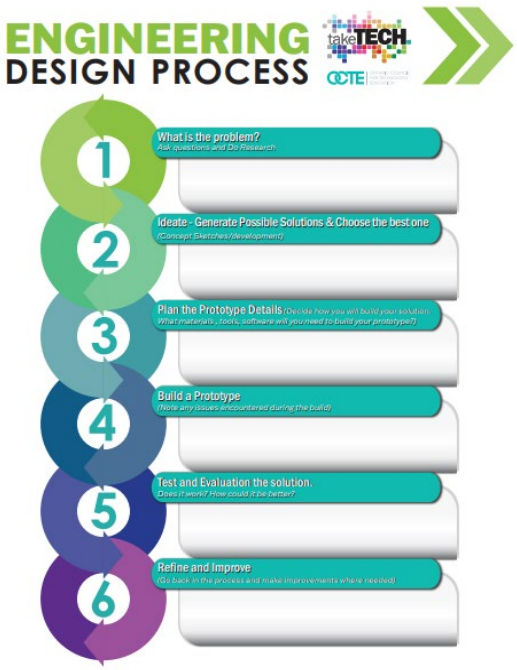
Challenge Question or Problem to be Solved



Design Challenge:

Create a unique gift for a friend or family member that will be made using additive manufacturing (3D printer)

Considerations:

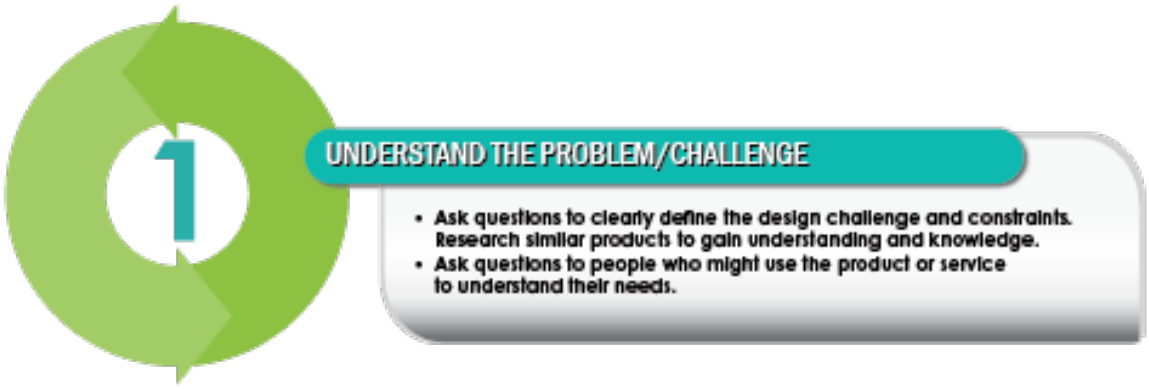
The product designed will be a gift for someone else. You must consider what the end user might need or want. You must consider what style, colours, and theme they would like.

The product designed will be made using additive manufacturing. This must be considered when considering potential design solutions.

If students are not familiar with additive manufacturing, consider showing the following video.

Criteria:

- The design must be modelled using CAD software
- The design cannot take anymore than 3 hours to print (This time can change depending on machine and time available)
- The end product must be unique



Students should list /summarize their understanding of the design challenge, constraints and considerations in their own words.

- What are the design criteria you need to know?

Any solution has a maximum printing time, this will be a limitation on potential solutions. Consider what products would be most suitable for additive manufacturing (3D printing)

- What are the constraints your potential solutions must include? (Cost, material, size, safety etc)

Examples of constraints: Machine printing size, time constraint, student skill with 3D modelling.
Example of Safety consideration: If the end product is being made for a young child, it must not be a choking hazard.

- What fundamental concepts must you consider when developing solutions?

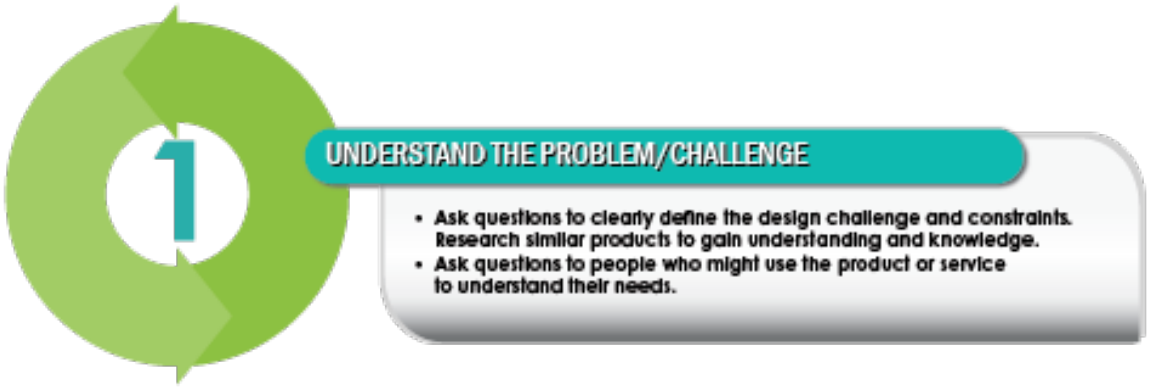
Example:

The **aesthetics** of a gift is important, you must consider the shape, colour, patterns, and symmetry.

To ensure environmental sustainability, consider how to make the final product using the least amount of material and waste possible. (Can the solution be made out of multiple parts to limit material or support structure needed?)

Fundamental Concepts

Aesthetics	**Ergonomics**	**Material**	**Control**
Safety	**Creation**	**Mechanism**	**Structure**
Environmental Sustainability	**Function**	**Power & Energy**	**Systems**
	Innovation		



Making a gift for someone else requires you to think about their needs.

What are the end-users' needs?

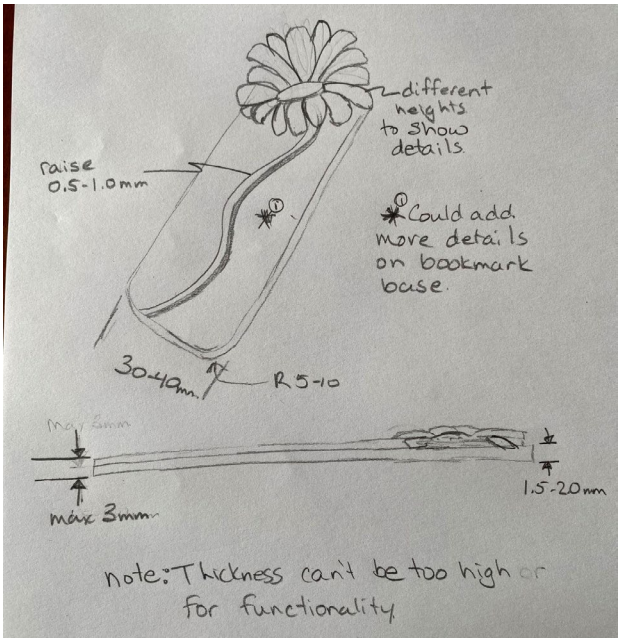
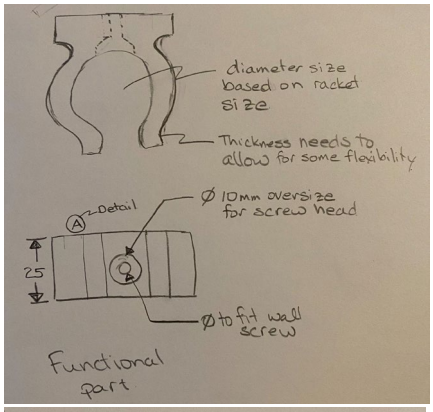
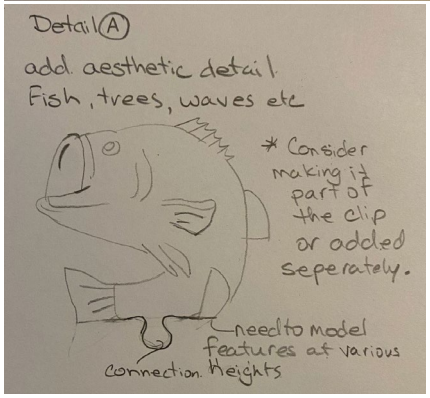
- Example: My grandmother likes to read and garden, making her a bookmark with a floral design would be functional and aesthetically pleasing
- Example: My cousin plays badminton and likes fishing, making a bracket for the wall to hold badminton rackets or fishing rods would help my cousin organize and display his equipment.
- Example: My friend has a lot of earrings and likes camping, so making a jewelry holder that has a camping theme would be functional and a unique design.

What products exist that can help guide your understanding for a solution? Use Reverse Engineering to help you develop potential solutions.

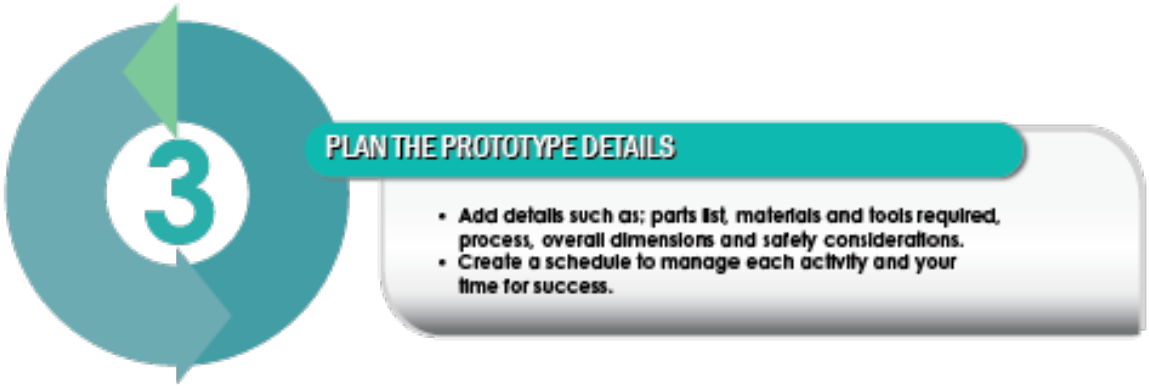
Using a design board to visually connect potential solutions with custom themes, colours, and styles allows you to develop your ideas before concepting your own unique designs.

GENERATE POTENTIAL SOLUTIONS

- Create a variety of possible solutions to meet the outlined constraints and fundamental concepts
- Analyse the solutions to choose the most appropriate one to develop further by using the end-users needs as consideration.

Concept #1 - Example bookmark	Concept #2 - Example racket/rod wall hook
	 
Concept #3	Concept #4

Concept 1 - Example Bookmark		Concept 2	
Pros	**Cons**	**Pros**	**Cons**
Will meet the design criteria outlined Will be a useful personalized gift that meets the needs of the end user Good design for additive manufacturing	Small details to make the pedals requires proficient 3D modelling skills Might be too much detail for 3D printing for the overall size of the product.	• • • •	• • • •



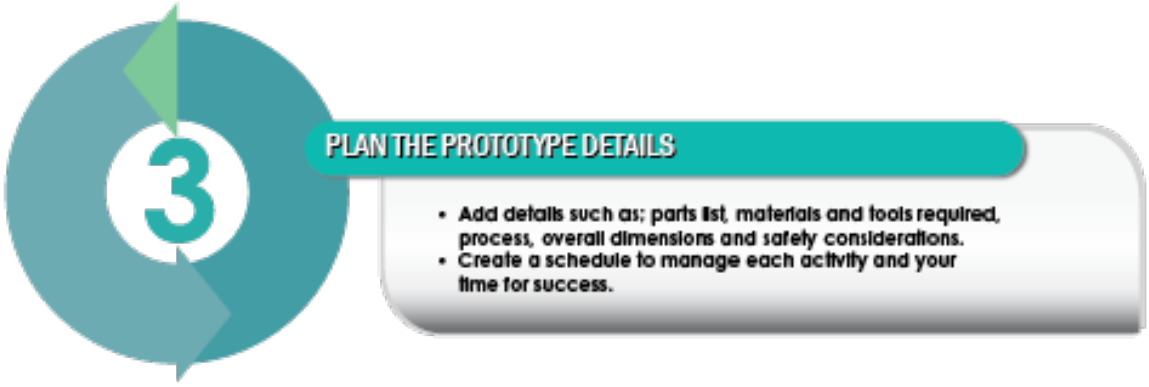
Material Required or supplied

Material	Size

1 PLA filament	The amount of material used depends on the design. The slicing software will calculate the length of filament used. Bookmark example rough overall dimensions 40 mm x 120 mm x 3 mm
2 Paint or markers to colour (optional)	
3	
4	
5	

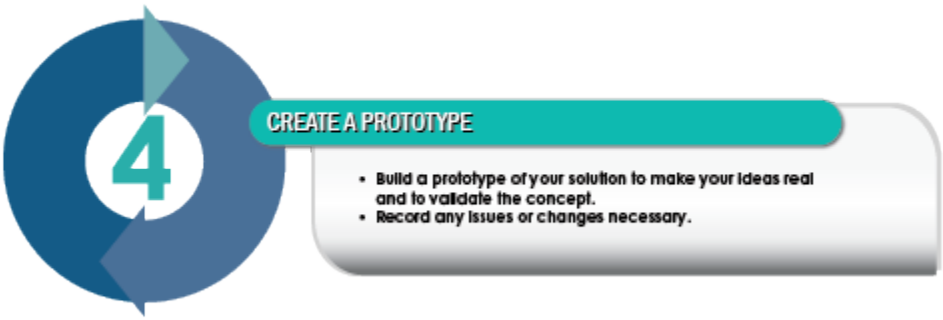
Tools Required or Supplied

1 3D printer	6
2 3D modelling software	7
3	8
4	9
5	10



List all **safety** and other **fundamental concepts** that need to be considered when working with the tools, chemicals or other materials for this project

Tool / Chemical	Safety Consideration:	Fundamental concepts - how are they considered?
1 3D printer	See OCTE safety docs	
2		
3		
4		
5		

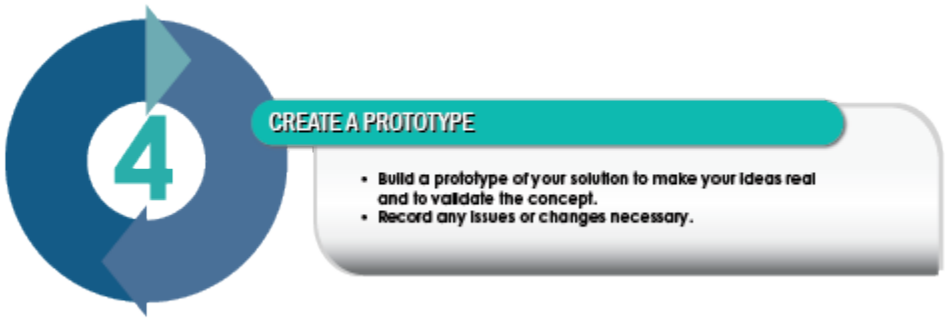


Plan the Prototype Details

List all safety considerations that need to be considered when working with the tools,

chemicals or other materials for this project.

Tool / Chemical	Safety Consideration:
1 3D printer	See OCTE Safedocs
2	
3	
4	
5	

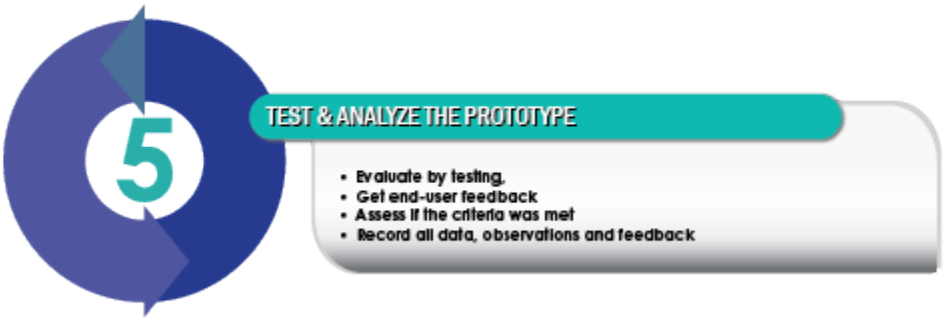


Create a physical/computer model of the chosen design solution to verify the functionality and feasibility of the concept. Consider which type of prototype will work best for your project.

Example: Students will model their design using 3D modelling. Should some designs require prototyping, this can occur as a full product or a partial prototype such as a joint to test our tolerance or design.

- ❏ A 3D CAD model Process sheets
- ❏ Videos to show techniques
- ❏ Home / Classroom / workshop Landscape layouts
- ❏ A marketing campaign or information session
- ❏ A hairstyle, arrangement, or product

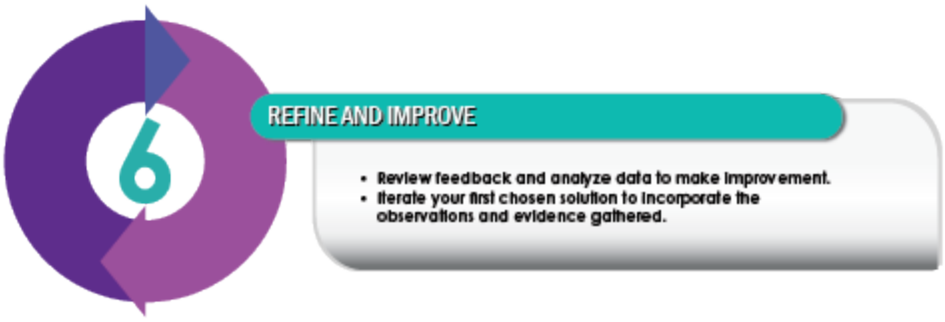
- ❑ A 3D printed part
- ❑ Cardboard model
- ❑ A Storyboard/ Website or Photograph
- ❑ A robot / Schematic / get specifics from specialists
- ❑ Plants / An indoor grow kit



Assess your working prototype in one of the following ways:

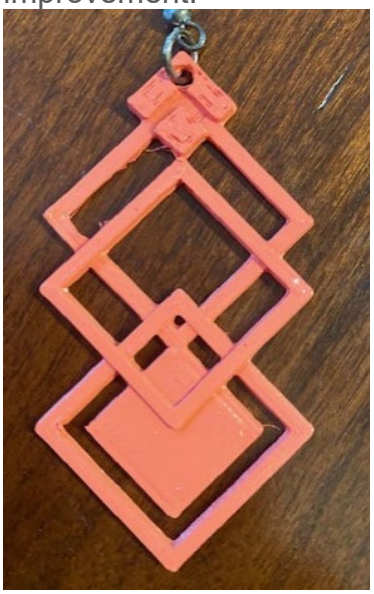
Example: For this design challenge, referencing the criteria in step 1 outlined by the teacher and based on the end users' needs and interests is one way to assess the prototype. The quality of the print and its aesthetics are important and should also be assessed and evaluated for improvements.

1. Test and collect data.
2. Assess if the prototype meets the specified criteria from step 1
3. Get user feedback. Ask Questions like:
    - Does it work like it is supposed to?
    - Does it meet the end-users needs?
    - Is it safe to use?
    - What would you change? Why?
    - What might you add or take away?
    - What other thoughts do you have now?



How can you improve your design?
Use testing, feedback, conversations and observations to guide iterative improvements.
Here is an example of how you can document changes.

Example: Earrings

Design issue: The top surface has imperfections due to the limitations in the printing quality Details of possible improvements: Increase the scale of the design and or increase the print time to improve the print quality.	Add image or sketch of potential improvement: 

Some additional reflection questions that could be posed:

1. What part of the model do you think was the most critical? Why? Relate it to the 3D printing setup and final product quality.
2. Evaluate your design. What changes would you make to your original design? Why?
3. Reflecting on the design process steps, which one do you think is the most critical and why? (Research, brainstorm, concept ideas, choose the best solution, build a prototype, test the prototype, re-evaluate).
4. Now that you have a better understanding of additive manufacturing, what industrie(s) do you think would benefit from this type of technology and why?

Examples of finished products

Additional Resources:

Video:

3D Printing - Protolabs

What is 3D Printing - Institute of Manufacturing, University of Cambridge
How to 3D print human tissue - Ted Ed

What is the role of slicing in 3D printing?

Article:

3D printing for Bike Manufacturing

Dwell - 3D printed homes

Websites:

Try Engineering - 3D printing