink 	Can we do things a different way to be more sustainable?	Transport groceries by cargo bike rather than van.
Reuse 	Can we *reuse a component* or product that exists already?	Reusing tyres as play equipment.
Recycle 	Can we *recycle the materials* in a waste product?	Recycling cans into stock steel sheet.
Repair 	Can we repair an existing product? Can we design a product to be repaired?	Replacing the screen on a ‘phone.
Reduce 	Can we reduce the amount of materials we use? Can we reduce the quantity or energy that we use?	Making components hollow. Designing lights that are not brighter than needed.
Refuse 	Can we refuse to use the product or component completely/?	Packaging toothpaste without an outer box.

TA2.3 Some Sustainability Words

Things you need to know:

Sustainability

Consumption of materials and power is said to be sustainable if we can *continue to use it at the current rate without it ever running out or causing pollution etc.*

Using fuel usually creates pollution.

Renewable

A material or energy source that naturally replenishes (comes back).

Example: Solar power or timber.

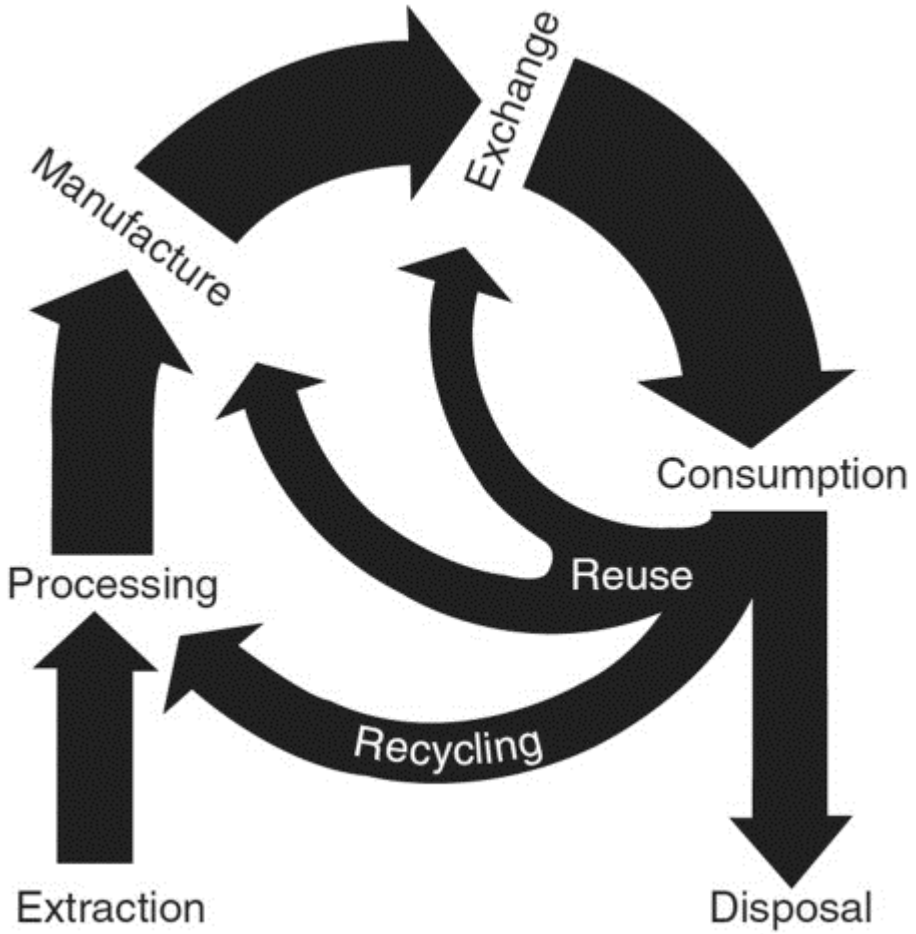
Reusable

A product that can be used many times.

Example: A reusable water bottle.

Circular Economy

In a circular economy, products, components and materials are reused and recycled instead of being thrown away



R038 Topic Area 3:

Communicating design outcomes

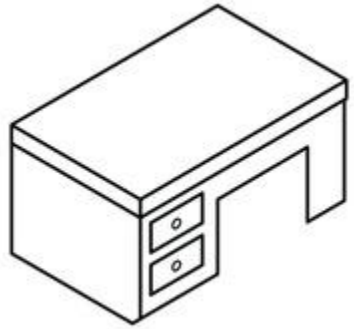
Unit R038 Principles of engineering design.

TA3.1 Types of drawing used in engineering

Engineers use many types of drawing styles

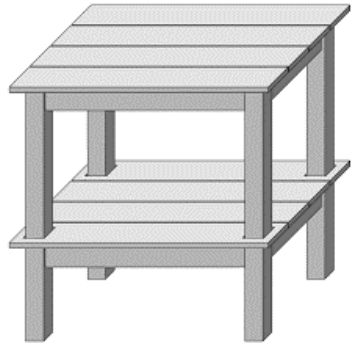
Isometric

A formal 3D style drawing.



Oblique

Another 3D style that is less realistic that isometric.

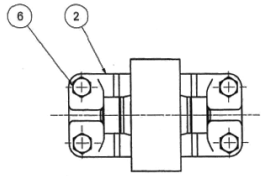


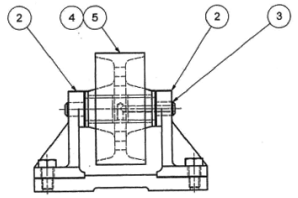
Freehand sketching

An informal style used to communicate ideas quickly.

Assembly Drawings

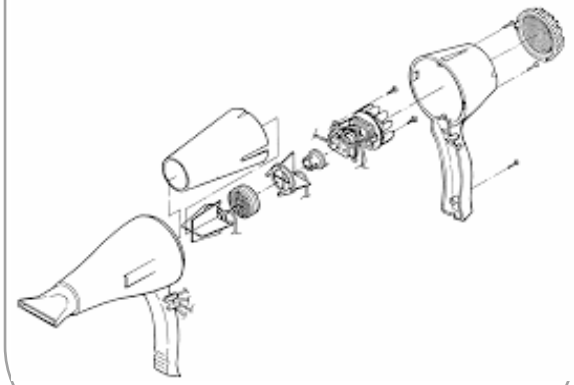
Drawings that show all components assembled together.





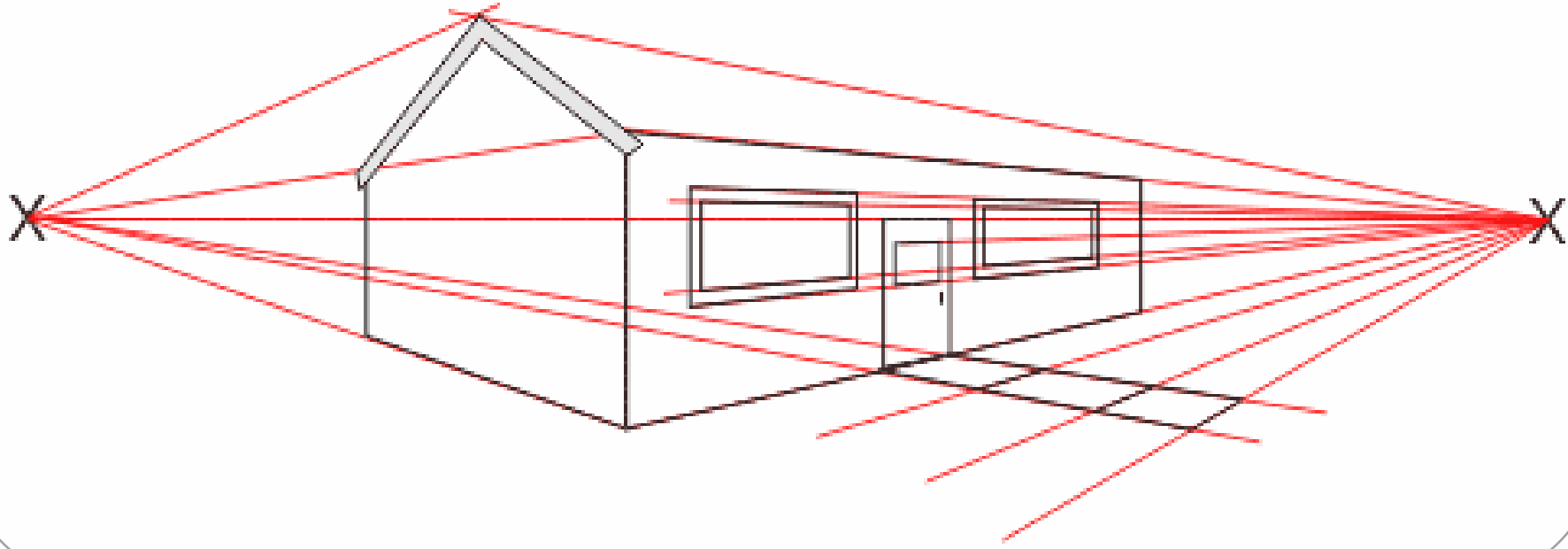
Exploded views

A type of assembly drawings that shows space between parts.



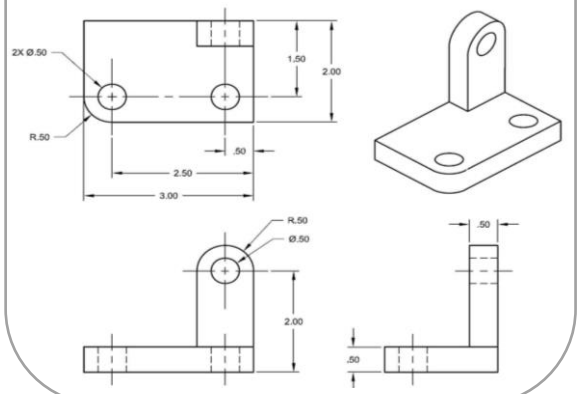
Perspective

Even more realistic than isometric drawing. The side of the object closer to the viewer is shown larger. This example is two-point perspective



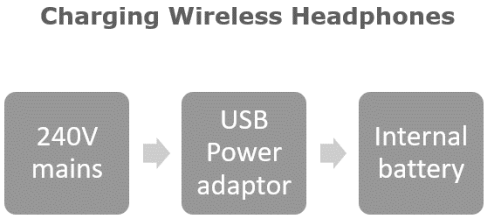
Orthographic drawing

A formal style of 2D drawing usually used to show dimensions. Drawn to scale.



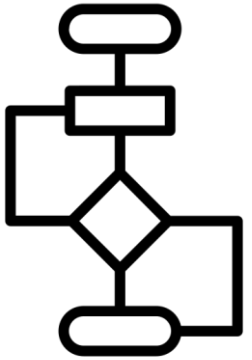
Block diagrams

A diagram of a system showing how stages relate to each other.



Flowcharts

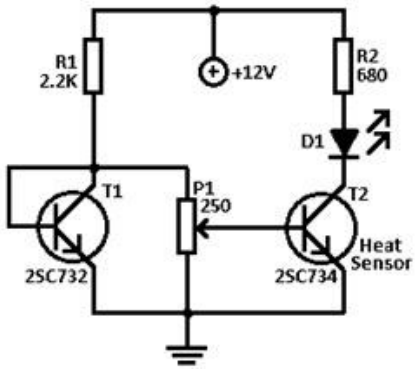
Used to show a decision making process.



Created by Lima Studio

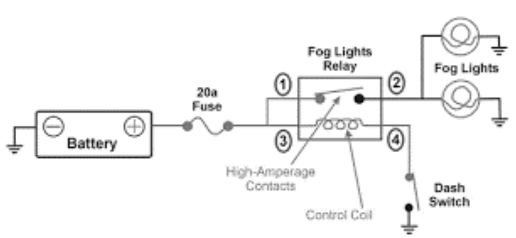
Circuit Diagram

Used to show how electronic components are connected in a circuit.

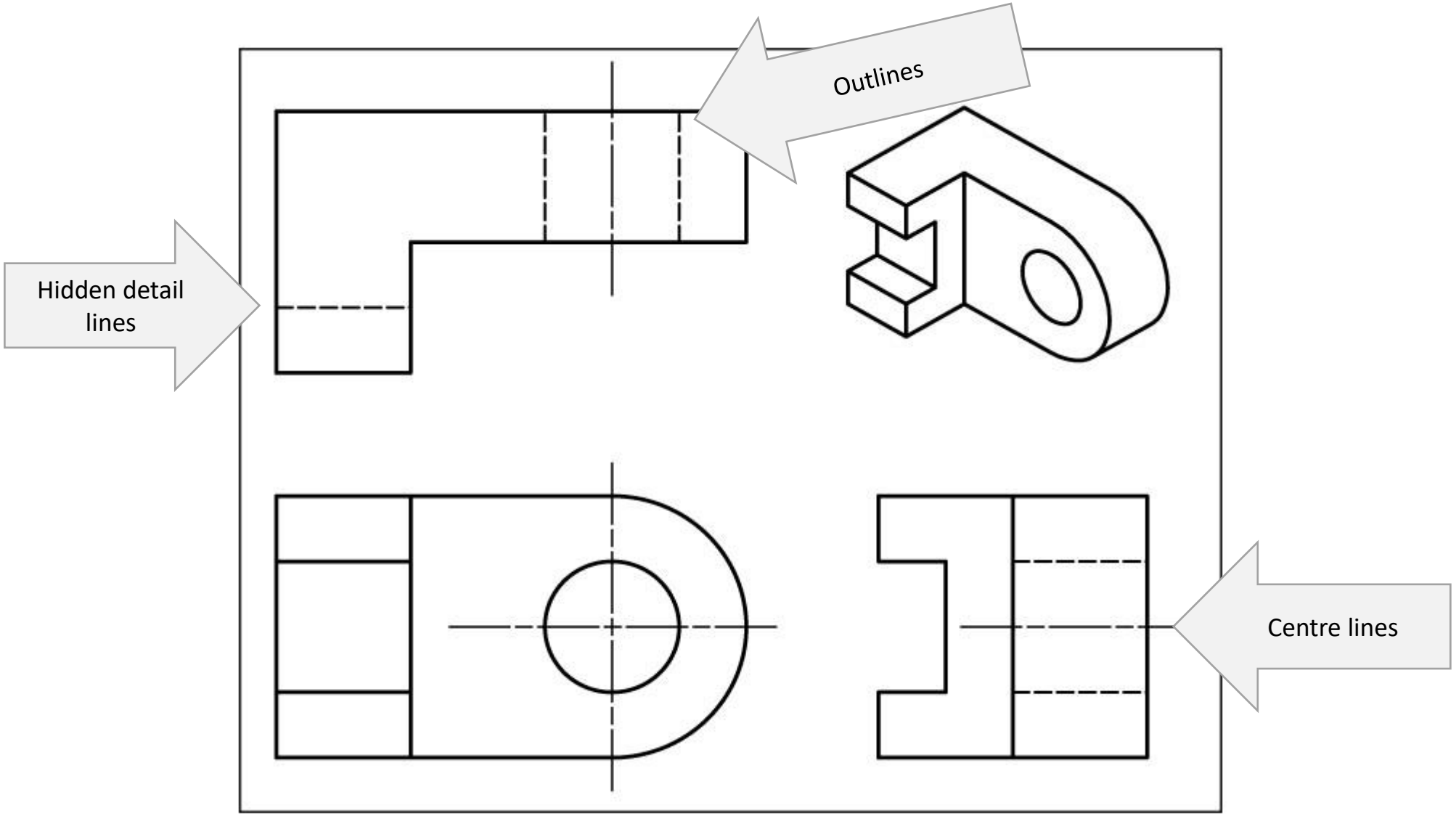


Wiring Diagram

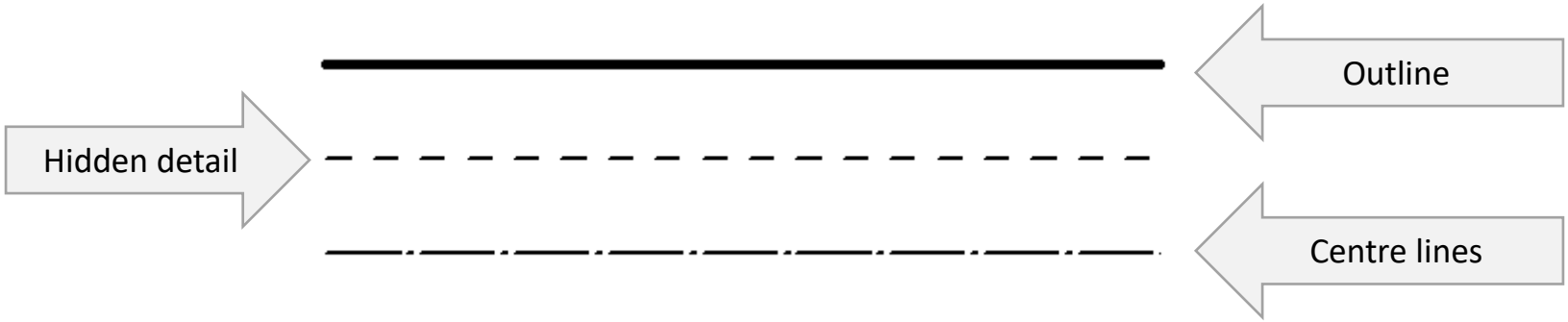
Shows how connections should be made within larger electrical systems.

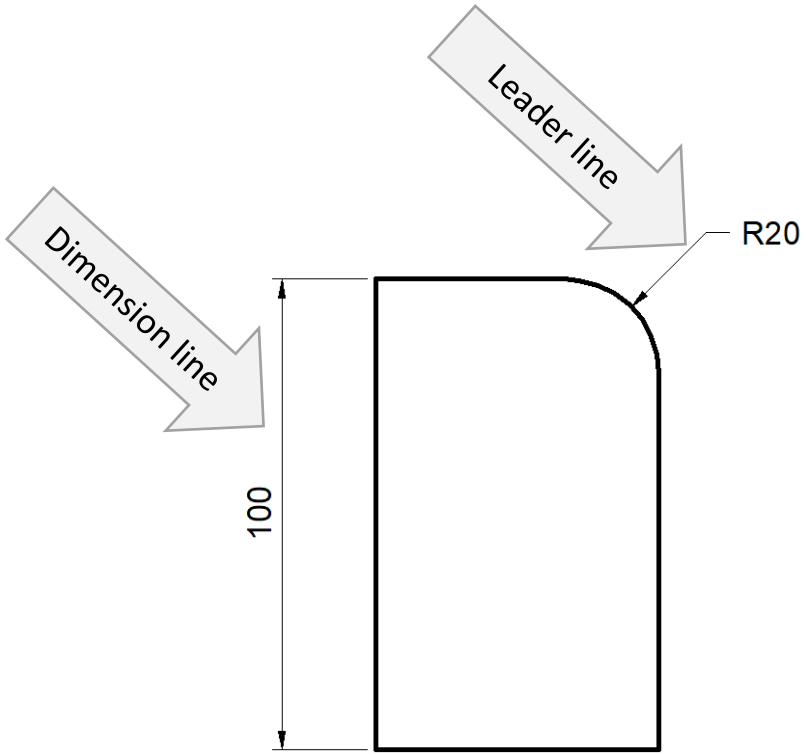


TA3.2 Basics of Orthographic Projection



TA3.2 Orthographic line types

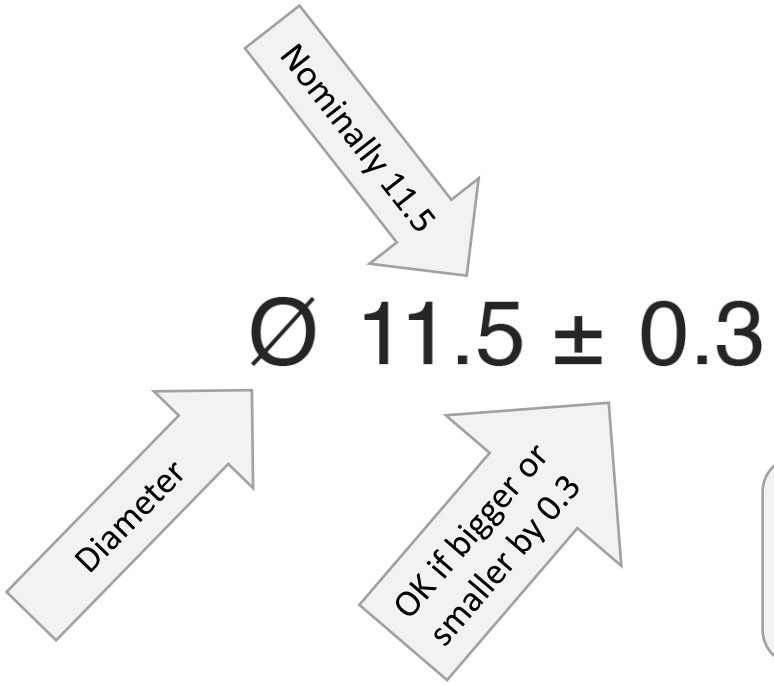




TA3.2 Tolerance basics

It is not possible to manufacture a component with complete accuracy.

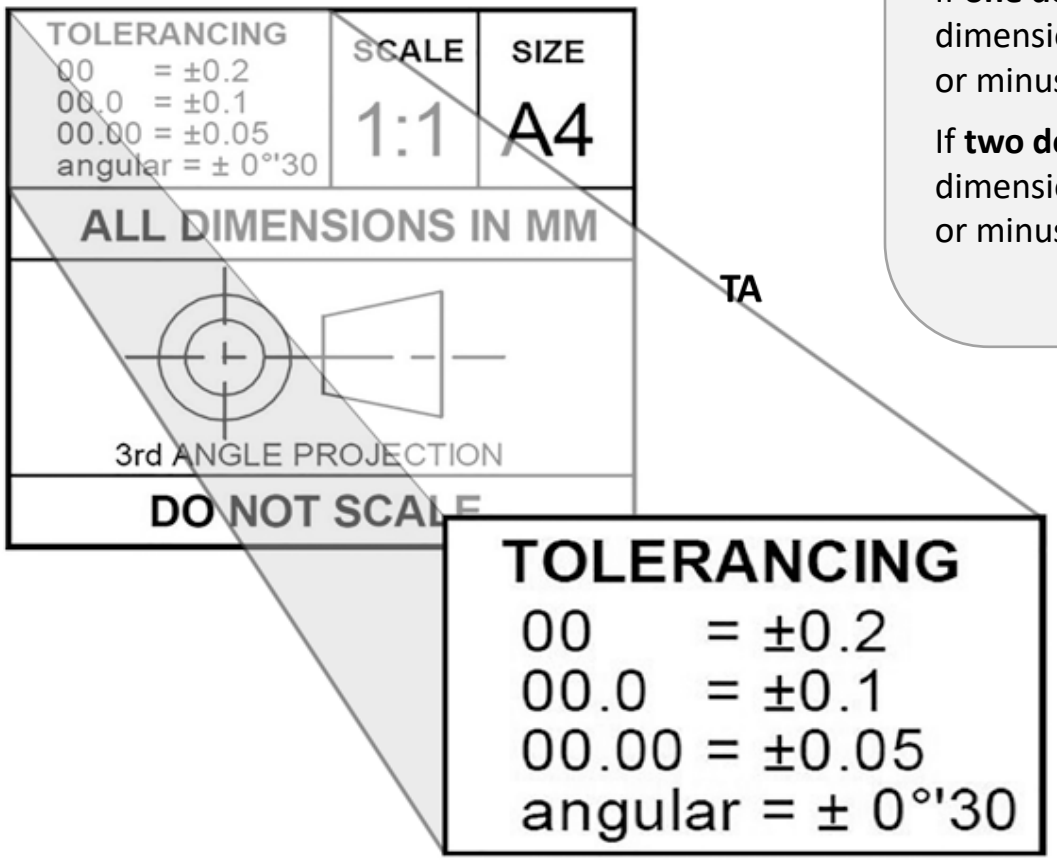
Specifying a tolerance tells the manufacturer the maximum permitted variation from the *nominal* dimension.



In this example, the feature would be acceptable if it were between 11.2 and 11.8.

3.2 Standard tolerance in the title block

Sometimes, standard tolerancing is used on a drawing.
These are used to alongside the dimension lines.



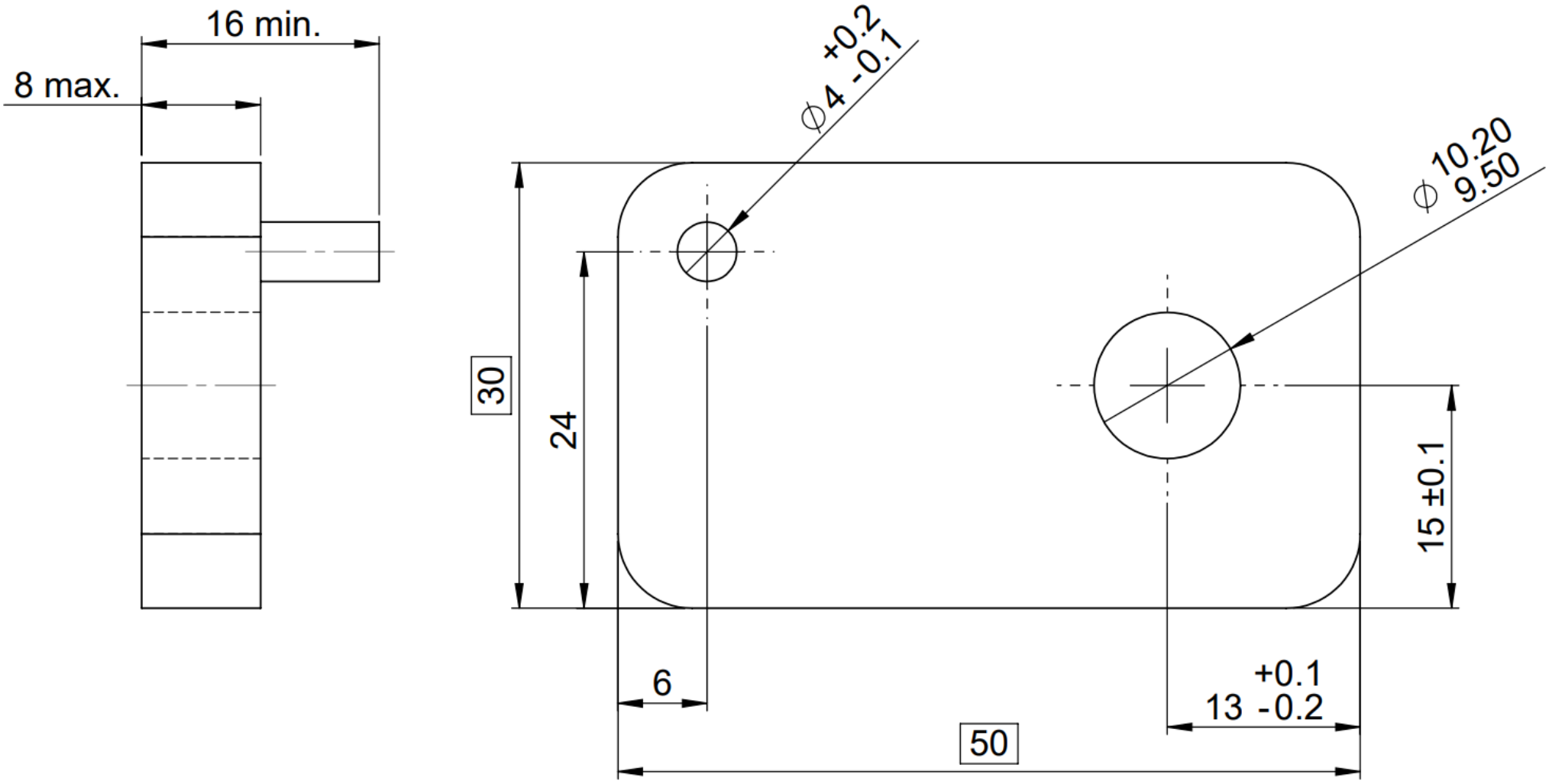
In this example:

If **no decimal places** are shown on the dimension line then the tolerance is **plus or minus 0.2**

If **one decimal place** are shown on the dimension line then the tolerance is plus or minus **0.1**

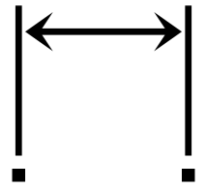
If **two decimal places** are shown on the dimension line then the tolerance is plus or minus **0.05**

TA3.2 Tolerance: Even more ways of showing it!



TA3.2 Standard Units

Engineers use standard units.
British Standards units are shown on this page.



Distance

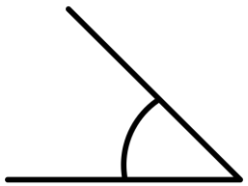
Distance is measures in **metres** and **millimetres**.

There are 1000 millimetres in a metre

Millimetres are abbreviated to **mm**.

Metres are abbreviated to **m**

Engineers *do not use centimetres.*



Created by AliWijaya
from the Noun Project

Angles

Angles is measures in **degrees** and **minutes**.

There are 360 degrees in a rotation.

There are 60 minutes in a degree.

Degrees are shown with a degrees symbol.

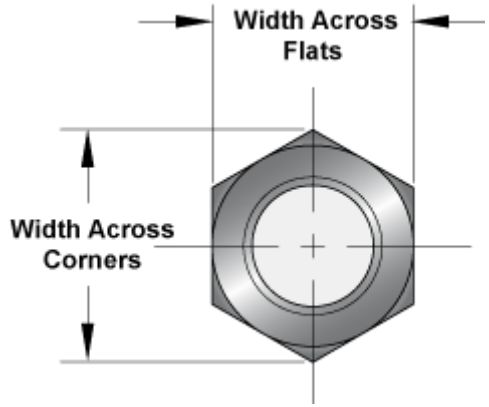
Minutes are indicated by an apostrophe.

Example:15 **degrees** and 30 **minutes** would be shown as 15^{o} 30’

TA3.2 Abbreviations

These abbreviations are standard in engineering drawings

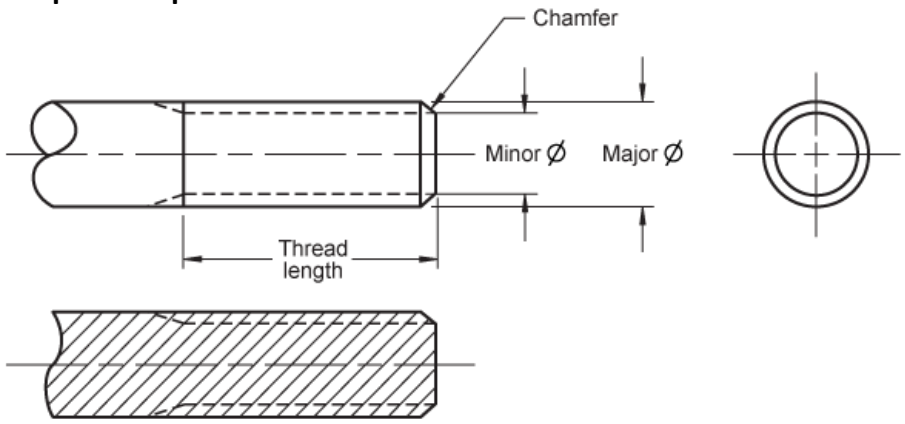
A/F	Across flats
CL	Centre line
Ø	Diameter
DRG	Drawing
MATL	Material
SQ	Square



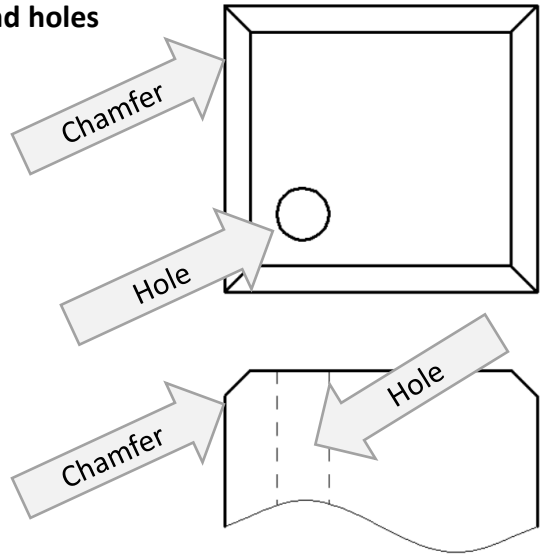
TA3.2 Representations of mechanical features

There are conventions in how certain features are shown.

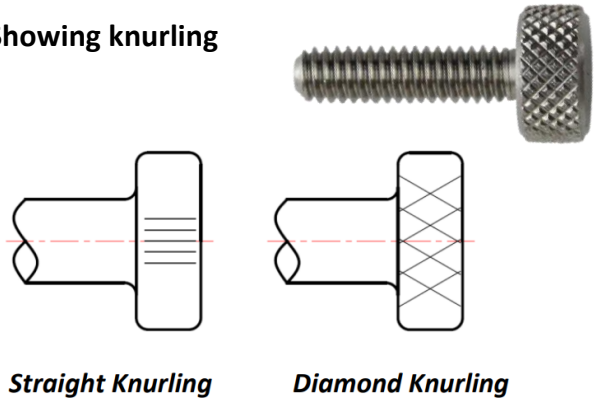
Simplified representation of threads



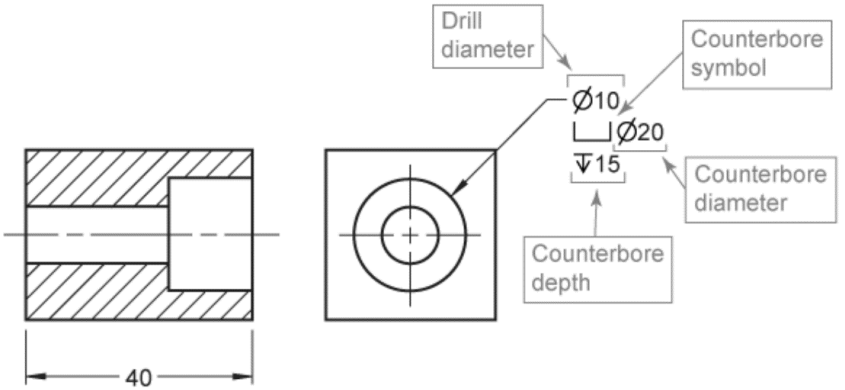
Chamfer and holes



Showing knurling



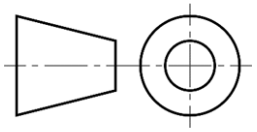
Showing & dimensioning countersinks
(e.g. for a machine screw)

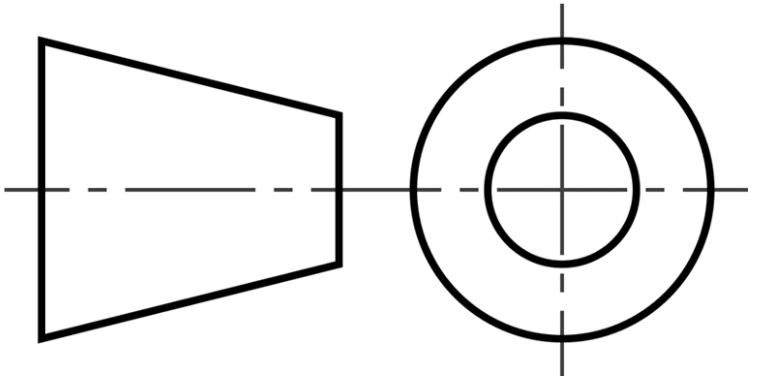


TA3.2 A Title Block is shown on engineering drawings

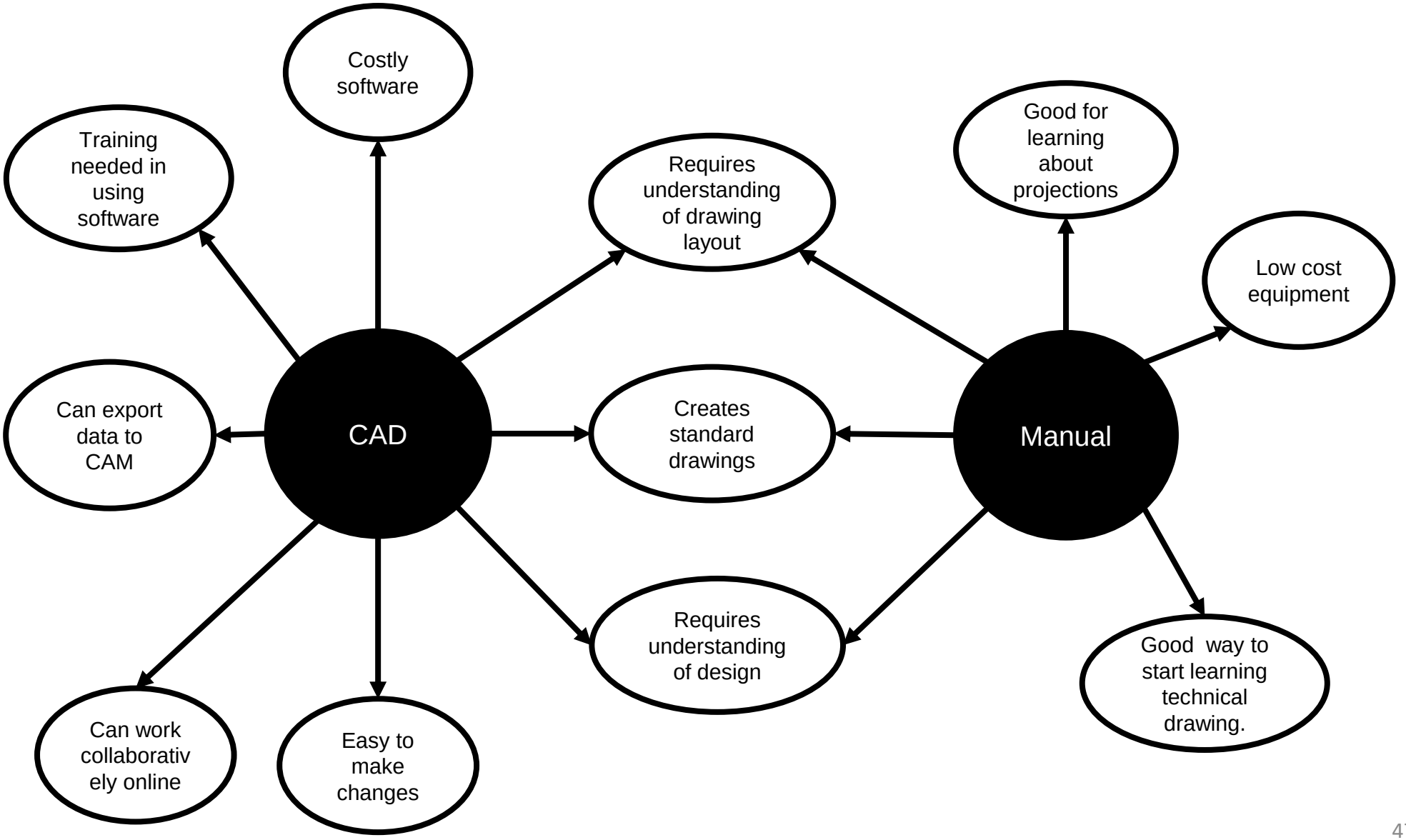
The title block is the bit within the green border. Data in red is example only.

Title block example

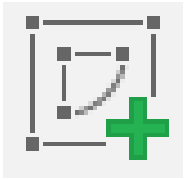
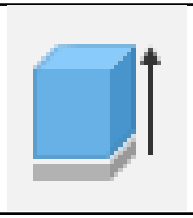
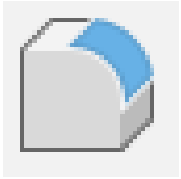
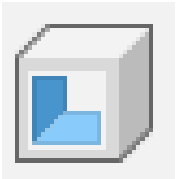
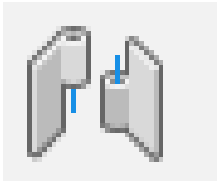
Title:	Desk lamp base	**Date:**	19/1/23	**Drawn by:**	P Miles
Scale:	1:1	**Version:**	3	**Tolerance:**	± 0.2 unless stated otherwise
All dimensions in millimetres					



TA3.3 CAD vs manual drawing techniques



TA3.3 Basic CAD modelling tools

	Sketch	A drawing from which a 3D shape is made.
	Extrude	Makes a 2D sketch 3D.
	Fillet	Rounds corners.
	Move / Copy	Moves or copies.
	Shell	Hollow out.
	Assemble	Join components together

R038 Topic Area 4:

Evaluating design ideas

Unit R038 Principles of engineering design.

TA4.1 Methods of evaluating design ideas

How to judge designs

Production of Models

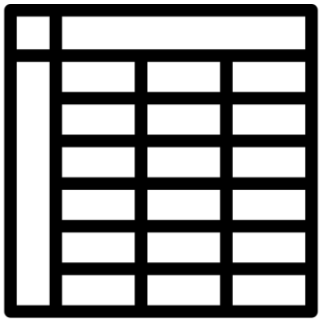
Create a model of the design.

***Qualitative* comparison with design brief and specification**

Judge the design against the original objectives.

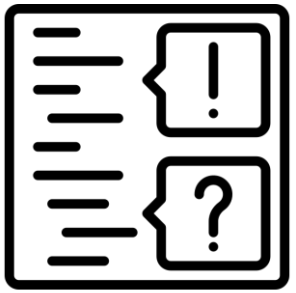
Ranking matrixes

Create a table and compare designs by scoring them.



Quality Function Deployment (QFD)

A standard method of assessing customer needs and comparing them with products.



Created by Ben Davis

Example Ranking Matrix

	A	B	C	D
1		**Fairphone V4**	**Galaxy X-Cover 5**	**Doogee S6**
2	Aesthetics	3	4	4
3	Cost	2	3	4
4	Consumer	4	4	5
5	Environment of use	3	5	5
6	Environment (sustainability)	5	2	2
7	Size	4	3	4
8	Safety	3	4	4
9	Functions	3	3	4
10	Materials	5	3	3
11	Mean average:	**3.6**	**3.4**	**3.9**

R040 TA1: Product Evaluation – Ranking matrixes

Engineers can collate results of scoring in a matrix like this to make it easier to make comparisons.

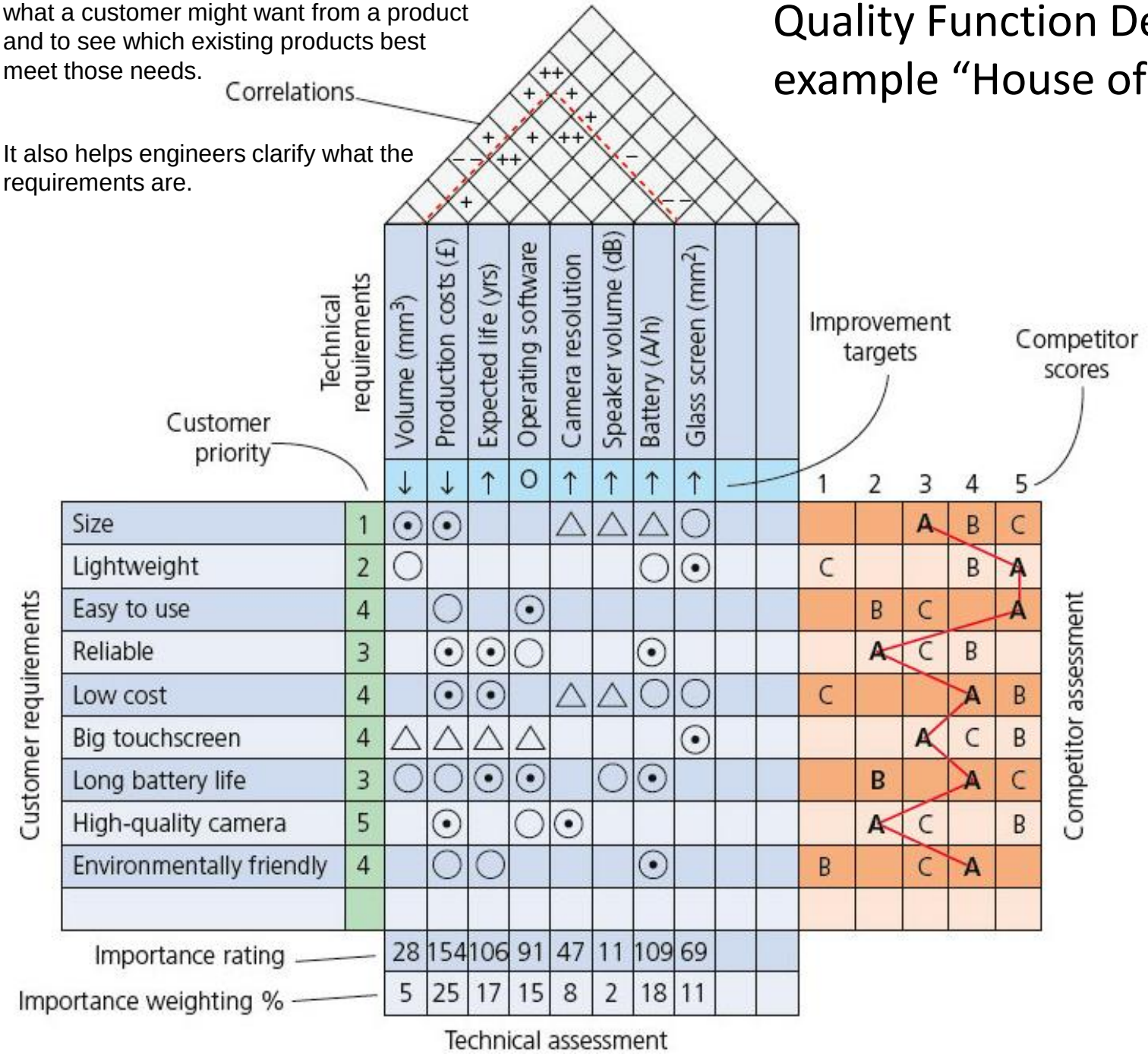
You will need to use ACCESS FM from topic 1.2.1 of R038

	Design 1	**Design 2**	**Design 3**	**Design 4**
Aesthetics	5	1	5	2
Cost (Value for money)	4	5	1	3
Consumer suitability	2	1	4	2
Environment suitability	1	1	4	5
Safety	3	2	3	2
Size suitability	3	2	4	1
Functions	2	1	5	4
Material suitability	4	2	3	4
Total:	**24**	**15**	**29**	**23**

This is a standard method of recording what a customer might want from a product and to see which existing products best meet those needs.

It also helps engineers clarify what the requirements are.

Quality Function Deployment (QFD) example “House of Quality”.



Correlations:
++ Strong positive
\+ Positive
– Negative
– – Strong negative

Relationships:
⊙ Strongest = 9
◯ Medium = 3
△ Weak = 1
No assignment = 0

Competitors:
A Phone A (*)
B Phone B
C Phone C

QFD Step 1	QFD Step 2
Add the customer requirements and priority. In the example, these are size, lightweight, easy to use, reliability, low cost, big touchscreen, and so on. Each one has a priority from 1 (least important) to 5 (most important) assigned to it. These have been determined using primary and secondary customer research.	List the technical requirements for the product. For the phone, these are volume, production cost, expected life, operating software, camera resolution, and so on. Try to use requirements that can be measured, such as volume in mm^3 and production cost in £. However, not all of them need to be measured.

QFD Step 3	QFD Step 4
Add improvement target arrows to the technical requirements. For example, it is desirable for the product to have a lower production cost (down arrow), but the resolution of the camera should be higher (up arrow).	Complete the centre grid to assign the relationship of the customer requirements to technical requirements. You will see that three different relationship symbols (circles and a triangle) are used, worth 1 point, 3 points or 9 points. As an example, if a customer wants a low-cost phone then this will affect the production cost, so the '9' symbol is placed in the box where they meet as there is a strong relationship. The big touchscreen is only weakly related to the operating software so a '1' symbol is used. Where they are not related, it is left blank.

QFD Step 5a

The next step is to calculate the importance ratings and importance weights along the bottom. The customer priorities and relationship symbol values are used to calculate the final rating values.

This is a little trickier to do, so here is the first column (volume mm^3) with four relationship symbols done in full.

QFD Step 5b

All the other columns are completed in the same way.

To work out the percentage, divide this total by the total of all the importance ratings:

28+ (28 + 154 + 106 +91 +47 +11 + 109 +69) =

28 = 615 = 5%

Customer requirements	Customer priority	Relationship symbol	Score
Size	1	⊙ = 9	1 × 9 = 9
Lightweight	2	○ = 3	2 × 3 = 6
Big touchscreen	4	△ = 1	4 × 1 = 4
Long battery life	3	○ = 3	3 × 3 = 9
Total:			**28**

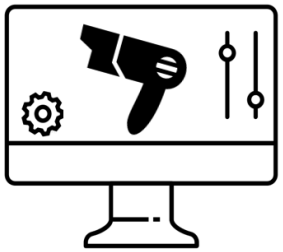
QFD Step 6	QFD Step 7 (Last one)
Complete the roof of the house, which is called the correlation matrix. Here + and - symbols are used to indicate the strength of the link between each of the technical requirements. In our example, there is a strong positive link between the volume (mm3) of the phone and the area of the glass screen (mm^2) so a '++' is entered where they meet (shown by the red dashed lines). The battery capacity has no impact on the screen size, so --' is entered where these two meet. Several of the others have been entered into the matrix.	The final step is to complete the competitor assessment matrix on the right. In our example, the main QFD matrix is for phone A, and this has been compared against competitors' phones B and C using a scale of 1 (worst) to 5 (best) against each of the customer requirements. A solid red line shows how phone A performs.

TA4.2 Modelling Methods

Ways of producing a design idea so that it can be evaluated.

Virtual 3D CAD model

- ✓ Requires no specialist tools or facilities.
- ✓ Easy to make changes.
- ✓ CAD can help make design decisions.
- × Cannot be handled.



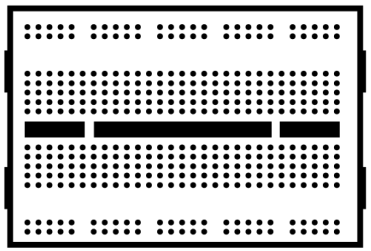
Card Modelling

- ✓ Inexpensive.
- ✓ Quick.
- ✓ Great for checking scale & ergonomics.
- × Not functional.

Breadboarding

Creating an electronic circuit on a generic circuit board.

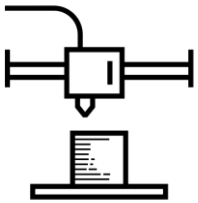
- ✓ Circuit is functionally accurate.
- × Much bigger than specialist printed circuit board.



3D printing

Produces a model directly from CAD data.

- ✓ Others specialist tools not needed.
- × May not be as strong as designed component.
- × Limitations in surface finish & texture.



Block Modelling

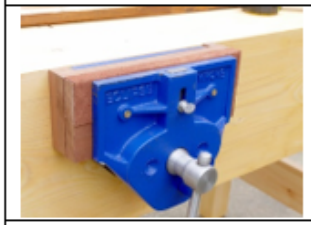
Non-functional but visually accurate model. Made of foam, timber, clay etc.

- ✓ Good for showing a client.
- ✓ Good for testing aesthetics & ergonomics.
- ✓ Promotional photographs.
- × Not functional

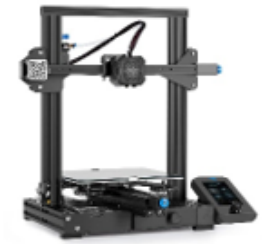
TA3.3 Equipment for Physical Modelling

Image	Name	Function	Materials *See also table below / overleaf*	Safety *See also table below / overleaf*
	Tenon saw.	Straight cuts.	Timber. Modelling foam.	Hold work firmly with bench hook, vice or cl (Ctrl) avoid slipping and injury. Keep hands behind or to side of blade.
	Coping Saw.	Curved cuts.	Timber. Modelling foam.	Hold work firmly with vice or clamp to avoid slipping and injury. Keep hands behind or to side of blade.
	Craft knife.	Cutting thin sheet. Trimming thin waste.	Think sheet paper, card or plastics. 3D printed models.	Extra training needed. Use safety ruler for cutting sheet. Cut away from body. Return immediately after use.

TA3.3 Equipment for Physical Modelling

Image	Name	Function	Materials *See also table below / overleaf*	Safety *See also table below / overleaf*
	Vice.	Holding work firmly.	All rigid materials: • Timber. • Modelling foam. • Plastics. • Metals.	Reduces risk by avoiding slippage.
	Rasps and files.	Removing small amounts of material.		Clamp work where possible and use both hands. This is more effective and prevents accidents caused by slippage. Remove burrs and splinters as soon as possible to prevent cuts to skin.
	Power sander.	Removing small amounts of material. Levelling a surface.		LEV extraction must be on to remove dust / preventing inhalation. Tie up hair and loose clothing to avoid entrapment. Keep fingers at least 40mm from abrabsive to avoid injury to skin.
	Abrasive paper.	Refining a finish by making it progressively smoother.		When using very fine abrasive, use LEV dust extraction or water to prevent inhalation of dust.

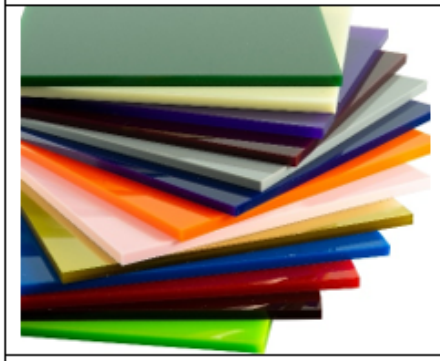
TA3.3 Equipment for Physical Modelling

Image	Name	Function	Materials *See also table below / overleaf*	Safety *See also table below / overleaf*
	3D printer.	Building a 3D model.	PLA. ABS.	Ensure appropriate ventilation. This is especially important with ABS. Prevents inhalation of fumes. Training needed to know which parts are hot. Avoid touching these to prevent burns to skin.
	Laser Cutter.	Cutting sheet material accurately.	Plywood 8mm or less. Acrylic sheet. Paper. Card.	LEV extraction must be on to prevent inhalation of fumes. Do not lift lid for 30 seconds after machine has completed for same reason. Ensure safety interlock is working on machine to prevent laser burns to skin.
	Spray booth.	Allowing safe application of sprayed finishes.	All spray finishes and adhesives.	Ensure LEV extraction is on to avoid inhaling fumes & droplets. Ensure work is completely within booth when using. Clear spray can after use in the booth. Use respirator mask for additional protection.

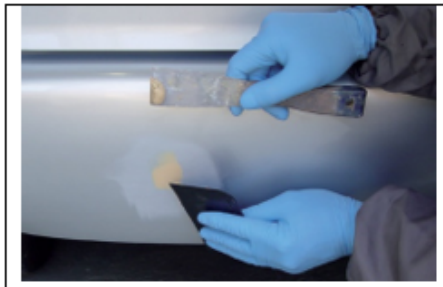
TA3.3 Materials for Physical Modelling

Image	Name	Suitable for	Limitations	Safety Issues
	Rigid polystyrene foam.	Curved surfaces. Making 3D shapes quickly by hand. Can be cut with hot wire cutter (additional safety issues).	Can only achieve limited detail. Structurally weak.	Polystyrene is safter than the alternative (polyurethane) but precautions are still needed: Small particles of waste ('sawdust') could be inhaled so LEV extraction and respirators should be used with fine abrasives. LEV extraction needed for hot wire cutting due to fumes.
	Balsa timber.	3D bodies. Low density structures. East to shape by hand.	Dents easily. Weak.	See equipment safety when cutting / abrading.
	Pine timber.	3D bodies. Stronger and more resilient than balsa. Inexpensive.	Somewhat harder to work by hand than balsa.	
	PVA wood glue.	Bonding timber.	Only bonds timber to timber.	None.

TA3.3 Materials for Physical Modelling

	Epoxy resin glue.	Bonds different materials strongly.	Messy and smelly.	Use in well ventilated room.
	Laser plywood.	Accurately made 2D shapes with depth.	Works best with 4mm plywood. Can only cut out or engrave in 2D.	See equipment safety when cutting / abrading.
	Laser acrylic sheet.		Can only cut out or engrave in 2D.	Take care not to shatter as pieces can be sharp. Clear away any broken material immediately.
	PLA filament.	3D printing. Extruded at about 200^{0}c Low fumes. Bioplastic so sustainable.	Resulting model softens easily with heat.	Use in well ventilated space.
	ABS filament.	3D printing. Extruded at about 250^{0}c Tougher than ABS.	Produces small amounts of toxic fumes when extruded.	Use in very well-ventilated space or with LEV extraction.

TA3.3 Materials for Physical Modelling

	Polyester filler.	Filling blemishes in rigid materials. Can be smoothed with abrasives when set.	Sets very quickly.	Produces fumes when curing so LEV extraction is needed. Can irritate hands when in use so gloves are needed. Can produce very fine dust when 'sanded' so should be smoothed with water or LEV ventilation.
	Wood filler (water based).	Filling blemishes in wood.	Takes longer to set than polyester filler.	As with abrading timber.
	Filler primer (spray).	Filling small scratches.	Must be sanded back after application. Only works on scratch-sized blemishes.	Ensure LEV extraction is on to avoid inhaling fumes & droplets. Ensure work is completely within booth when using. Clear spray can after use in the booth. Use respirator mask for additional protection. Keep away from flames and sparks as solvent is very flammable.
	Plastic primer (spray).	Allowing topcoat to stick to plastics.	The clear variety is hard to see when applying.	
	Topcoat (spray).	Providing colour and matt / gloss / metallic finish.	Drips and runs are common if not applied in light coats.	

TA4.3 Methods of evaluating a design outcome

Ways of measuring the success of a design.

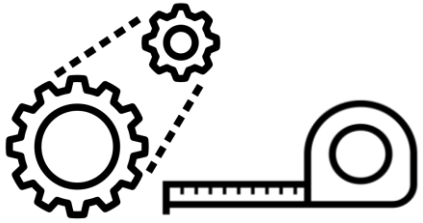
Why evaluate a design outcome?

- To demonstrate that the brief and design specification have been met.
- To compare alternative designs.
- To identify ways in which the design could be improved.

Measuring dimensions and functionality.

Measuring sizes and how well it functions.

- ✓ Objective judgements.
- ✓ Quantifiable.
- × Relies on an accurate understanding of what is really required.
- × Cannot measure qualitative issues e.g. aesthetics or comfort.



Created by Becris

User testing

Asking users to test the design and to give their feedback.

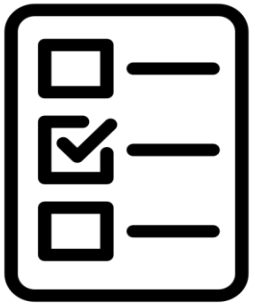
- ✓ Judged against what user actually wants.
- ✓ Good for qualitative judgements e.g. aesthetics or comfort.
- × Time consuming.
- × People's opinions differ.

Created by Gregor Cresnar from the Noun Project

***Quantitative* comparison with design brief and specification**

Judge the design against the original objectives using data.

- ✓ Comparisons can be shown clearly.
- ✓ Success or failure can be judged.
- × Difficult to include qualitative judgements.



Unit R039:

Communicating designs

Coursework.

Worth 30% of your final grade.

R039 Tasks

Details of this task change every year but here is a summary of the main stages of your project:

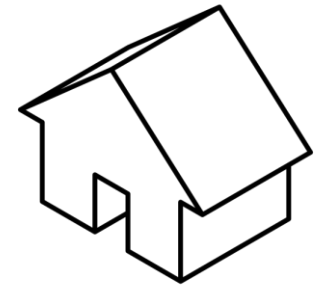
	Task 1	Create sketches of varied design ideas to meet a brief.
	Task 2	Develop one design idea with sketches and annotation.
	Task 3	Create standard engineering design drawings of the chosen design.
	Task 4	Model the design in CAD software (computer aided design)

R039 TA1: Manual production of freehand sketches

You need to show a variety of sketching skills in your work.

Created by Umer Younas from the Noun Project

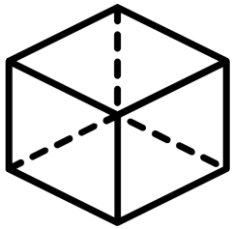
2D



Created by Juan Pablo Bravo from the Noun Project

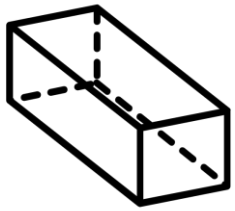
3D

Cube



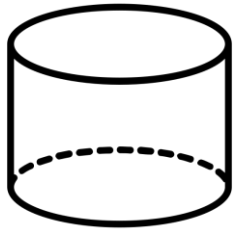
Created by ProSymbols

Rectangular block



Created by ProSymbols

Cylinder

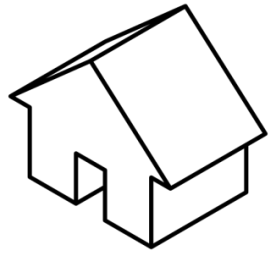


Created by ProSymbols

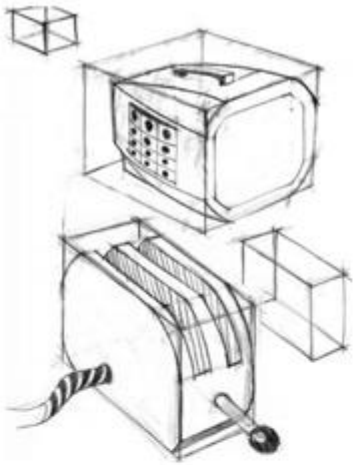
Hollow object

Created by ProSymbols

Compound shape



Created by Juan Pablo Bravo from the Noun Project

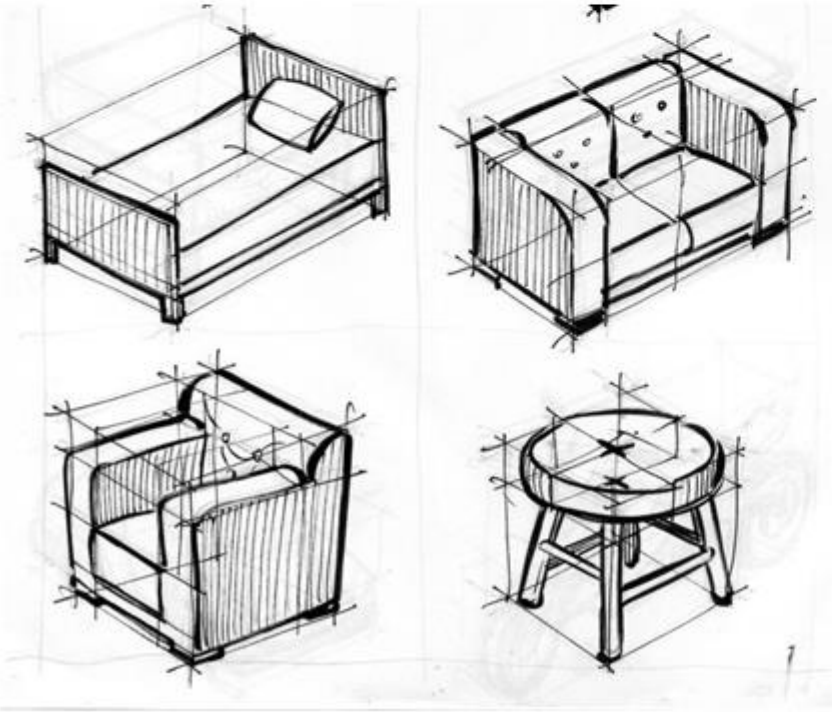


Crating

We construct an 'crate' to draw inside.

The finished drawing will also be 3D.

First we need to be able to sketch a cuboid in the isometric style.



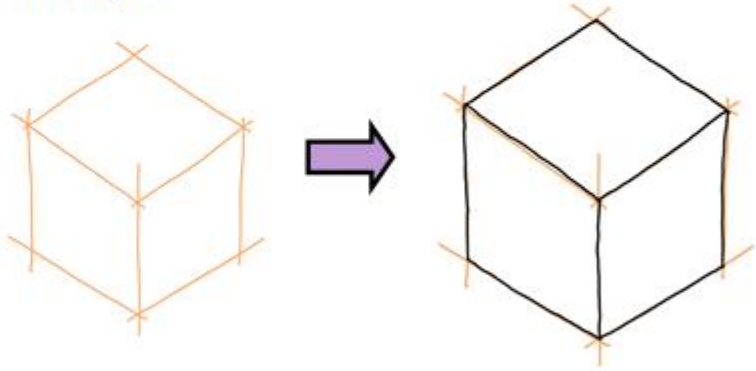
Drawing a cuboid

A cuboid is a cube or a rectangular cube.

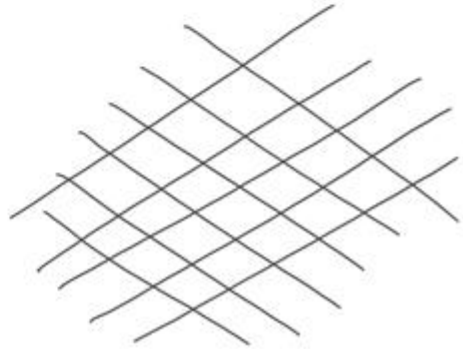
Guidance

- All vertical edges are drawn with a vertical line.
- All horizontal edges are drawn at about 30^0 from horizontal.
- The vertical and horizontal lines should be parallel to each other.

Try drawing this:



How did that work out? If it was disappointing, practice drawing parallel lines at 30^0 from horizontal and try again:

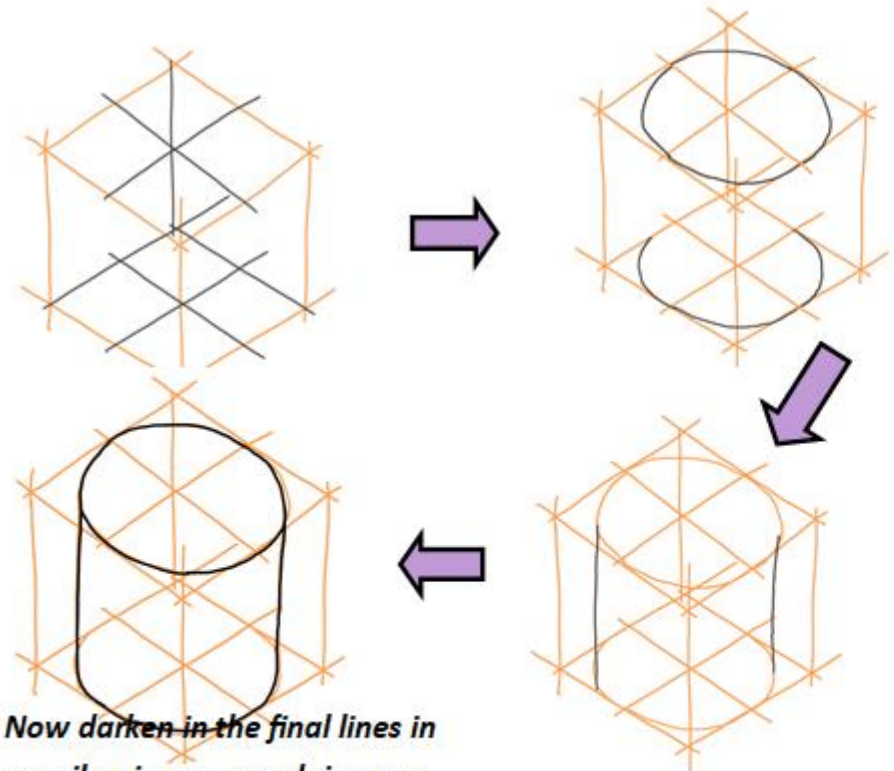


How to draw a cylinder

It is really helpful to be able to draw curves within the crate. This will show you how to do that.

The lines of the cuboid crate are called construction lines because they will help you construct the drawing. They should be done really lightly.

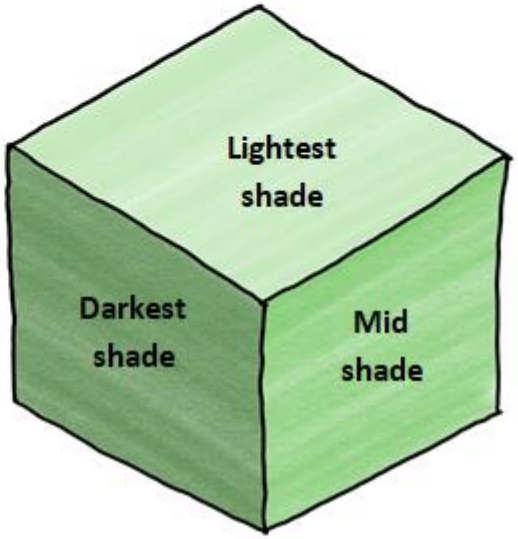
Try drawing this as lightly as possible in pencil. Start with a cuboid. New lines are shown in black:



Now darken in the final lines in pencil or in non-smudging pen.

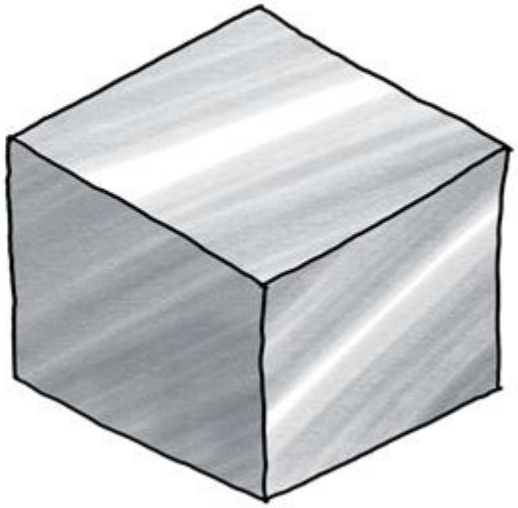
Rendering with shade

This is best in coloured pencil but ordinary pencil will do for now.



Using the same colour but different shades for a 3D effect.

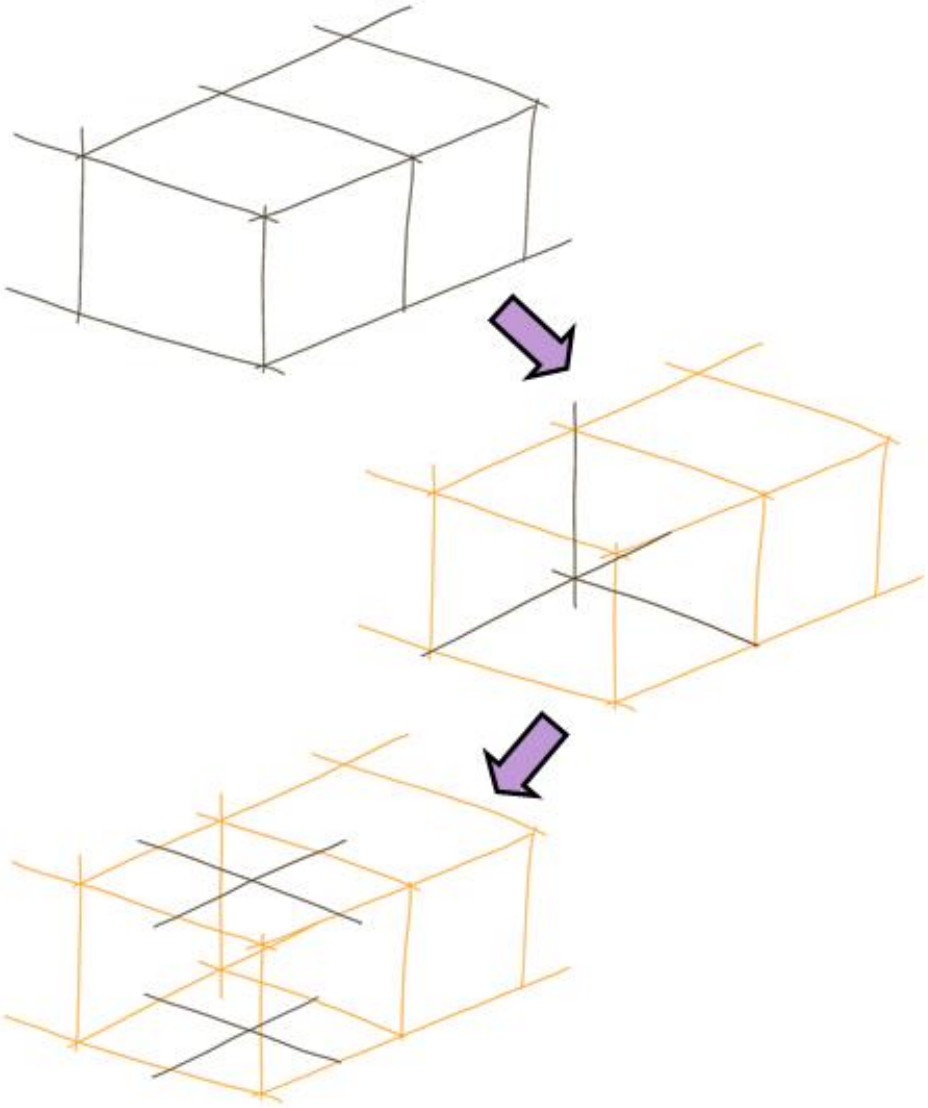
Leave light stripes for a gloss (shiny) effect.

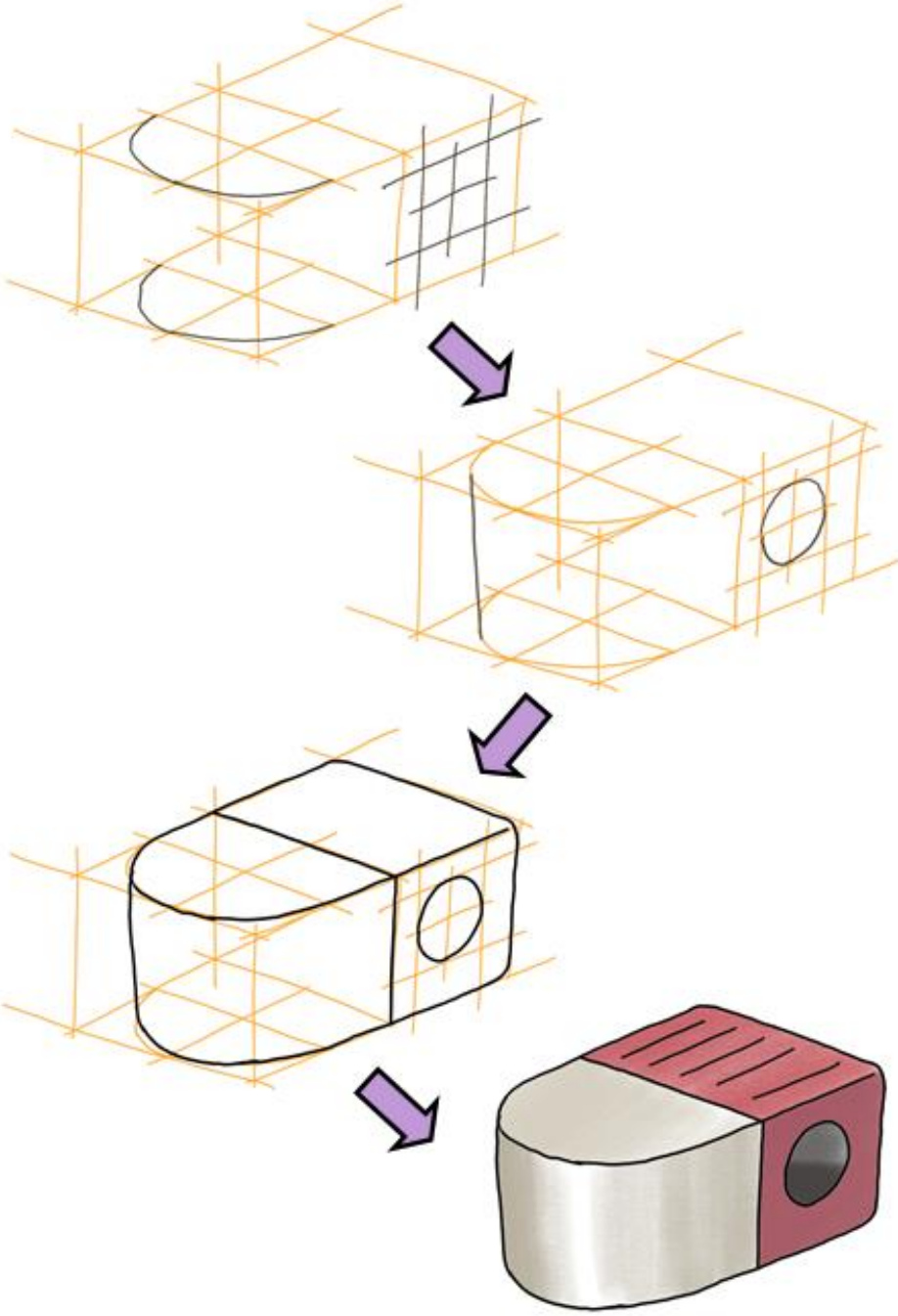


Drawing a sharpener / eraser

This exercise will help you to bring the skills together.

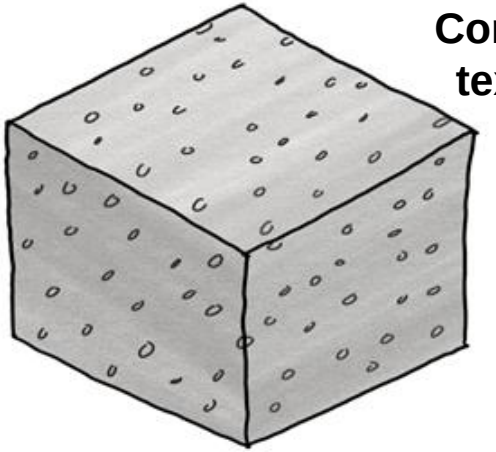
Remember to draw as lightly as possible in pencil to start with.



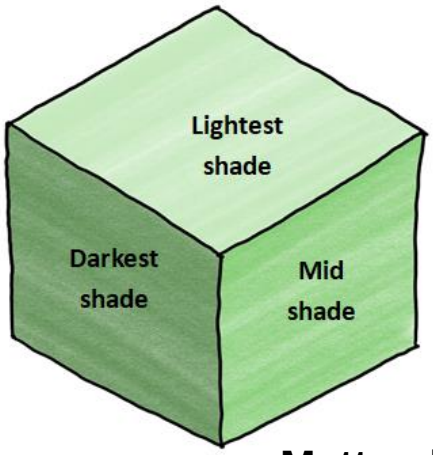


R039 TA1: Manual production of freehand sketches

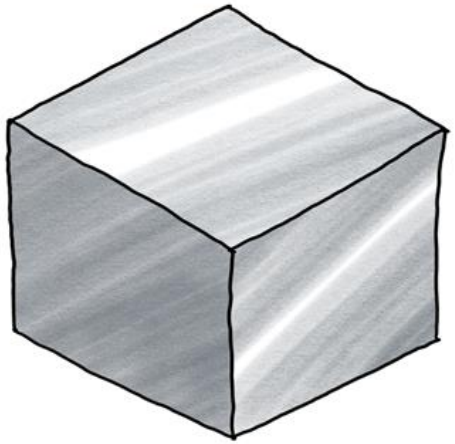
You need to show a variety of rendering skills in your work.



Concrete texture

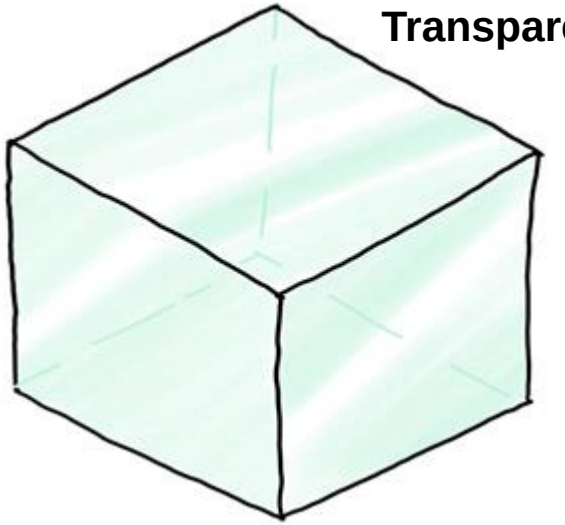


Matt colour

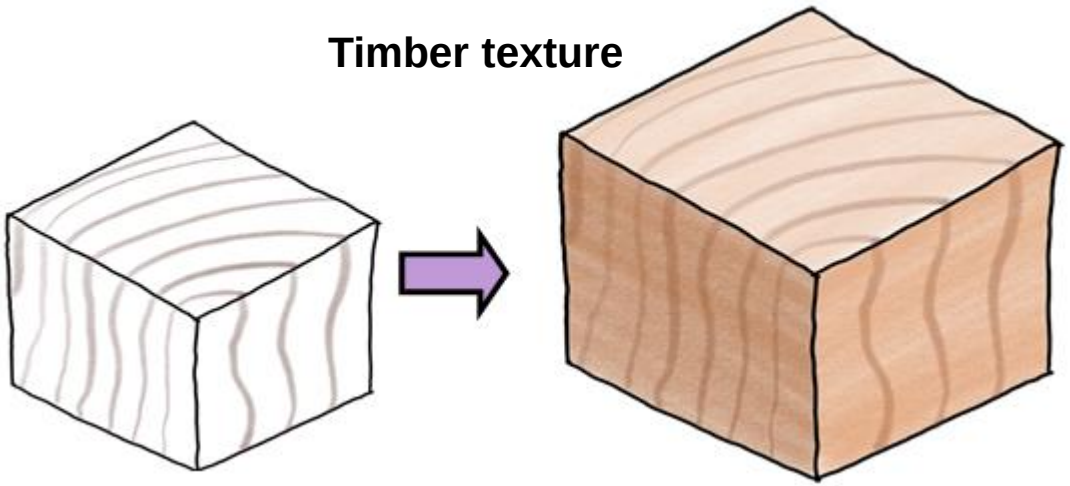


Gloss / metallic

Transparent

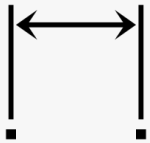


Timber texture



R039 TA1: Annotation & labelling

You need to include these with your drawings.

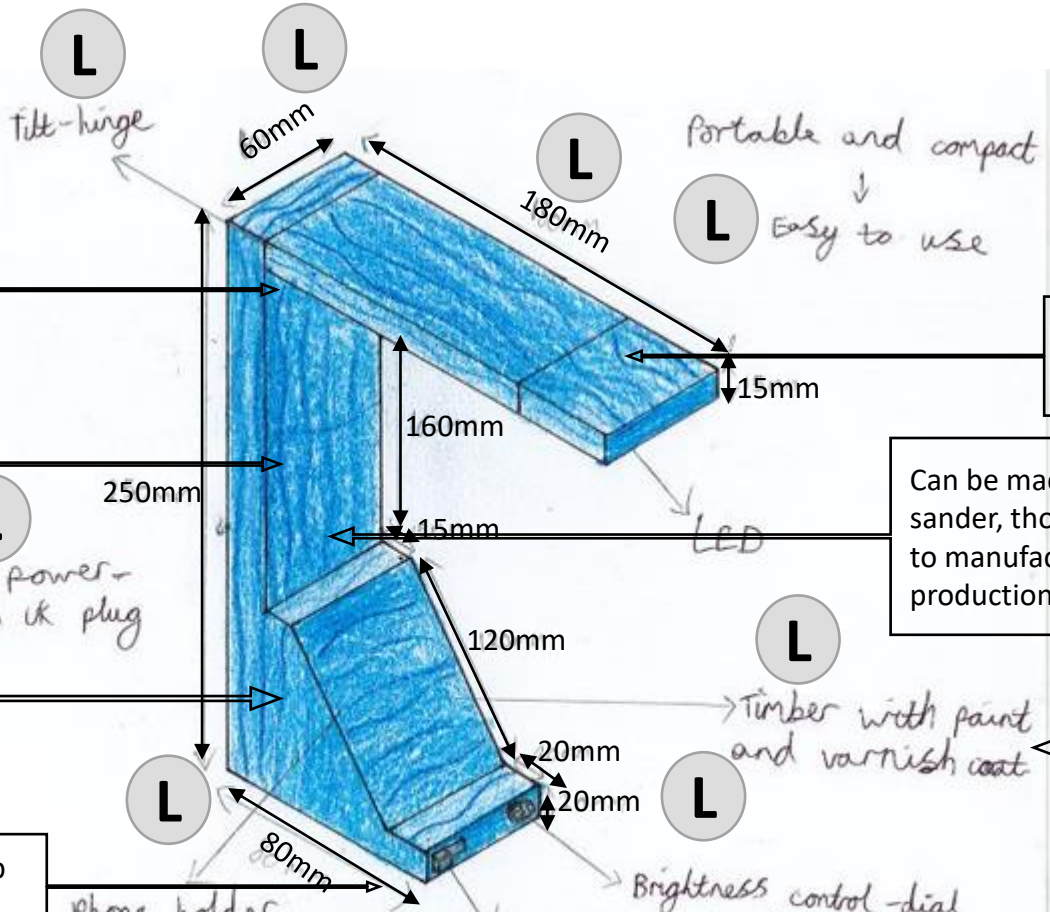
	**Label**	Statement of fact e.g. “Polycarbonate”
	**Annotation**	Explanation of the designer's thinking e.g. “Tough and transparent to let light through”.
	**Key features**	Explain features which are particularly important including those that meet stated requirements.
	**Materials**	What it will be made from
	**Dimensions**	Sizes of main components and of those which must fit with something else.

R039 TA1: Labelling & annotation

Here is an example of what labelling and annotation can look like:

Key

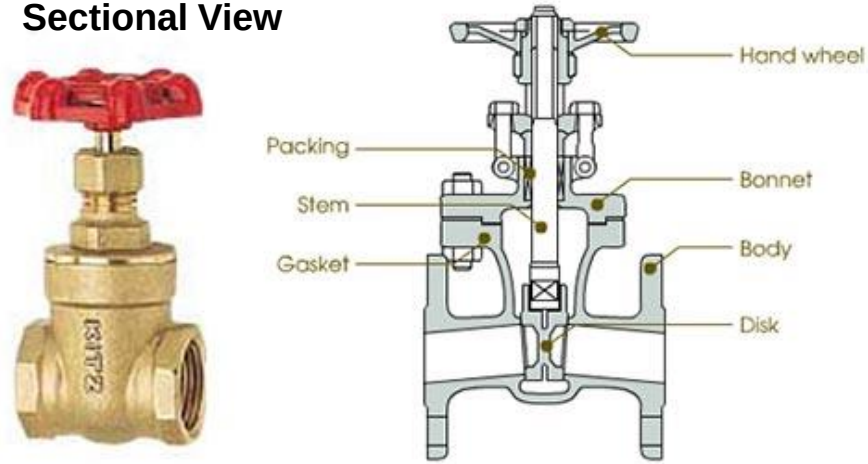
- **L** Label: Statement of fact
- **A** Annotation: Explaining



R039 TA2: Manual production of Engineering drawings

Engineers use a variety of styles of drawings which can be produced by hand.

Sectional View



You will also need to produce:

Created by Loritas Medina from the Noun Project

Assembly instructions.

Created by Division Icons from the Noun Project

Part lists.

Most of the drawing styles you need are in topic 3.1 of R038

R039 TA2: Parts list

A parts list can typically be laid out like this:

Part number	Part name	Quantity needed	Standard or specialist component	Material	Manufacturing method (non-standard only)
1	Upper body shell	1	Specialist	Polypropylene	Injection moulded
2	Lower body shell	1	Specialist	Polypropylene	Injection moulded
3	Self-tapping screw 20 x 4 mm	5	Standard	Steel	N/A
4	PP3 battery clip	1	Standard	Copper, steel	N/A
5					
6					
7					
8					

R039 Task 1: Mark Scheme

Topic Area 1: Manual production of freehand sketches

MB1: 1–4 marks	MB2: 5–8 marks	MB3: 9–12 marks
Produces a **limited** range of creative freehand design proposals. **Limited** consideration of the design specification. Uses a **basic** range of techniques.	Produces an **adequate** range of creative freehand design proposals. **Partial** consideration of the design specification. Uses an **adequate** range of techniques.	Produces a **wide** range of creative and innovative freehand design proposals. **Fully** considers the design specification. Uses a **comprehensive** range of techniques.
MB1: 1–2 marks	**MB2: 3–4 marks**	**MB3: 5–6 marks**
Evidence of analysis of design proposals with **limited** annotation. Justification demonstrates **limited** understanding of needs and wants of the client/user.	Evidence of analysis of design proposals, with **some** annotation. Justification demonstrating **some** understanding of needs and wants of the client/user.	Extensive evidence of analysis of design proposals that are **fully** annotated. Justification demonstrating a **detailed** understanding of needs and wants of the client/ user.

If your work does not meet Mark Band 1 criteria, you will be awarded zero marks for this task.

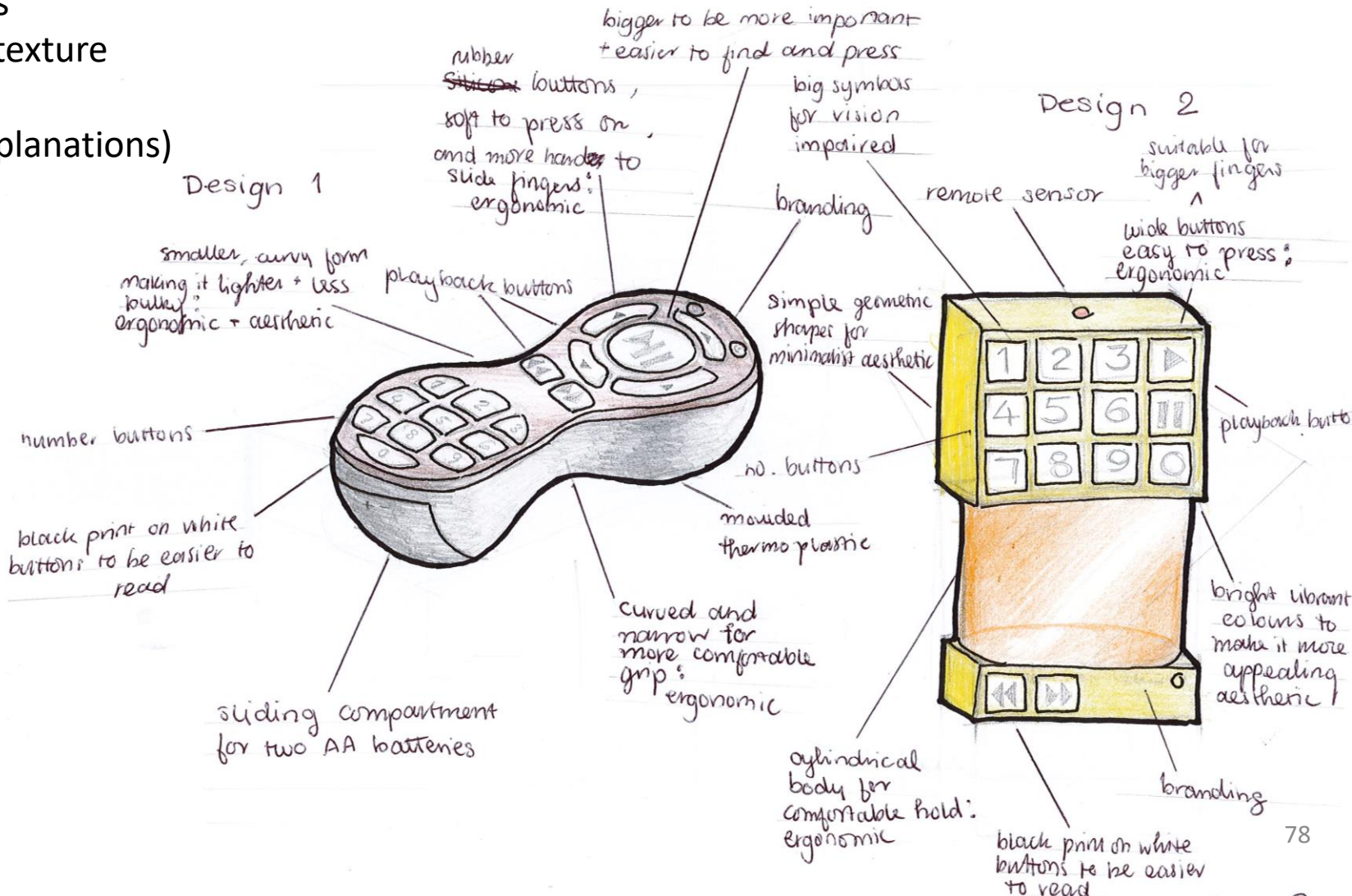
R039 Task 1: Example

Good because:

- ✓ Accurately Drawn
- ✓ Varied ideas
- ✓ Variety of styles
- ✓ Shade, tone & texture
- ✓ Labels (fact)
- ✓ Annotation (explanations)

Also needs

- ✓ More ideas on other pages.



R039 Task 2: Mark Scheme

Topic Area 1: Manual production of freehand sketches – Design Development

MB1: 1–4 marks	MB2: 5–8 marks	MB3: 9–12 marks
Produces a **basic** freehand sketch of design proposal.	Produces **adequate** freehand sketches of design proposal.	Produces **comprehensive** freehand sketches of design proposal.
Brief explanation of the key features of a design proposal with **limited** annotation.	**Adequate** explanation of the key features of a design proposal with **some** annotation.	**Detailed** explanation of the key features of a design proposal that is **fully** annotated.
Limited consideration of the design specification.	**Some** consideration of the design specification.	**Fully** considers the design specification.

If your work does not meet Mark Band 1 criteria, you will be awarded zero marks for this task.

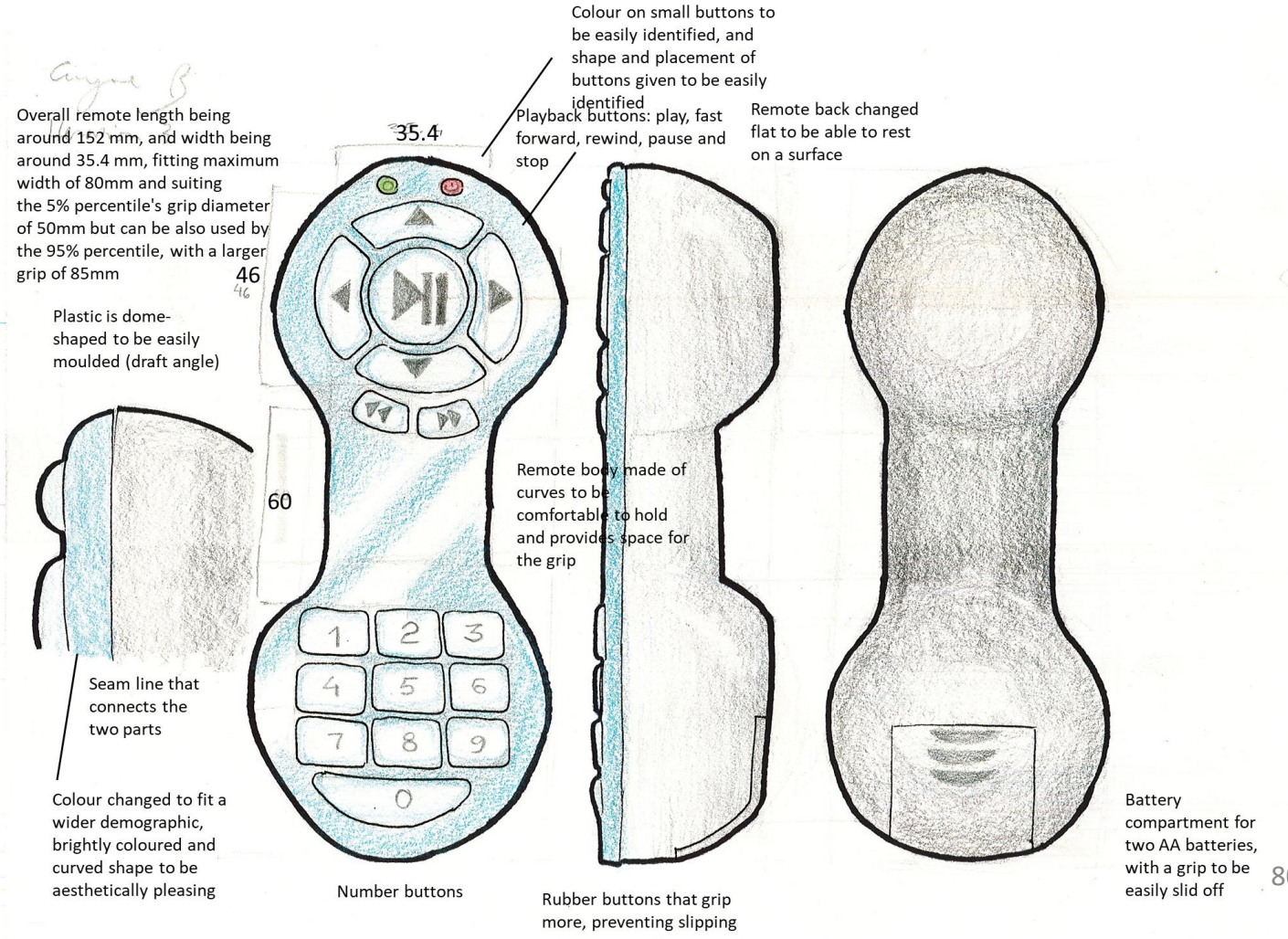
R039 Task 2: Example

Good because:

- ✓ More detailed version of design from Task 1
- ✓ Changes to make it better (explained)
- ✓ Accurately Drawn
- ✓ Shade, tone & texture
- ✓ Labels
- ✓ Annotation

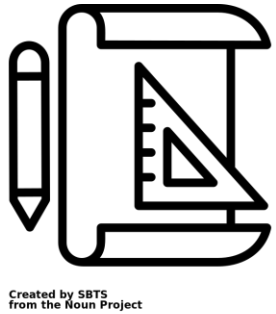
Also needs

- ✓ More variations.
- ✓ Variety of drawing styles



R039 Task 3: Mark Scheme

Most of the drawing styles you need are in topic 3.1 of R038



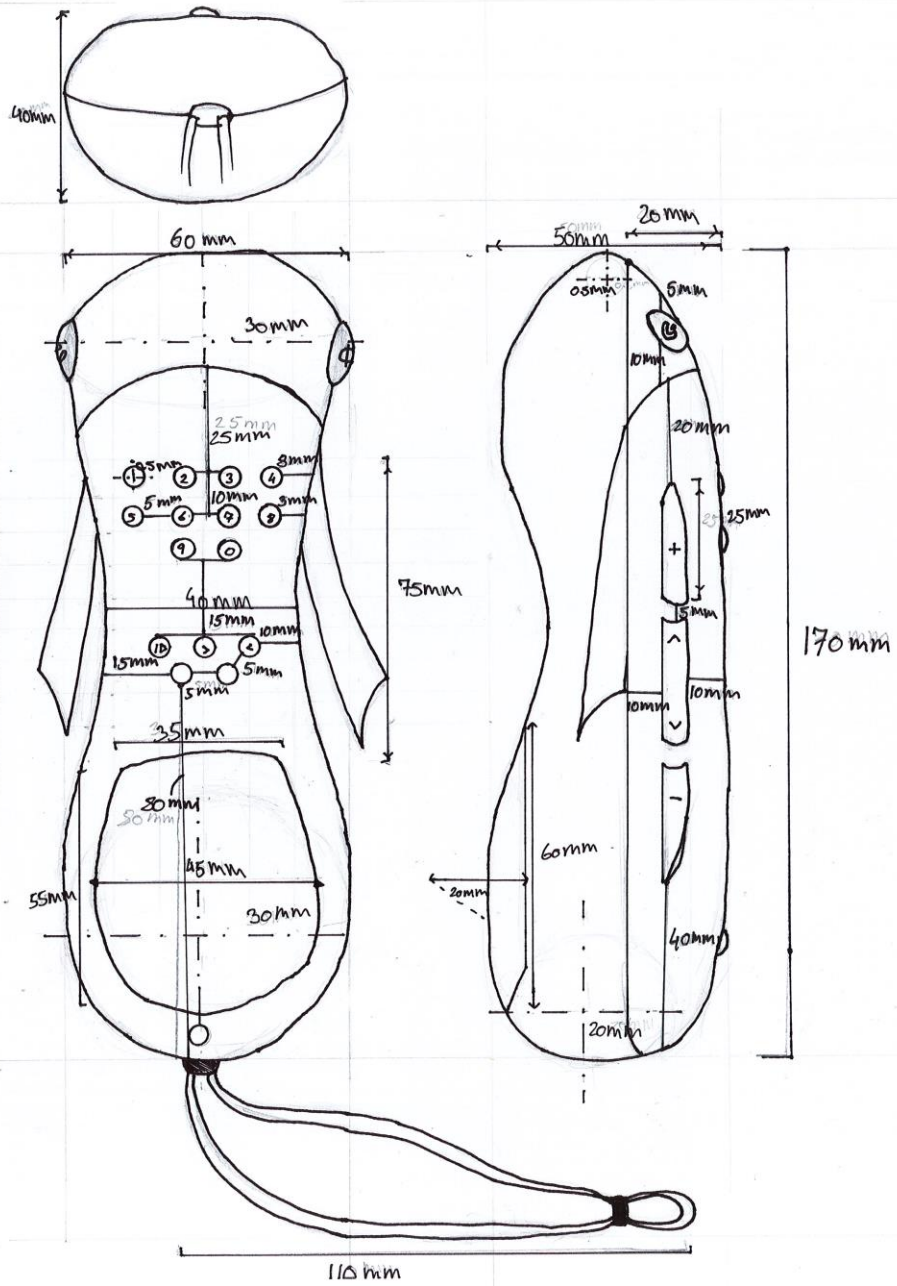
Topic Area 2: Manual production of engineering drawings

MB1: 1–4 marks	MB2: 5–8 marks	MB3: 9–12 marks
Produces a **basic** orthographic drawing. Produces an assembly drawing that is **limited** in detail. Production of drawings is **dependent** upon assistance or help from other sources.	Produces an **adequate** and accurate orthographic drawing. Produces an assembly drawing with **some** detail. Drawings are produced with **some** assistance or help from other sources.	Produces a **comprehensive** orthographic drawing. Produces a **fully** detailed assembly drawing. Drawings are produced **independently**.

If your work does not meet Mark Band 1 criteria, you will be awarded zero marks for this task.

3.1 Types of drawing used in engineering

R039 Task 3: Example



Good because:

- ✓ Accurately constructed
- ✓ Linear dimensions.
- ✓ Spacing dimensions.
- ✓ Variety of line styles.
- ✓ Follows standards
- ✓ Title block.

Also needs

- ✓ Radius / diameter dimensions.
- ✓ Visible construction lines.

Dept.	Technical reference	Created by: Sara Rowinska 23/1/23	Approved by.
Scale 1:1		Document type	Document status
		title : tv remote	DWG no.
		Tolerance : ± 0.2	
		version : 1	Rev. / Date of issue 1/23 / Sheet 1/1

R039 Task 4: Mark Scheme

Topic Area 3: Use of Computer Aided Design (CAD)

MB1: 1–6 marks	MB2: 7–12 marks	MB3: 13–18 marks
Use of CAD to produce a **simple** model of the design proposal. A **simple** 3D virtual model consisting of a very limited number of components. Production of a 3D virtual model is **dependent** upon assistance or help from other sources.	Use of CAD to produce an **adequate** model of the design proposal. An **adequate** 3D virtual model consisting of some components. Production of 3D virtual model is produced with **some** assistance or help from other sources.	Use of CAD to produce a **complex** model of the design proposal. A **detailed** 3D virtual model consisting of many components. 3D virtual models are produced **independently**.

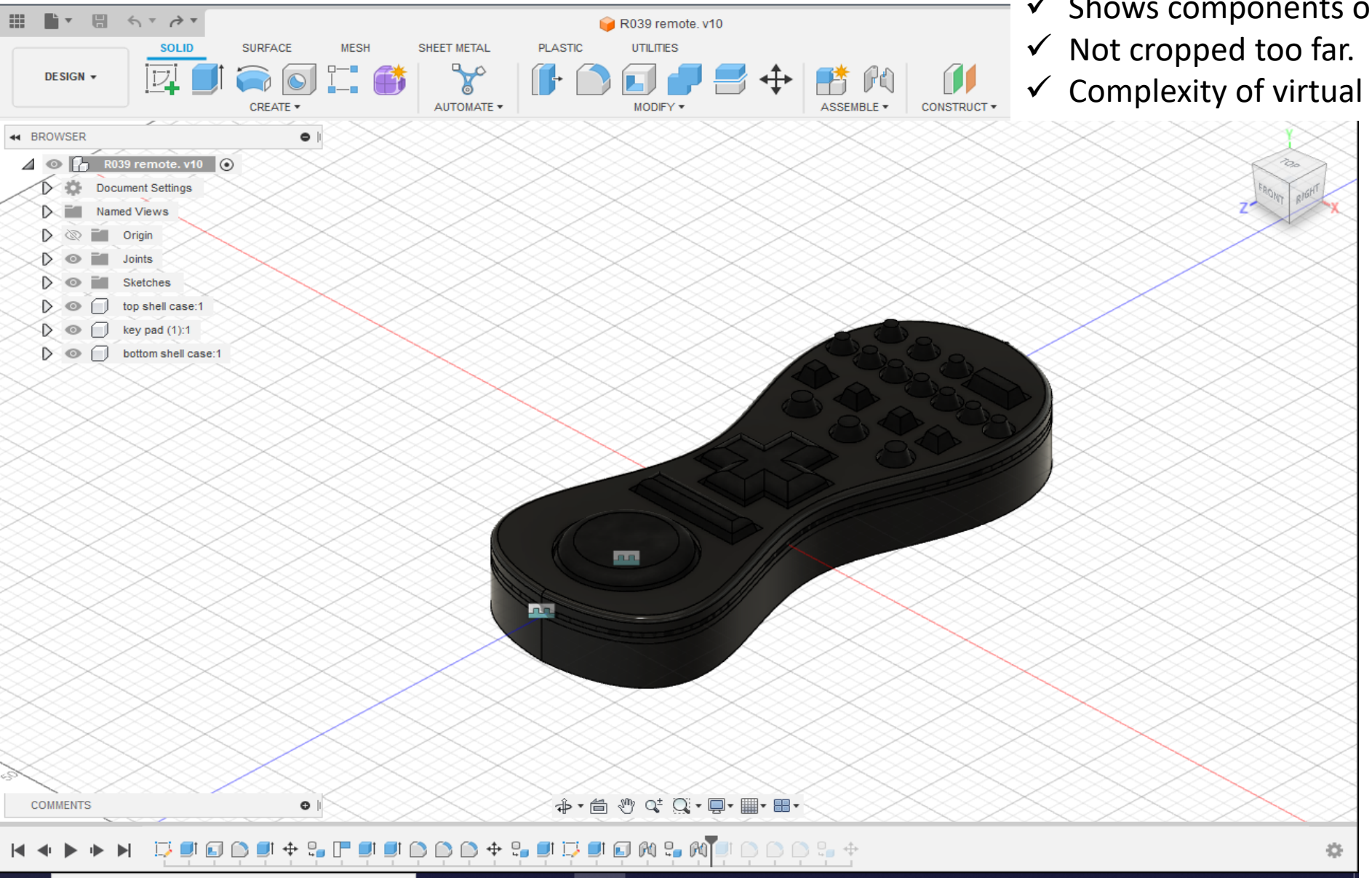
If your work does not meet Mark Band 1 criteria, you will be awarded zero marks for this task.

Useful information in topic 3.1 of R038

R039 Task 4: Example of software use

Good because:

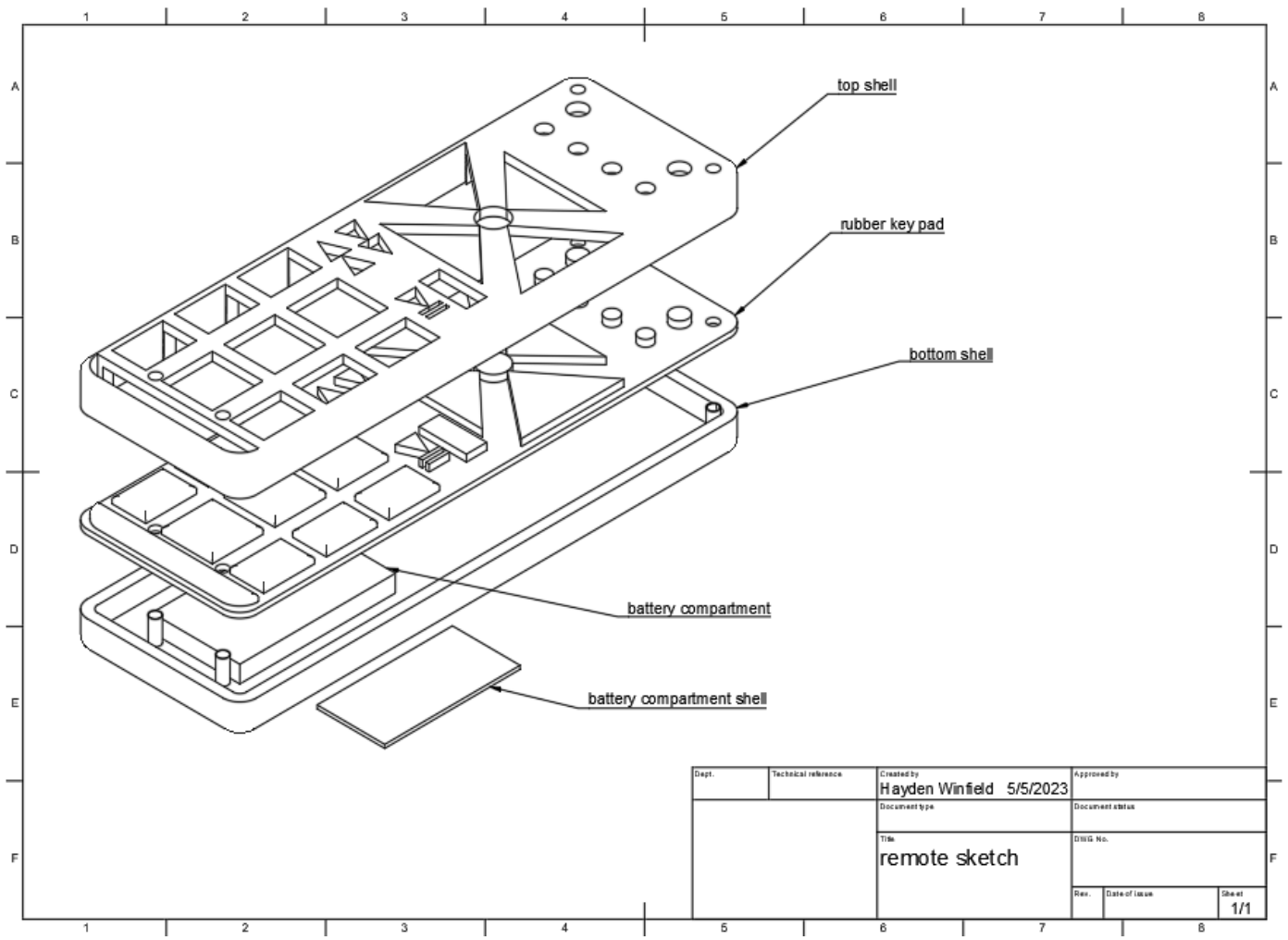
- ✓ Shows software being used.
- ✓ Shows timeline at bottom.
- ✓ Shows components on right.
- ✓ Not cropped too far.
- ✓ Complexity of virtual model.



R039 Task 4: Example of exploded view

Good because:

- ✓ Clear view.
- ✓ Components are labelled.
- ✓ Not cropped too far.
- ✓ Border visible.



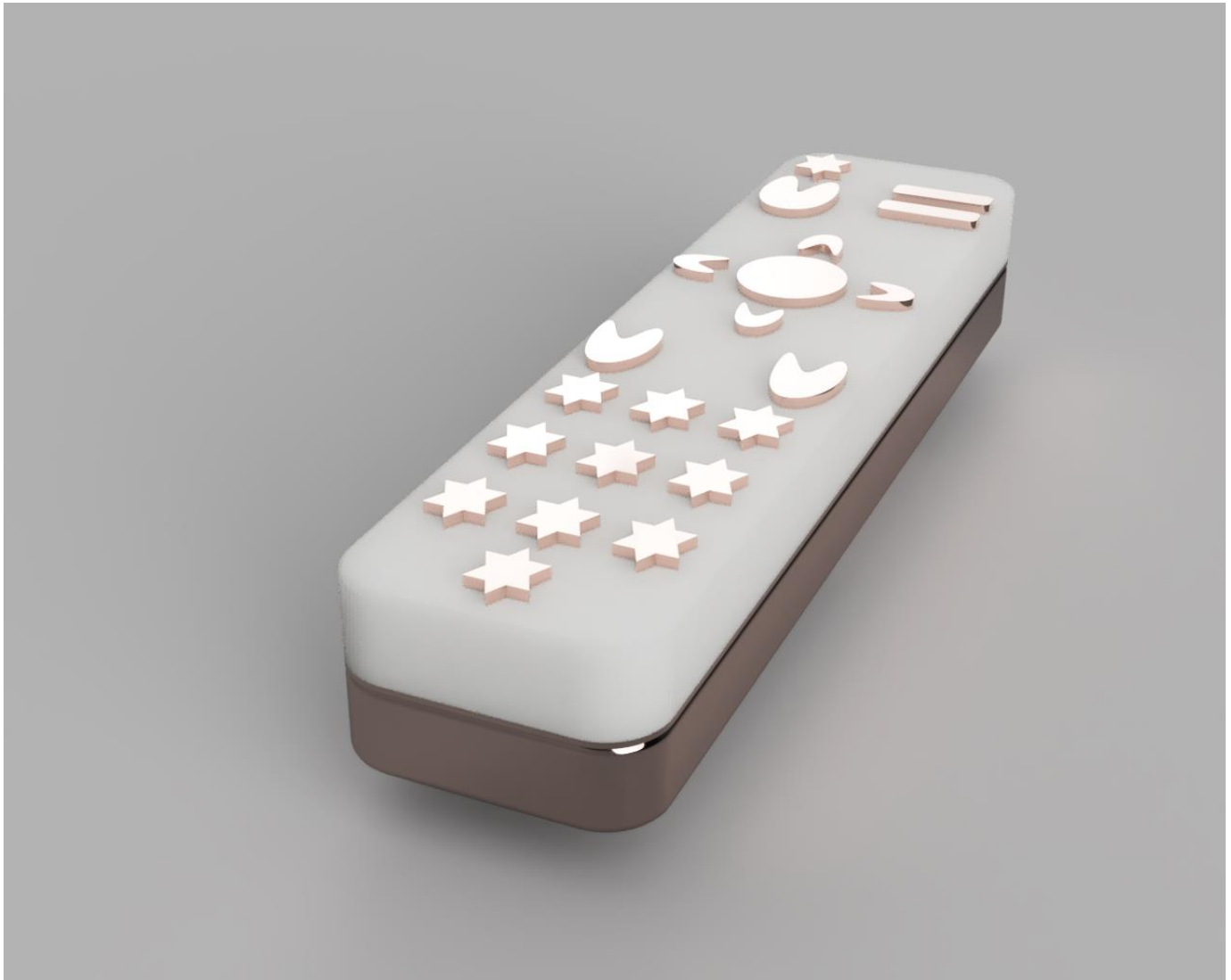
R039 Task 4: Renders

Good because:

- ✓ Perspective view.
- ✓ Interesting angle.
- ✓ Photo-realistic render.
- ✓ Materials chosen.

Also needs

- ✓ Different angles.
- ✓ Variety of materials.



Unit R040:

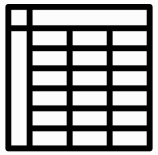
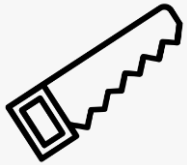
Design, evaluation and modelling

Coursework.

Worth 30% of your final grade.

R040 Tasks

Details of this task change every year but here is a summary of the main stages of your project:

	Task 1	Analyse & compare existing products.
	Task 2	Disassemble a product.
	Task 3	Create a CAD model from an existing drawing.
	Task 4	Plan production of a prototype.
	Task 5	Make the prototype
	Task 6	Evaluate the prototype.

R040 Task 1: Mark Scheme

Topic Area 1.1: Product Evaluation – Product Analysis

MB1: 1–3 marks	MB2: 4–6 marks	MB3: 7–9 marks
Produces a **basic** product analysis of the key features of products using ACCESS FM.	Produces an **adequate** product analysis of the key features of products using ACCESS FM.	Produces a **comprehensive** product analysis of the key features of products using ACCESS FM.
Provides a **basic** description of the strengths and weaknesses of existing products.	Provides an **adequate** description of the strengths and weaknesses of existing products.	Provides a **comprehensive** description of the strengths and weaknesses of existing products.
Basic use of an engineering matrix.	**Appropriate** use of an engineering matrix.	**Effective** use of an engineering matrix.

If your work does not meet Mark Band 1 criteria, you will be awarded zero marks for this task.

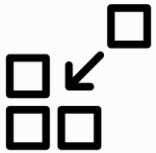
R040 Task 2: Mark Scheme

Topic Area 1.2: Product Evaluation – Product Disassembly

MB1: 1–3 marks	MB2: 4–6 marks	MB3: 7–9 marks
Disassembly of a product is **dependent** upon assistance or help from other sources.	Disassembly of a product is carried out with **some** assistance or help from other sources.	Disassembly of a product is carried out **independently**.
Limited understanding of potential hazards and safety considerations when using tools and equipment.	**Adequate** understanding of potential hazards and safety considerations when using tools and equipment.	**Clear** understanding of potential hazards and safety considerations when using tools and equipment.
Produces a **limited** analysis of the components, materials, production methods, assembly, and manufacturing methods used in an engineered product.	Produces an **adequate** analysis of the components, materials, production methods, assembly, and manufacturing methods used in an engineered product.	Produces a **comprehensive** analysis of the components, materials, production methods, assembly, and manufacturing methods used in an engineered product.

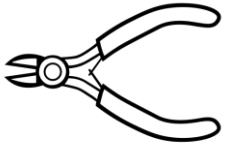
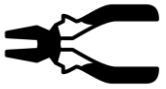
R040 TA1.2: Carry out product disassembly – Common assembly methods

These are ways in which components are commonly assembled.

	Temporary fixings
	Permanent fixings
	Adhesives
	Welds
	Push / snap fit / Clips

R040 TA1.2: Carry out product disassembly –
Common tools for disassembly

These are ways in which components are commonly disassembled.

	Spanner
	Socket set
	Screwdriver
	Wire cutter
	Hex wrench / Allen key
	Pliers

R040 TA1.2: Carry out product disassembly – Common materials and production methods

These are ways in which components are commonly assembled.

Material		Common production method
Plastics	Thermoplastics	• Injection moulding • Vacuum forming
	Thermosetting plastics	• Compression moulding
Metals	Ferrous	• Forging • Casting • Fabrication • Press-forming
	Non-ferrous	
Timber	Softwood	• Turning • Assembly by construction • Glued lamination • Routing • Sawing
	Hardwood	
	Manufactured board	
Ceramics	Ceramics are a group of materials based on minerals and includes glass and pottery.	• Slip casting • Sintering • Firing
Textiles	Including woven cloth and non-woven textiles.	• Sewing • Weaving • Thermal (heat) bonding

R040 Task 3: Mark Scheme

Topic Area 2: Virtual CAD 3D

MB1: 1–4 marks	MB2: 5–8 marks	MB3: 9–12 marks
Produces a **basic** 3D virtual model using CAD. Produces a **simple** 3D virtual model consisting of a very limited number of components. Demonstration of complex industry-related CAD activities is **dependent** upon assistance or help from other sources.	Produces an **adequate** 3D virtual model using CAD. Produces an **adequate** 3D virtual model consisting of some mated components. Demonstration of complex industry-related CAD activities is carried out with **some** assistance or help from other sources.	Produces a **comprehensive** 3D virtual model using CAD. Produces a **complex** 3D virtual model consisting of many mated components. Demonstration of complex industry-related CAD activities is carried out **independently**.

If your work does not meet Mark Band 1 criteria, you will be awarded zero marks for this task.

R040 Task 4: Mark Scheme

Topic Area 2: Physical modelling – Production Planning

MB1: 1–2 marks	MB2: 3–4 marks	MB3: 5–6 marks
A **basic** description of the planning stages to be used in the manufacturing of the prototype. Shows **limited** understanding of safety considerations. Completion of the production plan is **dependent** upon assistance or help from other sources.	An **adequate** description of the planning stages to be used in the manufacturing of the prototype. Shows **some** understanding of safety considerations. Completion of the production plan is carried out with **some** assistance or help from other sources.	A **comprehensive** description of the planning stages to be used in the manufacturing of the prototype. Shows a **detailed** understanding of safety considerations. Completion of the production plan is carried out **independently**.

If your work does not meet Mark Band 1 criteria, you will be awarded zero marks for this task.

R039 TA2: Production planning

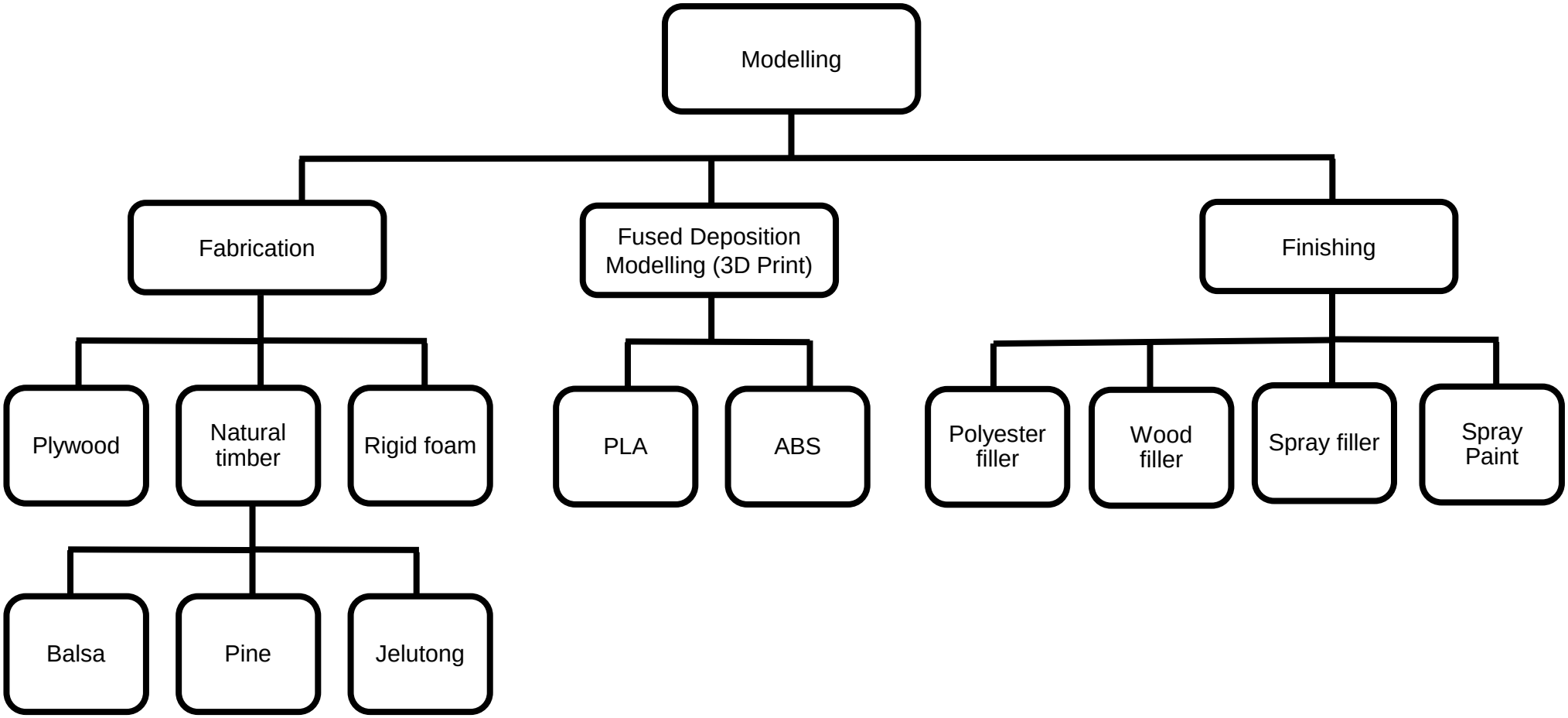
A production plan might typically look like this.

Stage	Description	Materials	Tools	Health & Safety
1	Cut timber parts to size.	Pine Strip	Tenon saw Bench hook	• Use correct technique to avoid saw injury. • Keep tools in centre of bench.
2	Drill mounting holes.	Pine parts	Pillar drill	• Ensure operator's box is clear. • Use guard and eye protection. • Take off rings and watch.
3	Etc.			
4				
5				
6				
7				
8				

See also R038 TA2.3 Risk Assessment

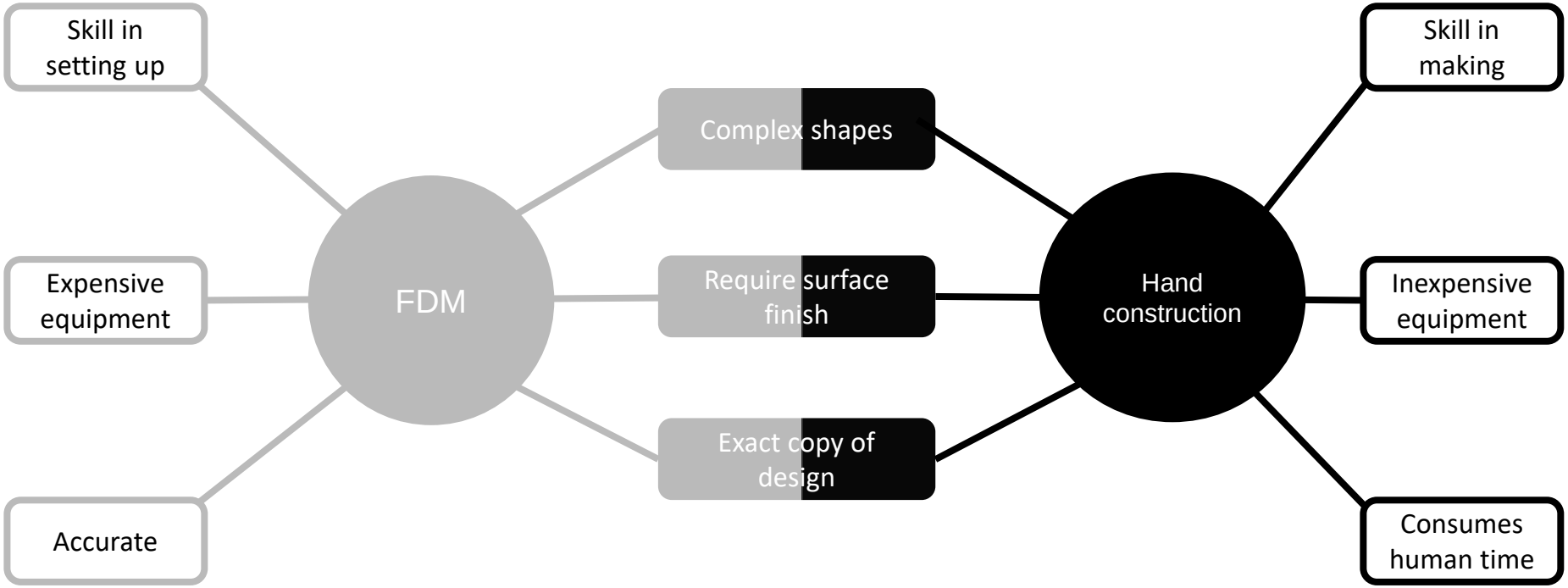
Modelling Materials for Prototyping

These materials are popular for making visual prototypes.



Modelling Methods for Prototyping

Hand construction and Fused Deposition Modelling (3D Printer)



Fabrication Modelling Materials for Prototyping

These materials are popular for making visual prototypes through hand fabrication.

Material	**Advantages**	**Limitations**
Rigid foam	• Easy to shape with hand tools. • Great for 3D curves.	• Rough finish. • Hard to prepare for paint.
Plywood	• Can be laser cut with accuracy. • Stable (does not warp or twist). • Strong in both directions. • Great for geometric shapes.	• Sheet meterial, needs layers for 3D shape. • Moderately hard to create smooth finish.
Balsa timber	• Easy to shape. • Lightweight.	• Dents easily. • Relatively expensive.
Jelutong timber	• Moderately easy to shape. • Easy to create a quality finish. • Strong.	• Relatively expensive. • Features latex canals (veins) which must be filled.
Pine timber	• Inexpensive. • Readily available.	• A coarse grain so it can be hard to get a smooth finish, especially on the end grain.

Finishing Materials for Prototyping

These materials are popular for creating a high quality final finish on models.

Material	**Advantages**	**Limitations**
Polyester filler	• Quick setting paste – good for filling imperfections a few mm deep. • Works on all rigid materials.	• Only workable for 5 minutes. • Needs extensive work with abrasives once set. • Releases harmful fumes which must be controlled.
Wood filler	• Workable for several minutes. • Quick setting paste – good for filling imperfections a few mm deep. • Does not produce harmful fumes.	• Dries in 24 hours typically. • Designed for timber only. • Needs extensive work with abrasives once set.
Spray filler	• Easy to apply - in several small coats. • Easier to apply evenly.	• Will not fill gaps bigger than 1-2mm. • Releases harmful fumes and particles which must be controlled.
Spray paint	• Variety of colours available. • Produces a high quality finish if surface preparation is good.	• High quality surface preparation needed. • Must be applied in several light coats. • Releases harmful fumes and particles which must be controlled.

FDM (Fused Deposition Modelling) Materials for Prototyping

These materials are popular for making visual prototypes using 3D Printing.

Material	**Advantages**	**Limitations**
ABS	• Available as FDM filament • Tough • Softens at 200c	• Works on only some FDM machines. • Can emit hazardous fumes when extruded.
PLA	• Available as filament. • Works with all FDM machines. • Low fume emission when extruded.	• Softens at 80c. • Not as tough as ABS.

R040 Task 5: Mark Scheme

Topic Area 2: Physical Modelling – Prototype Production

MB1: 1–6 marks	MB2: 7–12 marks	MB3: 13–18 marks
Dependent upon assistance to produce a prototype from a production plan.	Requires **some** assistance to produce a prototype from a production plan.	**Independently** produces a prototype from a production plan.
Dependent upon prompts to use PPE equipment when working with tools, machines, materials, chemicals, finishes and solvents.	Requires **some** prompting to use appropriate PPE when working with tools, machines, materials, chemicals, finishes and solvents.	**Independently** uses appropriate PPE when working with tools, machines, materials, chemicals, finishes and solvents.
Use tools and processes with **limited** effectiveness to produce and assemble an outcome that partly meets the production plan. The prototype will be incomplete.	Use tools and processes with **some** effectiveness to produce and assemble an outcome that mostly meets the production plan. The prototype will be mostly complete.	Use tools and processes **effectively** to produce and assemble an outcome that is of a high quality, accurate and fully meets the production plan. The prototype will be fully complete.
Produces a **limited** record of the key stages of making the prototype.	Produces an **adequate** record of most of the key stages of making the prototype.	Produces a **detailed** and accurate record of the key stages of making the prototype.

If your work does not meet Mark Band 1 criteria, you will be awarded zero marks for this task.

R039 TA2: Prototype Production

You will need to keep a ‘Making Diary’ to record how you made your prototype. Each stage will need at least one photograph & explanations.

At this stage I am filling imperfections with polyester filler.

I have mixed it following the manufacturers instructions and I must apply it within 10 minutes. I will then sand or file the excess.

I am wearing gloves to protect my hands and have extraction turned on to remove fumes. The filler is stored in a metal cabinet according to COSHH regulations.

At this stage I am using a file to remove the excess set polyester filler.

I have held the work in a vice to prevent it from moving. This will hep me get a 90 degree edge too.

When I finished, I used a vacuum cleaner to clear up the dust so that it would not breathed in by anyone.

R040 Task 6: Mark Scheme

Topic Area 2: Physical Modelling – Evaluation of a Prototype

MB1: 1–2 marks	MB2: 3–4 marks	MB3: 5–6 marks
Produces a **basic** evaluation of the prototype outcome against the product specification. Provides **limited** potential improvements. No justification is provided.	Produces an **adequate** evaluation of the prototype outcome against the product specification. Provides **some** potential improvements, with justification.	Produces a **comprehensive** evaluation of the prototype outcome against the product specification. Provides **detailed** potential improvements with justification.

If your work does not meet Mark Band 1 criteria, you will be awarded zero marks for this task.

R039 TA2: Evaluation of a prototype

You will need to keep evaluate your prototype.

Find the design specification. For each requirement, explain

 Created by Gregor Cresnar from the Noun Project	How it meets that requirement.
 Created by David Khai from the Noun Project	Ways in which it does not meet the requirement.
 Created by Maxim Kulikov from the Noun Project	Ideas for improvement.

Document the improvements.

Glossary of words use in mark schemes

Mark Band 1

Word	Meaning
Basic	• Work includes the minimum required. It is a starting point but is simplistic and not developed. • Understanding and skills are applied in a way that partly achieves the wanted or intended result, but it would not be useable without further input or work.
Brief/Briefly	• Work includes a small number of relevant facts or concepts but lacks detail, contextualisation or examples.
Dependent	• The student can perform a task when given regular assistance or help.
Few	• Work produced is restricted or narrow. It includes less than half of the information or examples expected for a full response.
Inefficient	• Outputs are produced but with great expense or effort because of poor organisation or design and not making the best use of available resources.
Limited	• Work produced is restricted in range or scope and includes only some of the information required. It evidences partial rather than full understanding. • Work produced is a starting point rather than a developed process, concept or output.
Minimal	• Includes very little in amount or quantity required.
Simple	• Includes a small number of relevant parts, which are not related to each other.
Superficial	• Work completed lacks depth and detail.

Glossary of words use in mark schemes

Mark Band 2

Mark Band (MB2) Words:

Word	Meaning
Adequate(ly)	• Work includes the appropriate number of relevant facts or concepts but does not include the full detail, contextualisation or examples.
Assisted	• The student can perform a task with occasional assistance or help.
Part(ly)/Partial	• To some extent but not completely. • Work produced is inclusive in range and scope. It evidences a mainly developed application of understanding, performance or output needed. • Work produced results in a process, concept or output that would be useable for its purpose.
Some	• Work produced is inclusive but not fully comprehensive. It includes over half the information or examples expected for a full response.
Sound	• Valid, logical, shows the student has secured most of the relevant understanding, but points or performance are not fully developed. • Applies understanding and skills to produce the wanted or intended result in a way that would be useable.

Glossary of words use in mark schemes

Mark Band 3

Mark Band (MB3) Words:

Word	Meaning
Accurate(ly)	• Acting or performing with care and precision. • Correct in all details.
All	• Work produced is fully comprehensive and wide-ranging. It includes almost all, or all the information or examples expected for a full response.
Clear(ly)	• Focused and accurately expressed, without ambiguity.
Complex	• Includes many relevant parts, all of which relate to each other logically.
Comprehensive(ly)	• The work produced is complete and includes everything required to show depth and breadth of understanding. • Applies the understanding and skills needed to successfully produce the wanted or intended result in a way that would be fully fit-for-purpose.
Consistent(ly)	• A level of performance which does not vary in quality over time.
Critical	• Objective analysis and evaluation in order to form: a judgement, evaluation of the evidence or effective trouble shooting/fault finding.
Detailed	• Gives point by point consideration of all the key information.
Effective	• Applies the skills required to the task and is successful in producing the desired or intended result. • The work produced is effective in relation to a brief.
Efficient	• Able to produce results or outputs with the minimum expense or effort, because of good organisation or design and making the best use of available resources.
Full(y)	• Work produced is comprehensive in range and scope. It evidences a fully developed application of understanding, performance or output needed. • Work produced results in a process, concept or output that would be fully fit-for-purpose.
Independent(ly)	• The student can perform a task without assistance or reliance on others.
Justify/Justified	• The reasons for doing something are explained in full.
Most(ly)	• Includes nearly all of what is expected to be included.
Wide (ranging)	• Includes many relevant details, examples or contexts; all of which are fully detailed, contextualised or exemplified.