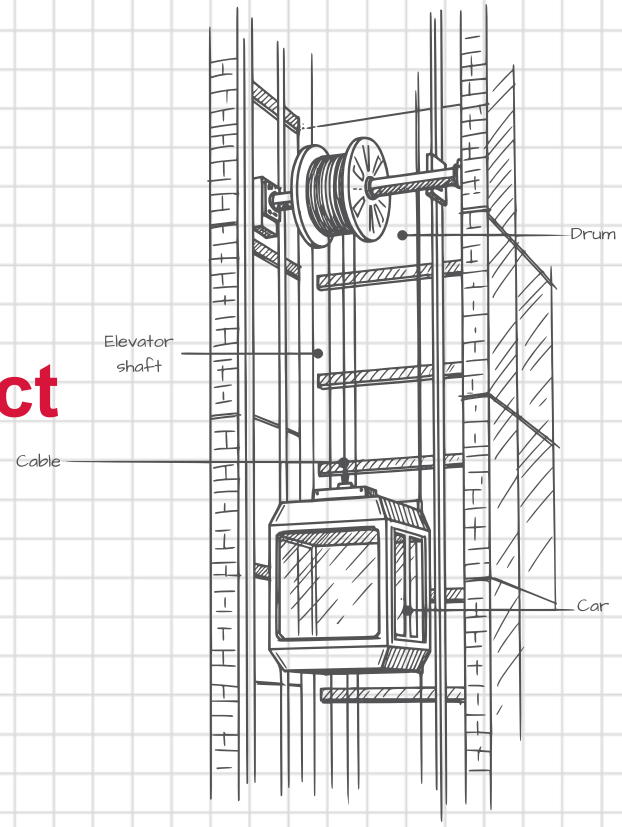
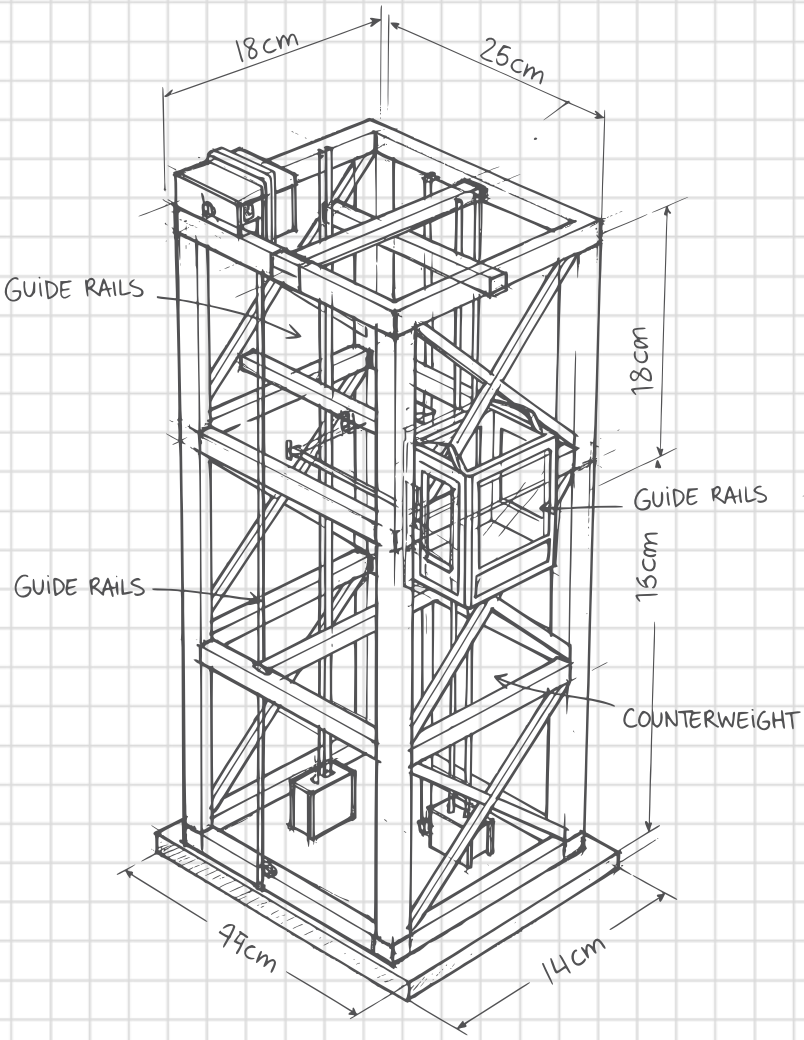
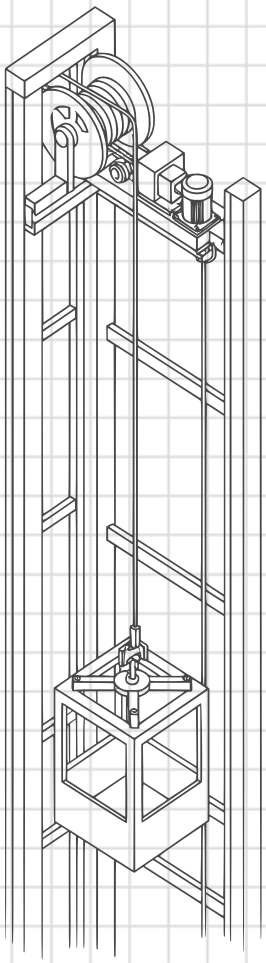
Name:

DESIGN FOLIO

Elevator Design Project



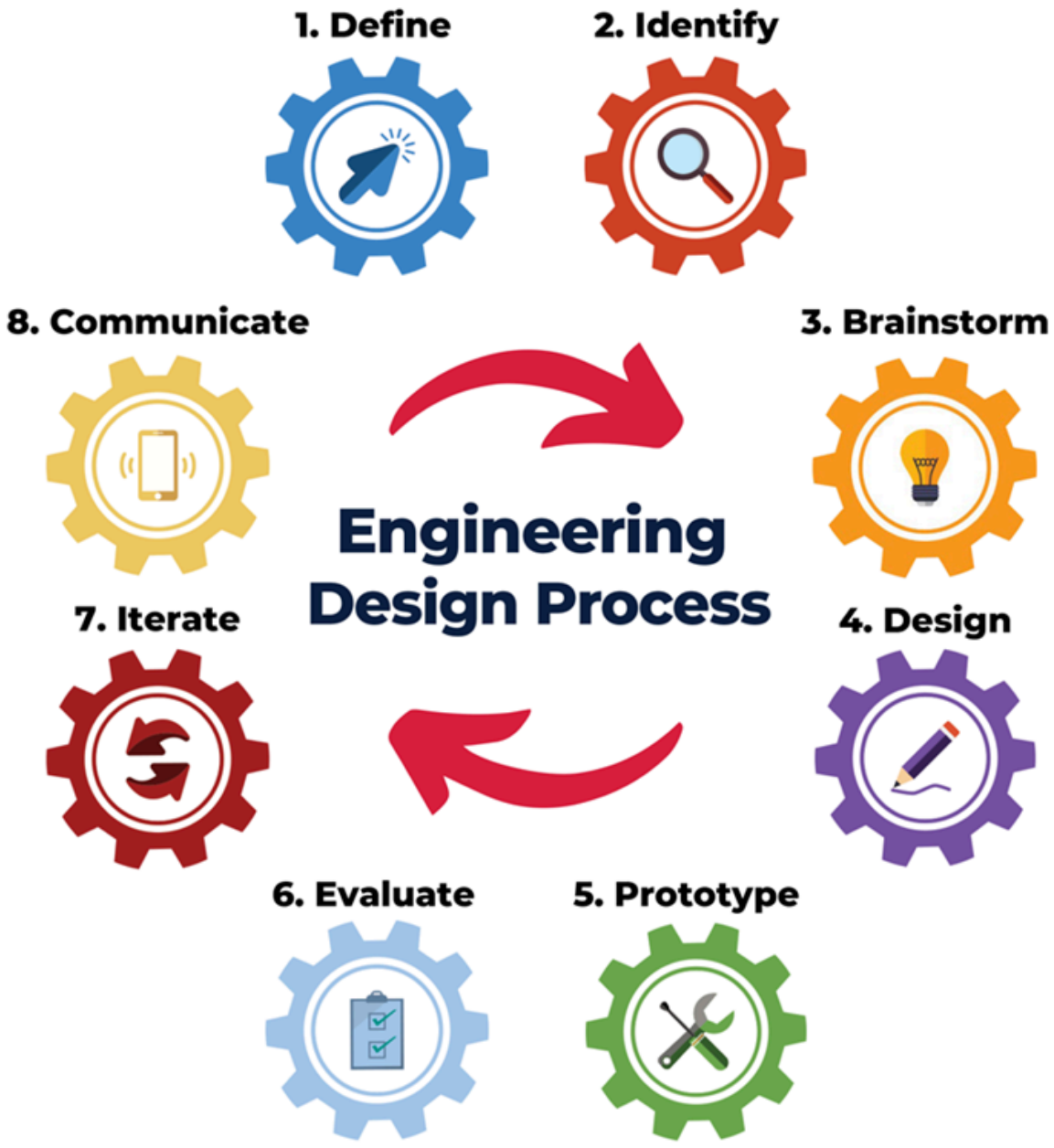




The Engineering Design Process

This folio guides you through the eight elements of the engineering design process. These elements will help guide you in solving problems and creating effective solutions.

Instructional videos and materials that support this folio are available at https://education.nsw.gov.au/teaching-and-learning/curriculum/stem/stem-curriculum-resources.



Define

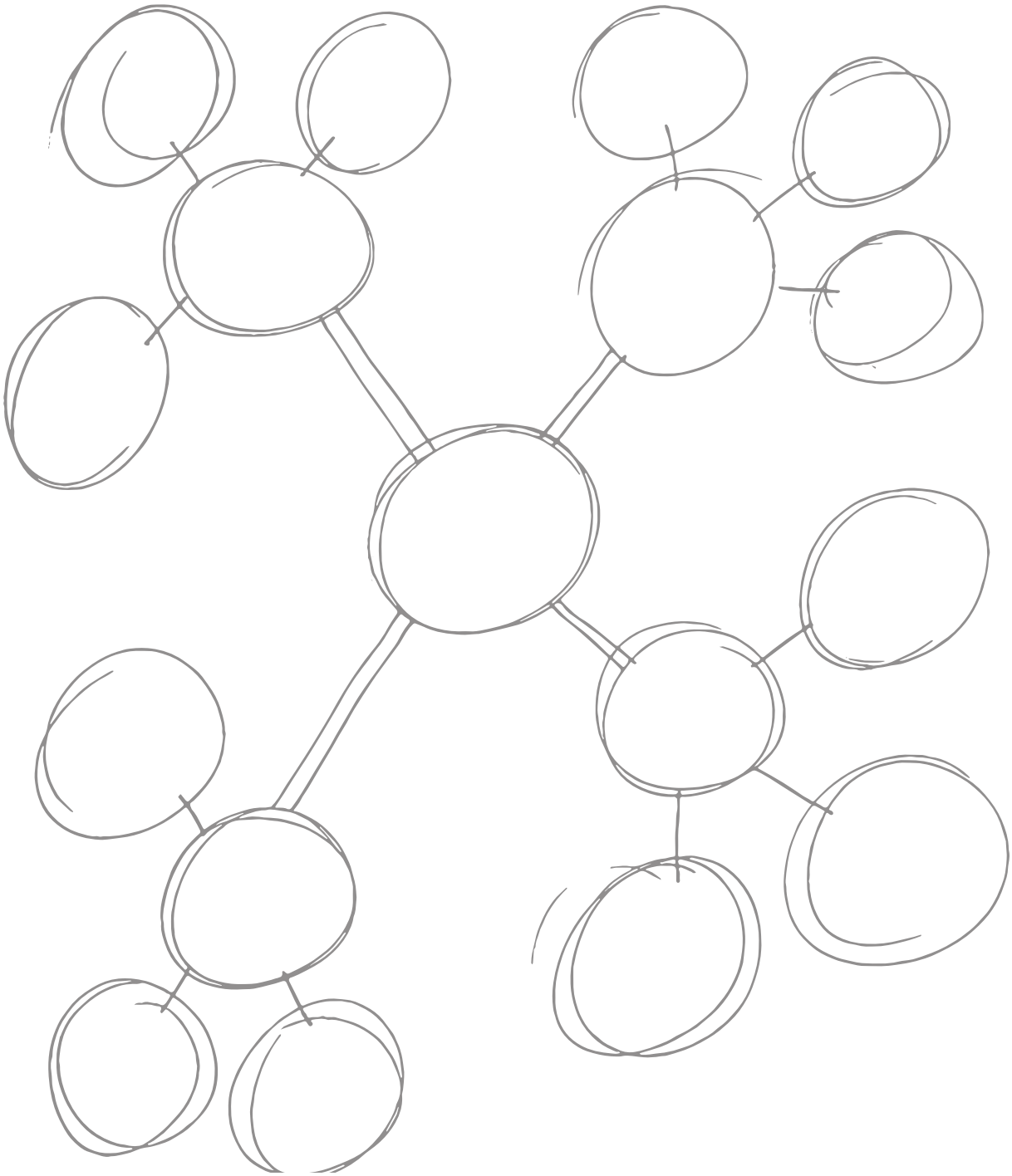
Design brief statement: Is a clear statement describing the problem or challenge to be solved.

_____

_____

You need to investigate different areas to fully understand the problem. Use the mind-map template below to help define the problem and identify what needs to be researched to develop a solution.

Always speak to people who will use your solution. To spark ideas, research other designs and try to understand their mechanisms.



Select two areas of research that you have identified in your mind map that you will investigate further.

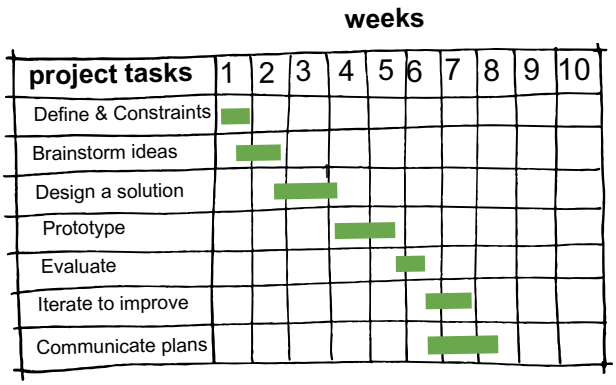
_____ _____

Activity: In the space below provide a summary of your findings from the two areas you researched.

Initial Idea Generation

In the space below produce a number of thumbnail sketches of possible ideas that might be useful in solving the problem. Use notations to explain your ideas where possible.

Identify



A Gantt chart is commonly used by industry as a tool in project planning. In the project shown (left) 'Iterate' and 'Communicate' are scheduled for the same week. Why might that be?

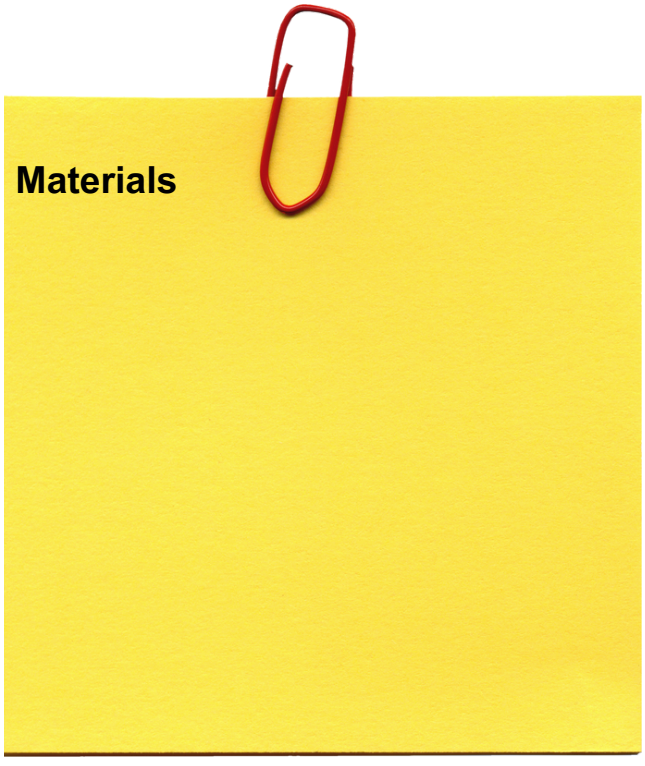
Activity
Try scheduling your own project in this blank Gantt chart (right) . Your teacher will specify a project completion date. You may also be given a date for 'deliverables'. It could be that you report on your progress at agreed 'milestones'.

weeks

Project tasks	1	2	3	4	5	6	7	8	9	10

A constraint is a limitation that must be satisfied by a design, e.g. time, materials or cost.

Identify materials
The available materials is a constraint to work within. Identify (name) the materials that you have access to. On the Post It note to the right, please make a materials list.



Design brief statement:

Criteria for success:

A '**Design brief statement**' is what designers e.g. architects, interior designers and product designers write down to show they understand a project. It states the purpose of the design and how success will be measured, i.e. visually appealing to a particular group of people, sales numbers, easy to use, etc.
Activity: On the post Note to the left write a more detailed design brief statement, now you have completed additional research.

Criteria for success are clear goals that show if your design works well and meets the design brief.
Activity: On the note pad write a list of criteria for your project.

'In the space to the right answer the following questions related to tools, equipment, machinery and safety.

1. Now is a good time to find out which tools and equipment you will have access to. Make a list of equipment you might need.

2. Will you need training before using some machinery?

Think about safety.
3. Identify the hazards and write down your top safety tips.

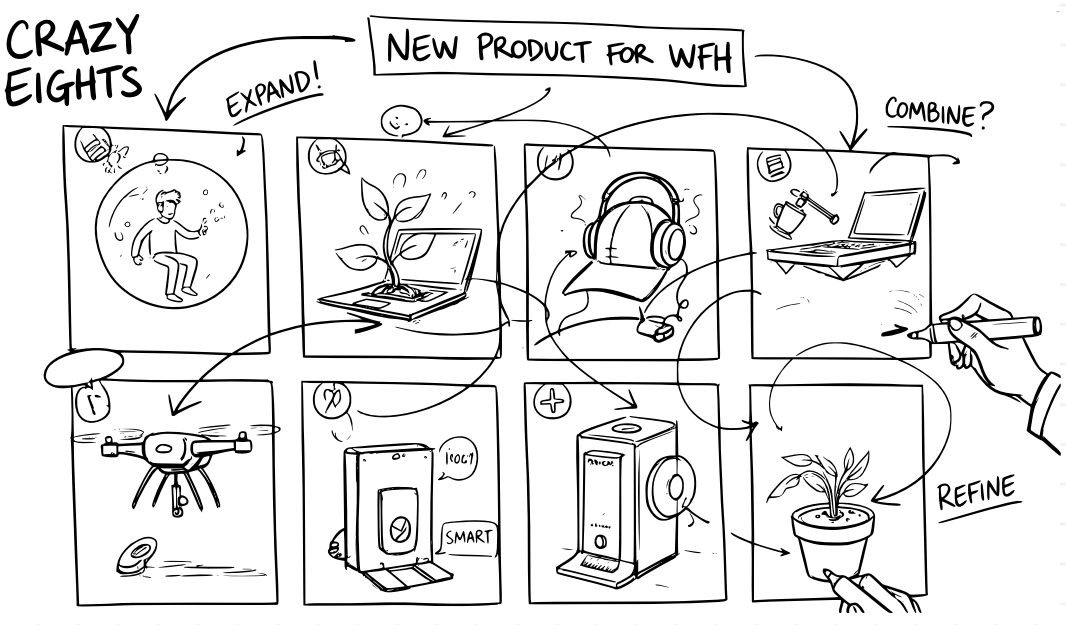
Investigate safety

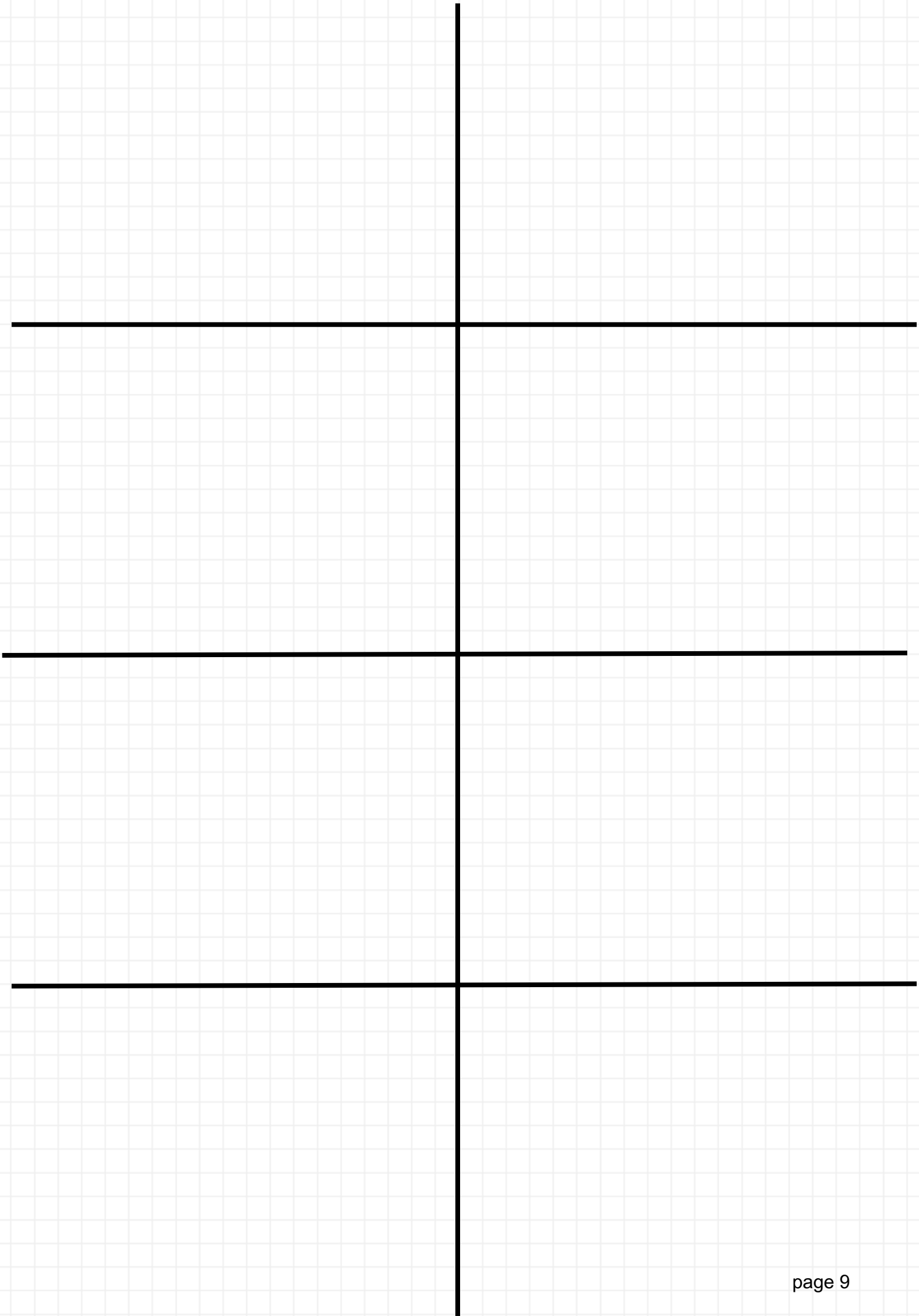
Brainstorm

Activity: Use this page to capture initial thumbnail sketches. Draw parts individually, or as an 'assembly'.
Be sure to use notes (annotations) next to your sketches to help explain your ideas.

Thumbnails are small, quick sketches. They are 'thoughts on paper' with no time for neatness. Label the important parts.

Activity: Use the next page for a ‘Crazy eights’ brainstorm activity. Crazy eights is a rapid brainstorming technique where you sketch or write down eight different ideas in eight minutes to quickly generate a wide range of solutions. Draw one idea per box each minute. Do not worry about neatness. Label important parts.





Design

Design drawings show the shape, material and size of all physical components.

Activity: Sketch orthogonal projection of the design you want to make.
Draw to a scale if you can. i.e 1:2 (half size) or 1:4 (quarter size).

Scale means making something smaller or larger while keeping its shape.

Top view

Side view

Front view

Activity: Make an isometric drawing/sketch of your design solution.

Prototype

A prototype is where you construct a working example of your design.

Activity: Attach some photographs of your prototype to this page and, if possible, a link to a video of your prototype in action.
Or
Outline the construction of your prototype and describe at least two ways you overcame obstacles during the construction.

Prototype
Unlike a static model, a prototype is for testing whether the design will work as expected. Usually new insights are gained once the engineers get to experiment with the physical product.

Evaluate

Test and evaluate prototypes against the set constraints and success criteria set at the beginning of the process.

Testing: The best conditions for testing a new design is under real conditions. Conduct a series of tests on your Prototype and evaluate the results using the PMI template below.

Plus, minus, interesting (PMI) is a quick method for evaluating ideas.
Write down all the positive points of your design, then all the negative. Note anything interesting, e.g. questions that need to be answered to move forward.

Test results Did you meet your criteria and constraints?

Plus Identify what parts of your design worked well.

Minus Consider where your design did not perform as well as expected.

Interesting Observations that are neither plus or minus, although worth noting.

Iterate

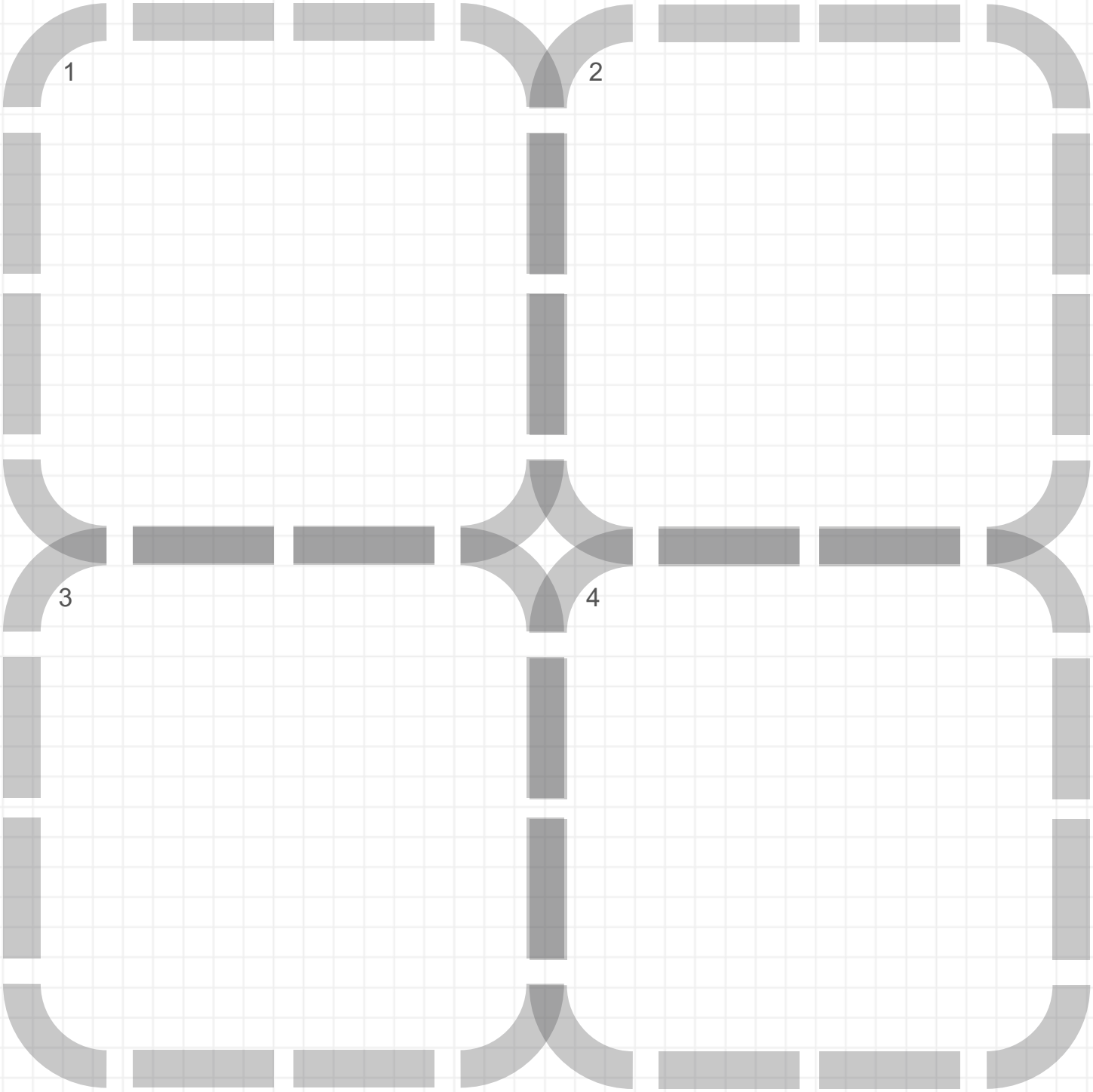
An iteration is the next or improved version of a design.

Often with design projects, we don't get time to make an improved version/iteration. Let's at least consider a second iteration.

Activity: In the boxes below, sketch and/or explain four possible improvements to your design. Apply what you learnt from testing & evaluating.

Tip: 'Annotate' your work, i.e. use arrows and notes on your sketches. Work like an engineer!

Record changes and iterations to your coding if you have used a microcontroller.



Communicate

Records of the design are kept, usually as a drawing or digital (CAD) file. This information is important for other members of a team who may have to update or modify the design in the future.

Activity:
Produce an orthogonal drawing (a front and top view) of your design as well as a 'close up' view of any parts that are too small to see clearly on the other views.

Use a ruler to draw straight lines. Include dimensions (measurements) on your plans and keep dimension lines thin. Label important parts such as the elevator car, pulley, counterweight or motor.

Communicate

Activity:
Produce an isometric drawing of your final design. Include dimensions (measurements) on your plans.

Glossary

Algorithm
A step-by-step set of instructions that a computer or microcontroller follows to complete a task.

Block coding
Programming using drag-and-drop blocks instead of typed code.

Drum elevator
An older type of elevator that uses a cylindrical drum to wind and unwind a cable, raising and lowering the elevator car, or cab.

Elevator
A machine that vertically transports people or goods between different floors of a building or other structure.

Elevator cable
Or hoisting rope, is attached to the elevator drum and runs from the top of the elevator shaft, down to the top of the elevator car.

Elevator car
The cab or compartment that carries passengers or freight up and down the elevator shaft.

Elevator counterweight
A heavy stack of metal or concrete blocks that runs up and down inside the Elevator shaft on its own set of rails. It is connected to the Elevator car by the same cables. Its job is to balance the weight of the car plus about half the weight of the passengers. Think of it like a seesaw partner that makes it much easier and faster for the motor to lift the load, saving a huge amount of energy.

Elevator drum
A cylindrical component that directly winds and unwinds the cables connected to the elevator car. As the drum rotates, it effectively reels in or spools out the cables, directly raising or lowering the elevator car. Note: Using a drum can place greater strain on motors.

Elevator pulley (in traction elevator systems)
A grooved wheel that a rope or cable passes over. In modern elevators, pulleys (sheaves) are used in conjunction with a motor and counterweights. The motor turns a traction sheave, and the friction between the sheave and the cables allows the elevator car to be raised and lowered. Pulleys primarily change the direction of force and, when used in combination with a counterweight, can provide mechanical advantage and reduce the power needed by the motor.

Elevator shaft
The long, vertical tunnel built into a building that the Elevator car moves up and down inside. It’s a dedicated, empty, and enclosed space that also holds all the important safety and mechanical equipment (like the guide rails and sometimes the counterweights).

Glossary

Elevator - traction elevator
The most common and fastest type of elevator. It works by using cables wrapped around a motorized pulley (called a sheave) at the top of the shaft. One end of the cables is attached to the Elevator car and the other is attached to a heavy Counterweight. The motor turns the pulley, and the friction (or "traction") of the cables against the pulley moves the car up or down.

Force
A push or pull on an object, measured in newtons (N).

Isometric drawing
A drawing method that shows a 3D object (like a box or machine part) in a single picture on a flat page. It's unique because all the width, depth, and height lines are drawn to scale, and the horizontal lines go off at 30-degree angles from the vertical lines. This gives the object a 3D look without using perspective (which would make lines shrink as they go back).

Load
The weight or force that a structure or mechanism must move or support.

Microcontroller board
A circuit board that contains a microcontroller, which is a small computer used to control the operation of electronic devices. The board typically has memory, programmable input/output peripherals, and is used to execute specific control programs, such as managing motor speed or reading sensors in an elevator system.

Orthographic projection
A special method of drawing used by engineers and architects to create flat, 2D diagrams of a 3D object like a machine part or a building. Instead of one 3D picture, you draw three or more separate views such as the front, top, and side.

Prototyping
An iterative process of creating a preliminary model or models of a solution, or its parts, to test and refine its functionality, design and usability before final production.

Servomotor - continuous
Also known as a 360° servo, it is a type of servo motor that rotates continuously in either direction rather than moving to a specific angular position.

Servomotor - positional
A motor that is commanded to move to a specific angle and then hold that position. It is ideal for precise movements, such as operating door mechanisms or steering.

Torque
The twisting force that causes rotation in mechanical systems.

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