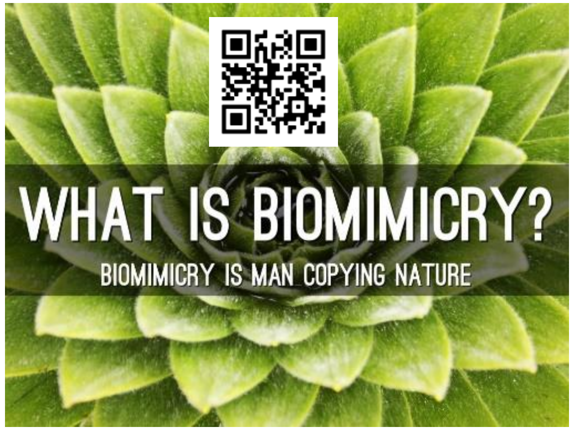
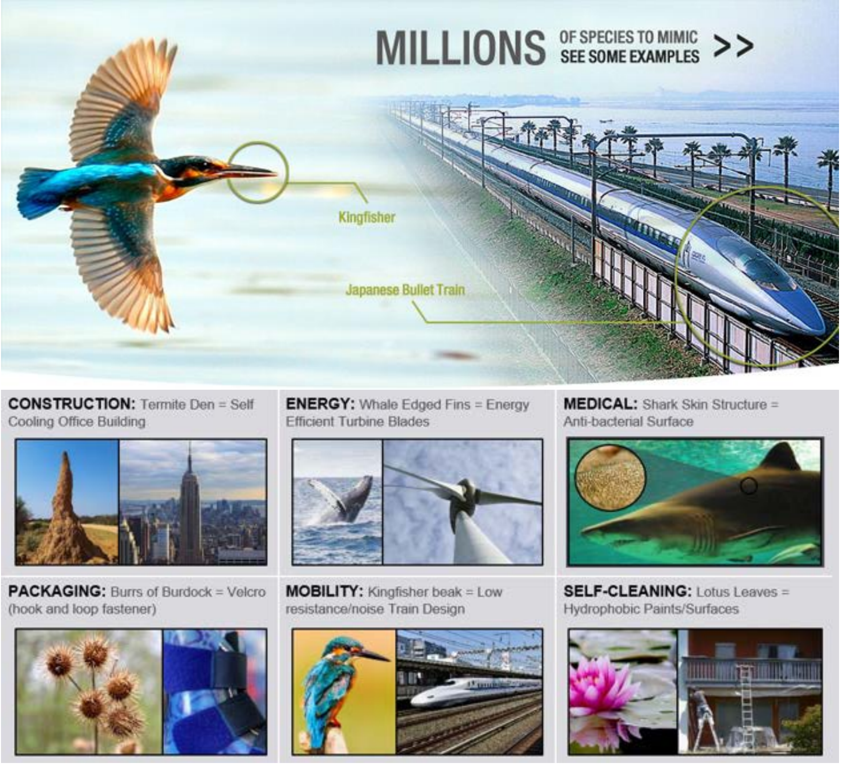


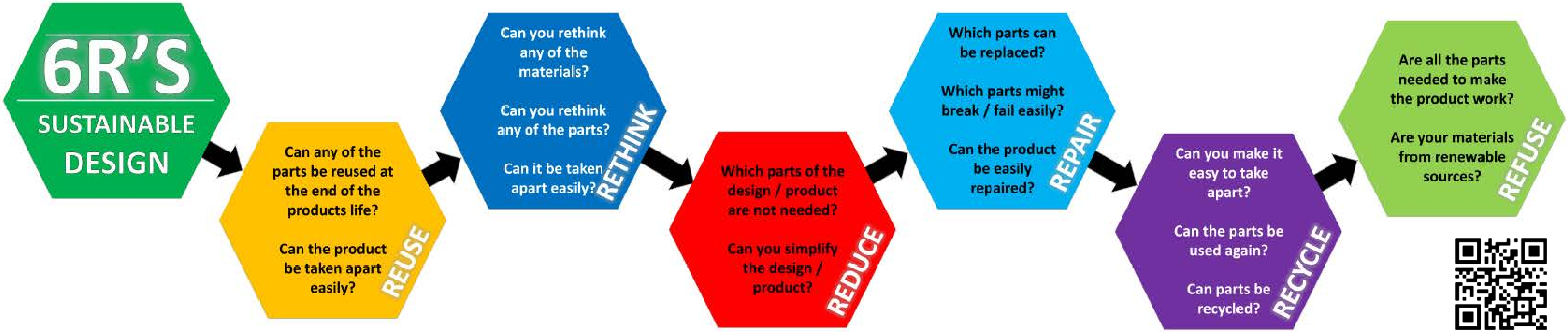
It is not a new idea.

Humans have been looking at nature for answers to both complex and simple problems throughout our existence. Nature has solved many of today's engineering problems.

Dictionary Definition:

'The design and production of materials, structures, and systems that are modelled on biological entities and processes'



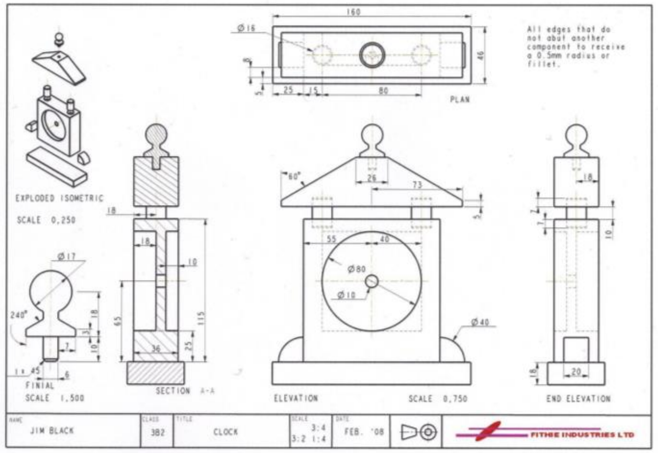


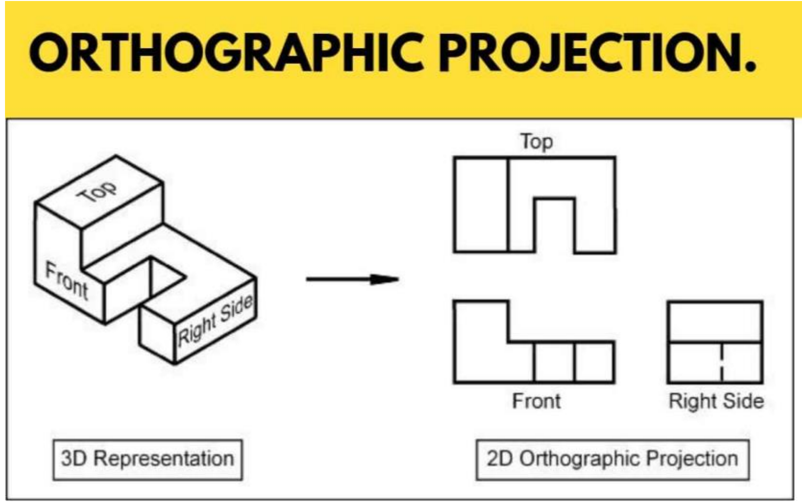
Orthographic Drawing

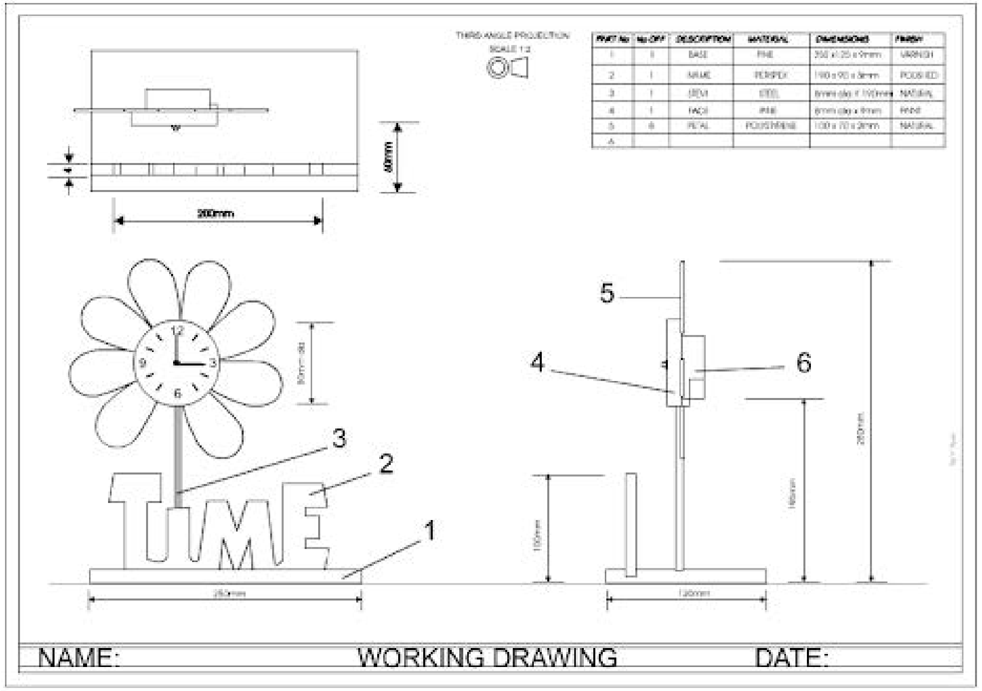
An orthographic drawing represents a three-dimensional object using several two-dimensional views of the object. It is also known as an orthographic projection. For example, you can see in the images below the front, top and side views of a clock.

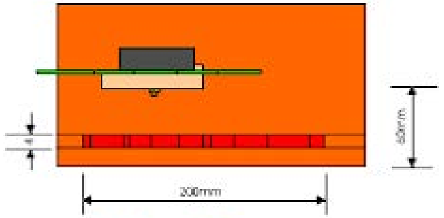
Take a minute and imagine you are shopping for a chair to go in your living room. You find the perfect one, but it is way too expensive. Fortunately, you have a cousin that builds furniture. Maybe he can build the chair for you! Describing the chair over the phone was more than a challenge. Your cousin suggests you send him pictures of the chair from multiple angles, along with the measurements.

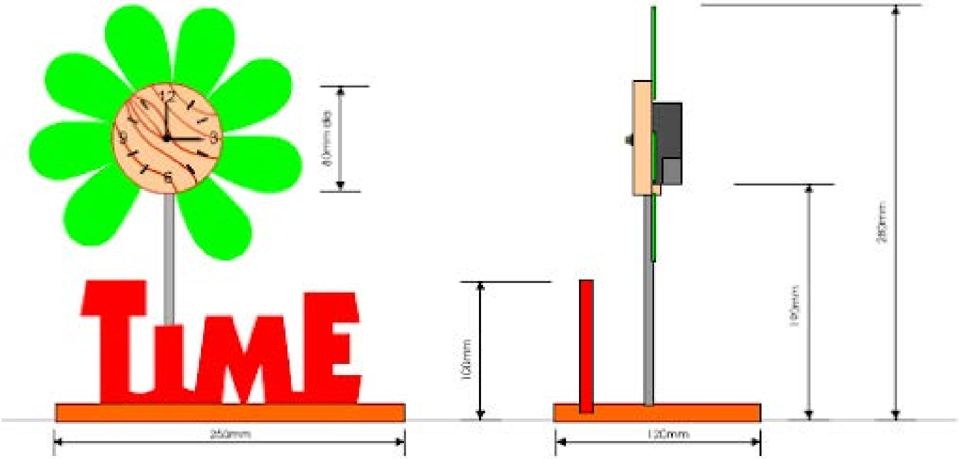
This experience illustrates the process that a furniture designer must go through in order for the manufacturer to create the chair as intended. Three-dimensional drawings can be used to show the overall concept and design, but they are often not clear or detailed enough. Orthographic drawings can help to overcome those challenges.



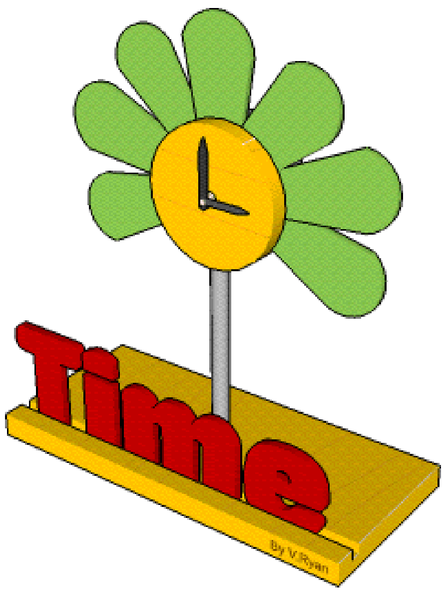


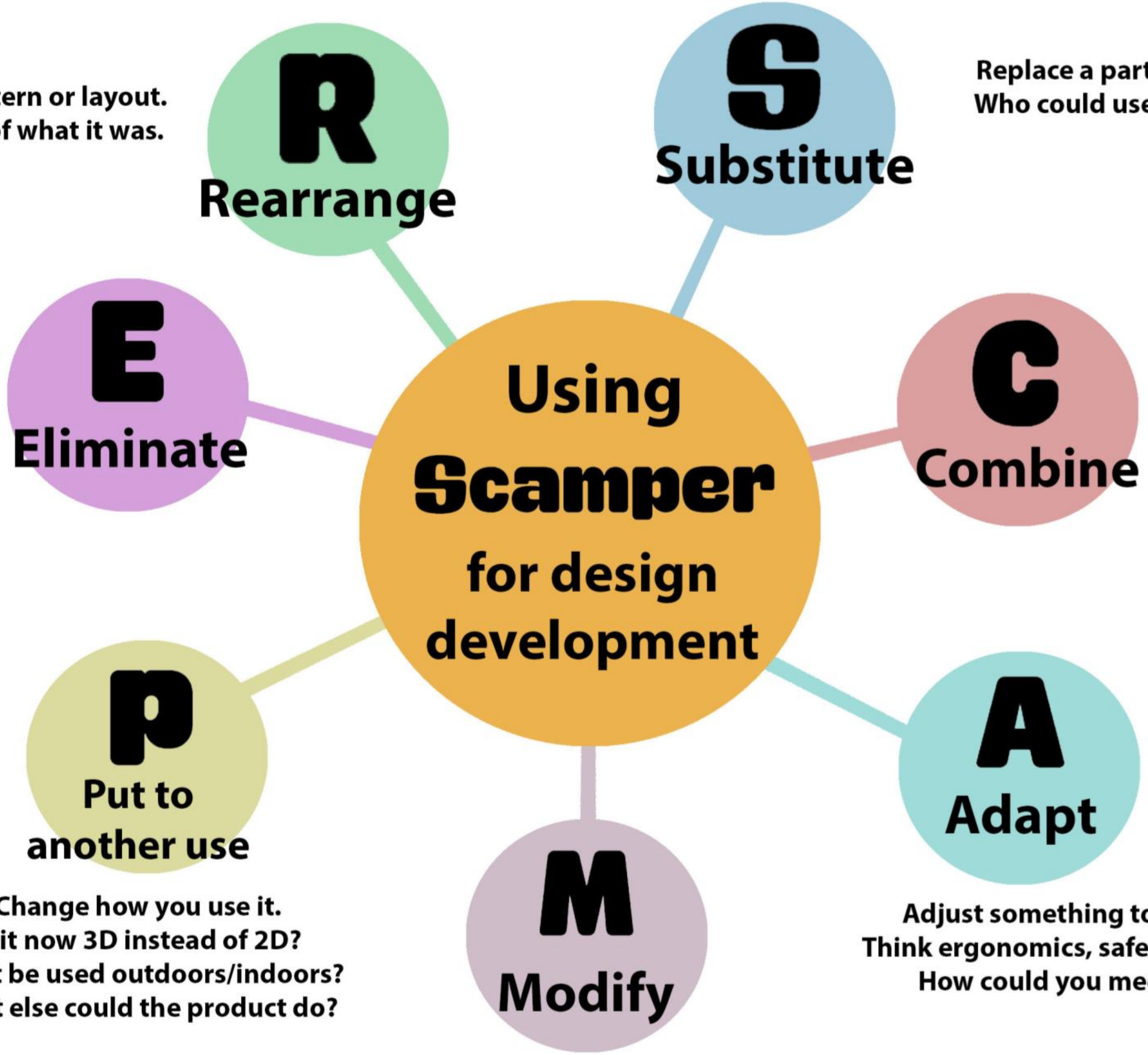






THREE DIMENSIONAL VIEW





YouTube

SCAMPER

Creative thinking and problem-solving are essential parts of the design process to turn ideas into innovation and break the barriers against creativity. One of the successful methods used in creative thinking is the SCAMPER technique. While there are different creative thinking and problem-solving techniques such as reversed brainstorming, SCAMPER is considered one of the easiest and most direct methods. The SCAMPER technique is based very simply on the idea that what is new is actually a modification of existing old things around us.

CAD/CAM: What is it?

- CAD/CAM has developed the way we manufacture and design products within Design and Technology
- Can you name three products in the classroom that have been manufactured using the CAD/CAM process?
- Why is it relevant for the company who manufactured the products to use CAD/CAM processes for the specific products?

ICT: it has its purpose too

ICT can also be used in the following ways to aid the design and making process, identify what the activities or terms below mean:

Online Survey, Product Analysis, Research, Communication, Presentation and Analysis.

CNC: Making made easy

CNC is an important factor in producing an accurately made product within the CAM category:

- What does CNC mean?
- Do you have any CNC machines in your school, if so what are they?
- What projects have you used them for or to create?
- How to do they benefit the making process?

CAD: Why do we use it?

- What is meant by CAD?
- How can it save time in the drawing process?
- What are the advantages of using CAD in product development?
- How can it enhance communication during the drawing process?
- What problems might introducing CAD software have in the design process?

KnowIT CAD/CAM/ICT

CAD/CAM: It has its benefits and its downfalls.

CAD/CAM as you know has radically moved designing and making forward, separate the terms below into advantages or disadvantages:

Quicker, Accuracy, Unemployment, Communication, Virtual, Physically seeing, 24/7, Maintenance, Cost, Training, Time Management and Traditional Skills.

Take it further and explain why they are in the category you have placed them in?

CAM: How it does it help with making?

CAM is now traditionally used to manufacture products:

- How can it improve the quality of a product?
- What effect can it have on the workforce?
- How can it aid making time?
- How is it better for batch making compared to human making skills?

CAD Software

What type of CAD software have you used form the list below? What have you used them for in your school projects?

- 2D Design
- Pro Desktop
- Solid Works
- Auto Desk
- Google Sketch Up
- Crocodile clips/Circuit Wizard

3D Printing: Its even easier to model

Over the past few years, 3D printing has evolved and become more cost effective to use in school:

- How does 3D printing help with the modelling process?
- How does it work?
- Do you have one in school? If so what have you seen it used for?

Exemplar Outcomes:

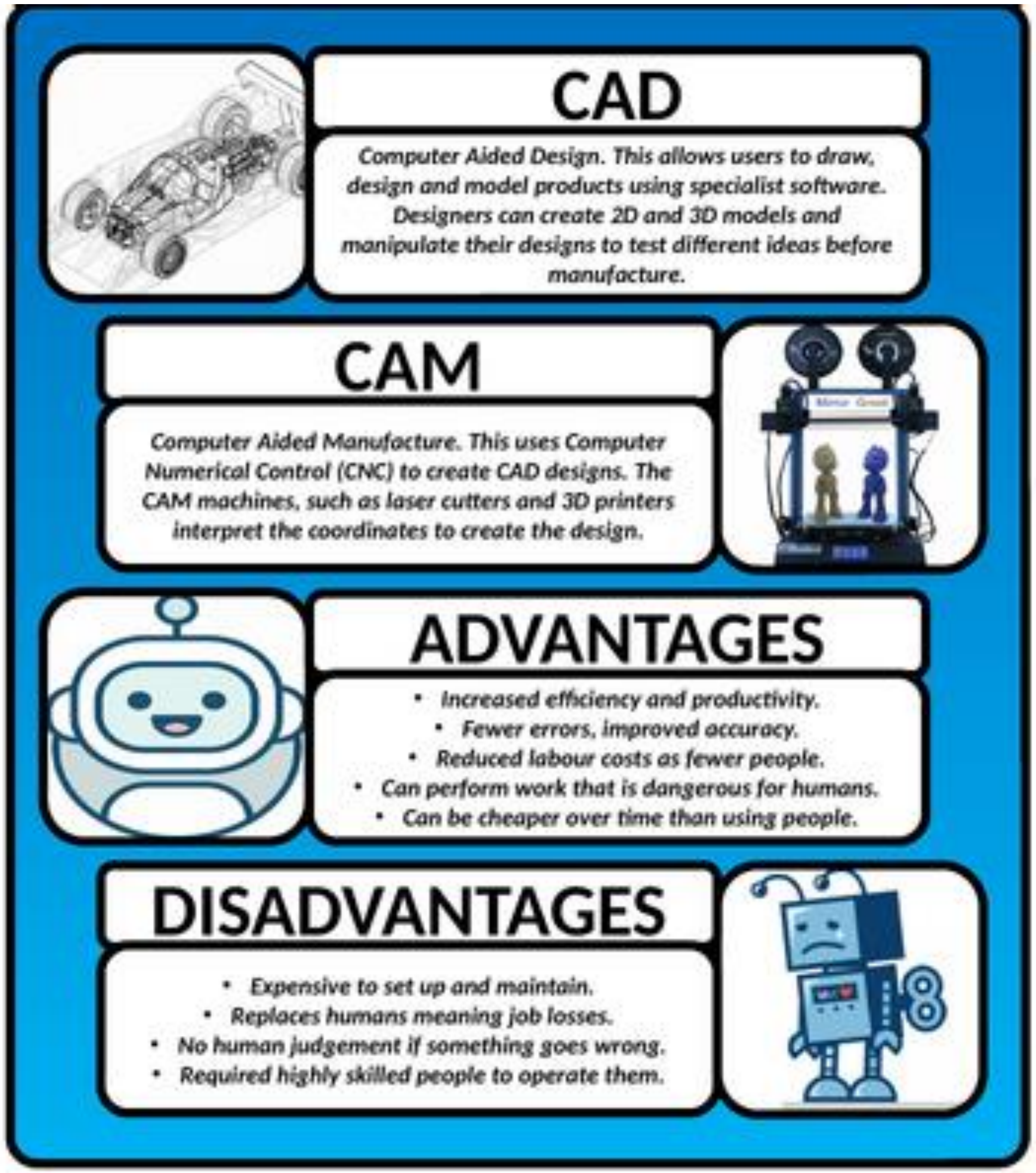
Below are exemplar outcomes of laser cut clocks made by previous students to help you understand the level of detail in your design ideas to achieve your target grade. The clocks are made from acrylic and plywood.

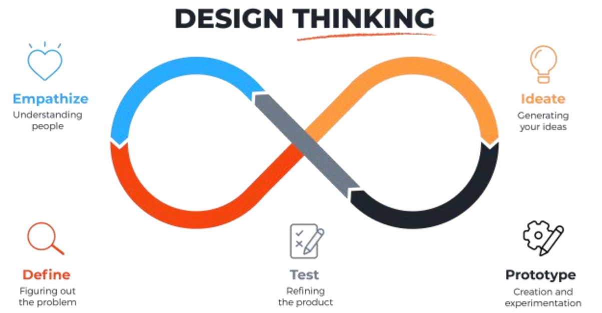
Bronze

Silver

Gold

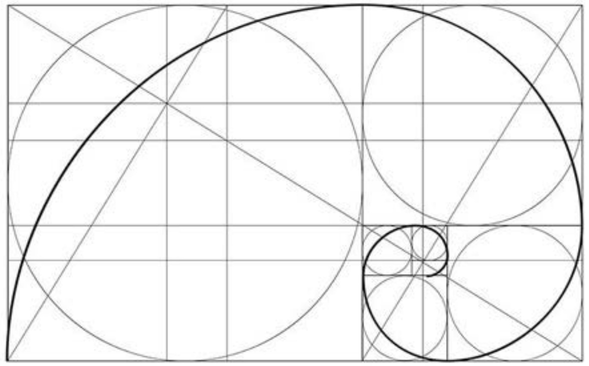
Platinum

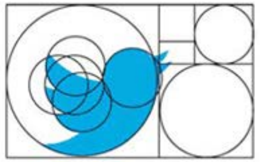


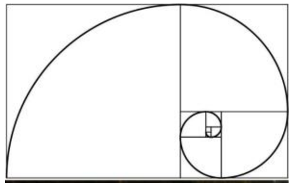


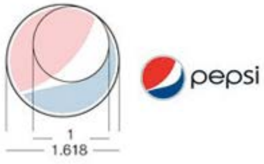
What is Design Thinking?
Design thinking is a non-linear, iterative process that teams use to understand users, challenge assumptions, redefine problems and create innovative solutions to prototype and test. Involving five phases—Empathize, Define, Ideate, Prototype and Test—it is most useful to tackle problems that are ill-defined or unknown.

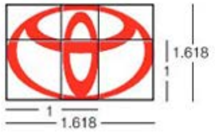
The Golden Ratio is a mathematical ratio that's commonly found in nature. It can be used to create visually-pleasing, organic-looking compositions in your design projects or artwork. Whether you're a graphic designer, illustrator or digital artist, the Golden Ratio, also known as the Golden Mean, The Golden Section, or the Greek letter phi, can be used to bring harmony and structure to your projects.











1.1 Technology in Manufacturing

System 	A collection of parts that work together to do something. made up of **Input, Process** and **Output**
Smart Technology 	Machines communicating to carry out tasks without human input. Eg. Stock level checks. Online orders
Automation	Machines doing tasks without much/any human input
	**Adv.** Speed, Cheap, Accurate. **Disadv.** Expensive. Jobs.
Communication Systems 	Smart machines communicate with no human input. Humans communicate with phone, email, video call etc.

Manufacturing System

Input	Process	Output
All materials tools and equipment you start off with	What happens to the input eg. Measuring, cutting, forming.	The result of the system. (The finished product)

1.2 Production Systems

CAD CorelDRAW	**Computer Aided Design.** Eg. 2D design for graphics/ programming laser cutter. 3D modelling.
CAM 	**Computer Aided Manufacturing.** Eg. Laser cutting, 3D printing.
CNC 	Computer Numerically Controlled
Advantages of CAD/CAM	Quicker to produce many. Accurate. Shared easily. Save on shipping and labour costs.
Disadvantages of CAD/CAM	Expensive to set up and train staff.

1.3 Product Sustainability

Sustainability 	The impact of a process or product on the environment.
Sustainable 	A process or material that can be used without causing permanent damage to the environment or using finite
Finite materials 	Will run out and can not be replaced (eg. Metal/oil)
Non-finite materials 	Will not run out, can be replaced (eg. Wood)
Carbon Footprint 	Amount of greenhouse gas released into the atmosphere by making, using, and disposing of a product.
Global warming 	Average earth temperature rising, causing damage to habitats leading to extinction.
Obsolete 	No longer useful. Outdated.
Planned Obsolescence 	When a product is designed to become outdated or useless quickly.

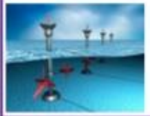
1.4 Product Sustainability and Social Issues

	Continuous improvement	Manufacturers constantly improve products. Often done to sell more (eg. New iphone models often).
Life cycle assessment	Life cycle assessment	Look at each stage of the life of a product to work out its total environmental impact.
	Material choice	Is the material environmentally damaging? Use a lot of energy to extract? Finite? Or is it sustainable?
	Manufacture 	Does manufacturing process use a lot of energy? Waste a lot of material? Product toxic gases?
	Using the product 	Is the product efficient when being used? Does it use a lot of energy/fuel? Give off toxic fumes?
	Product disposal	Does the product end up in a landfill? Pollute the environment? Harm wildlife?
	Recycling	Materials can be used again to prevent new materials being extracted. Also reduces disposal waste.
The 6 Rs	Repair	Fix things instead of throwing them away
	Re-use	Pass on old products or re-purpose (eg old tire = swing)
	Recycle	Recycling uses less energy than obtaining new materials. Also prevents finite resources being used.
	Rethink	Think about making the design more efficient.
	Reduce	Reduce the number of products customers need to buy (eg. Rechargeable batteries)
	Refuse	Refuse to but wasteful products.

1.5 Products in Society

Enterprise 	Identifying new business opportunities and taking advantage of them
Crowdfunding	Large number of people (backers) invest money to fund an idea.
Virtual marketing	Promoting a product online through social media, email or pushing it to the top of search engine results
Co-operative	A business that is owned and run by its members
Fairtrade	Ensures that workers/farmers get paid a fair price
Market pull 	When a product is made due to consumer demand
Technology push 	Advances in technology drive the design of new products.
Culture	Way of life, traditions, beliefs, fashion.

1.6 Powering Systems

	Fossil Fuels 	Natural resources that can not be replaced. (Coal, Oil, Gas)
Types of renewable energy	Wind 	Wind farms, energy from the wind.
	Solar 	Solar panels. Energy from the sun.
	Tidal 	Energy from the sea, tides.
	Hydro 	Uses a dam, generators make energy as water passes through.
	Biomass 	Burning waste wood or crop material.
	For renewable energy 	Reduces burning fossil fuels. Methods becoming more efficient. Pressure from people and other countries.
	Against renewable energy 	Initial cost. Reliability. Effect on landscape.

2.1 Properties of Materials

Working Properties	Strength	Withstand forces without breaking
	Hardness	Withstand scratches, abrasion or denting
	Toughness	Resistance to breaking or snapping
	Elasticity	Stretch and return to original shape
	Malleability	How easy to bend or shape
	Ductility	How easy to be drawn out into a wire
Physical Properties	Electrical Conductivity 	Electrical conductors let electricity pass through easily
	Thermal Conductivity 	Thermal conductors let heat pass through them easily
	Fusibility	High fusibility means low melting point
	Density	Mass per unit of volume
	Absorbency	How good at soaking up moisture
Ferrous metal		Contains iron
Alloy		Mixture of 2 or more metals

2.2 Paper, Board and Timber

Paper		Cartridge	High quality, textured, for sketching/cards
		Layout	Thin and translucent, for sketching
		Tracing	Semi-transparent, for copying images
		Grid	Has a square or isometric pattern.
		Bleed proof	Ink wont bleed, design with marker pens
Board		Solid white	Bleached surface for printing on. Packaging
		Ink jet card	Ink doesn't bleed. Ink jet printing
		Corrugated card 	Cardboard – fluted inner core adding strength and rigidity. Packaging
		Duplex	Different on each side. Food packaging
		Foam core	Polystyrene foam between 2 card layers
		Foil-lined	Board + aluminium lining. Food packaging
Timber	Softwood	Pine	Light colour, quite strong, cheap. Construction
		Larch	Attractive, hard, tough, durable. Decking/fences
		Spruce	Red/brown, hard, not durable. Crates/structures
	Hardwood	Oak	Good finish. Tough, durable, strong. Furniture
		Mahogany	Durable, easy to work with, expensive. Furniture
		Beech	Pink/brown, hard, can be bent. Chairs and toys
		Balsa	Low density, light, soft, easy to cut. Modelling
		Ash	Tough, absorbs shock. Tool handles/bats

2.5 Textiles and Manufactured Boards

Blended fabric		A yarn made of 2 or more different material.
Mixed fabric		A fabric made of 2 or more different yarns
Manufactured wood boards	Manufactured Boards	Processed pieces of wood combined with glue into boards or sheets
	MDF 	Made from tiny fibres of softwood glued together. Cheap, can be painted. Shelves, flat pack furniture
	Plywood 	Several layers of wood glued together with grain at right angles each layer. Strong. Building/furniture
	Chipboard 	Compressed wood chips glued together. Cheap, not strong, absorbs water. Cheap self assembly furniture

3.1 Selecting Materials

Factors affecting material choice	**Functionality**	Must have the properties needed (strength etc)
	Availability	How easy it is to source (find) and buy
	Aesthetics	Needs to look right (colour, finish etc)
	Cost 	Must be cheap enough to make a profit
	Environment	Environmental impact of the material
	 **(wood)**	Renewable if replanted. Deforestation if not
	 **(metal)**	Non-renewable, mining damages eco-systems
	 **(plastic)**	Non-renewable (oil). Won't biodegrade
	Social factors 	Impact on people/society. Fair trade, conditions
	Ethical factors	No animal products, good working conditions etc
	Cultural factors	Views, religion, cultural differences

3.3 Scales of Production

One-off	**Info** 	Highly skilled workers make the whole product. Takes a lot of time. Can be made to measure
	Used for	One-off, small scale. Wedding dresses, prototypes, some expensive furniture
Batch	**Info** 	Specific quantity (batch) made in one go. Batch can be repeated. One process on whole 'batch', followed by another on the whole batch. Quicker than one off per product. Uses templates, jigs, moulds etc.
	Used for	Lots of one product (e.g. sofas, keyrings)
Mass	**Info** 	Lots of stages (simple, repetitive tasks). Each worker does one small part repeatedly. Assembly line. Expensive specialised equipment, high set up cost. Mostly unskilled staff. Robots can be used
	Used for	Thousands of identical products. Newspapers, cars
Continuous	**Info** 	Runs all of the time, 24hrs a day. Automated, not many workers. Machined make huge number of the same thing. Expensive set up, but then fast and cheap per product
	Used for	Vast quantity of same item. Aluminium foil, drinks

3.4 Quality Control

	Quality Control	Checks to make sure product is made to a high standard. Checks are made at every stage of manufacture
	Tolerance	The margin of error. Must be within _mm +/- _mm
QC test	**Go/No Go** 	A jig to measure and check a size is within tolerance
	Registration marks 	Usually a cross printed onto paper or board. Used to check printing plates are aligned correctly
	Check against original	Quicker than measuring to check each part
Methods	**Depth stops** 	Stops drilling at correct depth
	Programming laser cutter	Power setting, speed setting, thickness setting
	PCB exposure	Correct developing time for etching PCBs

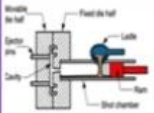
5.2 Stock Forms and Standard Components

	Stock form	Standard shape/size materials can be bought in
Timber (wood)	 Planed square edge	Rough surfaces shaved off to give smooth, sharp edges. Used for furniture etc.
Timber (wood)	 Rough sawn	Not smoothed. Cheaper. Construction (not seen)
Timber (wood)	 Mouldings	Strips with shaped cross section. Door frames etc.
Timber (wood)	 Manufactured	MDF/Plywood etc. Come in set sheet sizes and thicknesses. Cheap furniture, construction (plywood)
Metal	 Sheet	Flat sheets, can be press moulded
Metal	 Rod	Circular section sticks
Metal	 Tube	Like a rod, but hollow
Metal	 I-shaped girder	Strong girders used in construction
Plastic	 Sheet/ tube/rod	Standard sizes and thicknesses
Plastic	 Foam	Used for packaging and modelling
Plastic	 Films	Good for vacuum forming. Windows in packaging
Plastic	 Granules	Can be melted and used in casting and moulding
Plastic	 Powders	Can be used in moulding, as coating or 3D printing
	Standard components	Ready made parts. Cheaper for the manufacturer
	 Temporary fixings	Can be taken apart if needed. Screws (thread grips the material). Nuts and Bolts (bolt grips the nut)

5.4 Shaping materials – Hand Tools

Saws	 Rip saw	Cutting wood
Saws	 Tenon saw	Straight cuts in small pieces of wood
Saws	 Hacksaw	For cutting metal and plastic
Saws	 Coping saw	Cutting curves in wood or plastic
	Wood chisel	Hit with a mallet to shape wood
	Cold chisel	Hit with hammer to shape metal
	 Plane	Has an angled blade, shaves off thin layers of wood
	 File	For shaping and smoothing metal
	 Abrasive paper	Different types for smoothing wood/metal/plastic
Drilling	 Bradawl	Press to make hole in wood/plastic to locate drill bit
Drilling	 Centre punch	Hit with hammer to dent metal to locate drill bit
Drilling	 Twist bit	Drill small holes in wood, metal, plastic
Drilling	 Flat bit	Large, flat bottomed holes, wood or plastic
Drilling	 Countersink bit	Make holes for screw heads to sit in
Drilling	 Hole saw	Make big holes in thin material

5.6 Shaping Techniques

Shaping	 Milling	Remove material one layer at a time
Shaping	 Lathes	Material held and rotated, shaped using tool/bit
Shaping	 3D printing	Additive CAM process, prints layers of molten plastic
Shaping	 Metal pressing	Press metal sheet between two moulds. Car doors etc.
Casting	 Casting	Molten material poured into a hollow mould
Casting	 Die casting	Metal or plastic melted and poured into mould
Bending	 Metal folder	Bending sheet metal. Aluminium, tin etc.
Bending	 Laminating	Thin wood strips glued and held in a curved jig
Bending	 Line bending	Acrylic sheets. Heat, bend when soft, solidifies.