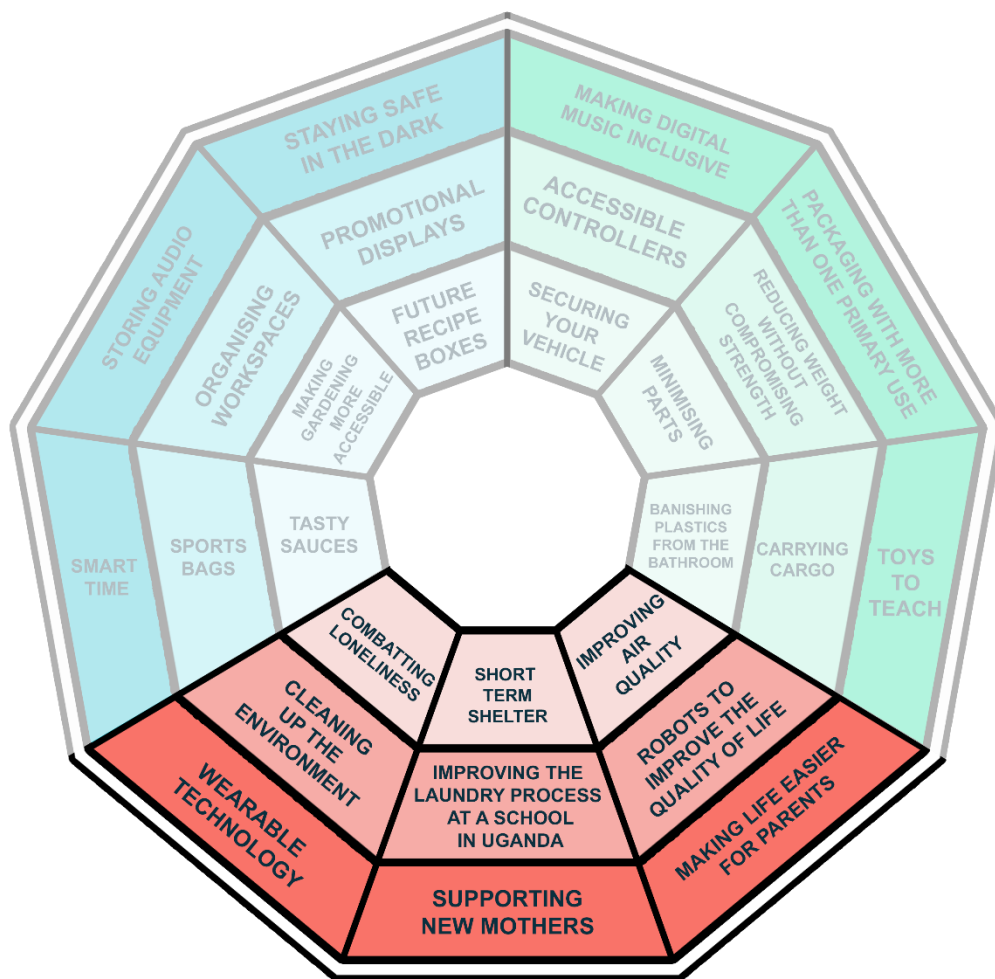


INSPIRED BY INDUSTRY

Cleaning up the environment

#InspiredbyJCB



Introduction

This context has been put together to allow for a range of opportunities for students to explore the causes and effects of pollution in the environment and to design solutions to combat pollution. The context is adaptable to a wide range of applications such as waste collection, management and disposal.

Materials

Whilst not exclusive to this context, it provides good opportunities to explore prototyping materials such as card and mechanical construction kits in the early stages of development. This context could also encourage the exploration of rapid prototyping techniques to realise ideas quickly and effectively using a range of CNC equipment.

Potential outcomes

Some outcomes are likely to be conceptual and may not be fully working. For example, a waste compactor may focus on the mechanical operation and a simple test rig may be appropriate to test and evaluate the process.

It is important that students are given some freedom within this context and so outcomes should vary between students / groups. You may decide to limit your class to a range of outcomes or applications or the components they need to incorporate.

There is an opportunity to look at rapid prototyping here as well as more traditional methods of product development. Smaller portable devices could be realised relatively quickly especially in prototype form. You may wish to explore making a 'what it looks like' prototype with students as well as a 'how it works' prototype – or may be an opportunity for introducing or developing 3D CAD work.

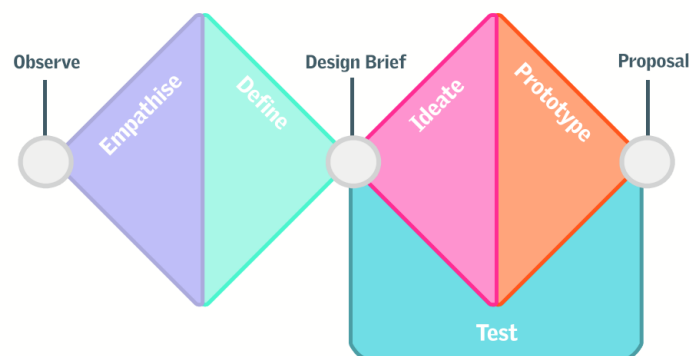
Examples may include (but not be limited to):

Can crusher, litter picker, a bin to encourage recycling for children, recycling sorter for home, beach comb/rake

Consider sharing work on social media using the hashtag #InspiredbyJCB

Design cycle

The design cycle shown can be worked through in a range of orders. It's advised that the areas are revisited throughout the process depending on your time. We advise that a graphical representation of thinking convergently and then divergently may be shown to your students, such as this example:



The following are some tips as to the type of activities you could do with your students.

Empathize stage

- Students should be **introduced to this term** if not already familiar.
- At the start of the context, **students should be thinking wide** with their thoughts, exploring the problem and not deciding too soon what they 'want to make', but observing what is happening.
- **Observations** (may be a video, producing a journal for someone to fill in, a phone call interview, email etc) should allow them to 'spot common problems' or identify opportunities for improvements over existing solutions. You may want to consider a walk around the school site, a trip into town, or more focused areas such as an allotment, playground or local industry.
- The following videos from Ford are good examples of empathetic design in industry [VIDEO 1](#) [VIDEO 2](#)
- The Big Life Fix [HERE](#) is fantastic for showing empathetic designing. Throughout the process the designers try to immerse themselves in the problem and regularly get feedback from the clients. Observing others is really important rather than just asking people what they want as they may not know!
- If gaining access to research is hard, you may want to **share collated research with your students**. As a group, note down all the potential issues you see – don't think at all about solutions yet, or even if they are able to be solved using a product – this is just a stage to highlight issues and concerns. It may be things like identifying the causes and effects of pollution.
- Students should get as much information to help them later on in the challenge, but also be aware the **research can be done at any relevant point** in the design process. They may present their findings in any way they feel appropriate or effective.

Define stage

- This is where students **try to get the real root of the problem** and decide what they are going to do. What aspect of designing or improvement will be their focus?
- There may be a whole range of problems associated with pollution. **Which of these would be the best to target and why?**
- The '5 why's' may be a good resource to run through with students. You could even pair them up to do this with each other at the define / empathy stage [VIDEO HERE](#)
- For older students, this case study from [DESIGN COUNCIL](#) is great to show how to define the problem and come up with innovative solutions.
- This is a good opportunity to introduce contextual challenges to students and get them to consider all aspects of the problem. It will undoubtedly need some support from you as a teacher. Please get students to share their thinking as clearly as they are able.
- Get students to **create a project letter or specification**. Whilst templates / writing frames are fine at KS3, you will want to avoid this at KS4. Consider using columns such as 'Essential', 'Desirable' and 'Definitely not'.

Ideate stage

- Ideas for a solution **may initially be through words**. You may want to consider listing the main types of pollutant that your device or system will focus on.
- Encourage students to think wide initially. No ideas are too silly, or too big.
- Ask students to do some blue-sky thinking using mind maps, six thinking hats and SWOT analysis of proposals.
- Ideas can also be produced through making or modelling. Get students experimenting with modelling or rapid prototyping early in the design development phase.
- The outcome can also be modelled using 3D CAD to help visualise colours and materials in a more realistic way and without the use of materials.
- There are a range of videos on YouTube to help students with sketching techniques, [HERE](#) for example.
- Product design sketching tutorials can be found [HERE](#)
- The Design Museum have some nice, short, case-study videos [HERE](#)
- Students should be encouraged to sketch on anything to hand – envelopes, packaging etc. This may be a good method to stop students potentially being daunted by blank paper.
- Encourage zoomed-in parts of the product to focus on details and annotation.
- **Annotation** may be things they like, things they are not happy with and explanation of parts that are not clear from the picture.
- **A range of techniques** such as 2D, 3D, exploded and cross sections are good. By this stage, students should be selecting and using a variety of approaches to best communicate.
- **Further research may be needed** at this stage. Consider a handling collection of devices that attempt to solve the same or a similar issue. Can they think of other products that perform a similar function?
- Ideas don't have to be revolutionary and completely new. **They can be a development of an existing product**, but you may well see an opportunity for something totally new!
- Maybe they can start with an existing product and improve it. This [VIDEO](#) is a good introduction to this for older students / teachers.
- You could introduce modern / smart materials, which may generate alternative approaches or ideas for students.

Prototype stage

- A nice video from BBC Bitesize is [HERE](#)
- This short video from The Design Museum looks at the journey a designer had to design and make a collapsible bottle. [HERE](#).
- There are a number of videos by Jude Pullen from Big Life Fix [HERE](#) on how to create shapes in card. However, many may not have access to materials / tools and so C.A.D. may be more suitable.
- The following are all suitable CAD programs:
 - [AUTODESK](#) free for schools/students. Mac & Windows
 - [CREO](#) free for schools/students (PC only)
 - [FREECAD](#) free for schools/students
 - [ONSHAPE](#) free for schools/students

- [SKETCHUP](#) free for schools/students
- [SOLIDEDGE](#) free for schools/students
- [SOLIDWORKS](#)
- There are some good Autodesk Fusion tutorials [HERE](#) and TinkerCad [HERE](#)
- **It is worth discussing with students why they create a model or prototype.**
What are you wanting to test or evaluate; function, comfort, aesthetics etc? Choosing the correct fidelity or detail of model and prototype is important. Making an informed decision regarding the fidelity of model is useful. Are they able to justify taking time to create a model, with a partner?
- **Ensure there is enough time for students** to make a series of prototypes, ideally with various fidelity.
- Whilst there are structured categories shown in this design process, **modelling / prototyping is likely to occur early on** as students play around with ideas. Ideas don't always need to be 2D sketches...
- In Key Stage 3 students also need to be able to effectively plan their time. This is also an opportunity to look at a **production schedule** and **time planning**. Consider creating a Gantt chart (or similar) to plan the most effective use of time during a unit of work. This is a tricky task and likely that students will underestimate how long things take (especially with machinery/tool bottlenecks etc) but a useful ongoing exercise to allow them to manage time more efficiently in KS4+.

Test stage

- Although this is the final stage of the design cycle, encourage students to evaluate throughout the process and act on their feedback (and consider the feedback of others too). **Testing is not a final thing, but a step to improve your designs further.**
- Consider AR (Augmented Reality). If you use windows, PAINT 3D allows you to open .obj (CAD) files and students can then view their design in a hand, or in the intended environment to see how it may appear in use.
- **Scope creep** is a good way of evaluating how far a proposal has deviated or advanced from the original design intent. Encourage students to check the original design intention regularly throughout the process.
- To help students that are **reluctant to improve their idea**, consider prompts such as "What if I could use any technology available?", "What if it had to be made in 1 day?", "What if you needed to make 100,000?", "What if it had to be made cheaper?", "What if it had to be made lighter?"
- JCB employ a process of continuous improvement originally called '**Kaizen**'. You could use these principles to see how prototypes could be improved further (more information in the presentation).
- How can students get feedback from users? Could they use technology to get a wide range of feedback – e.g. a Google Form? A poll on twitter?
- Get students to think about the main problem they identified earlier – does it actually do that? How successful is the outcome compared to the intention? Can the prototype be filmed during use? **How well does it work? Has it improved through the various iterations?**
- Prompts for younger students e.g. ACCESS FM are suitable approaches. For older students they need to consider a wider range of aspects such as scalability, manufacturing techniques and limitations, ergonomics etc.

Focused Tasks

'Sketch ideas'	'CAD'	'Increased fidelity'	'Syringe grabber'
Sketching ideas is often the most simple, but effective, method of ideation and developing concepts. Practice this method of communication to improve your proficiency and to aid in communicating your design concepts to others.	CAD software will allow you to visualise your concepts, but it can also analyse structures and show how mechanical assemblies would work. Consider a system to collect and compact trash. How would that work mechanically? Use CAD to create and assemble the component parts for testing.	Ideation is a divergent process where you want to generate and explore as many ideas as possible. Development is convergent where you refine those ideas towards a prototype outcome. Experiment with a range of fidelity (quality) beginning with rough sketches and quick models before advancing on to more detailed outcomes using rapid prototyping technologies.	JCB machinery often uses hydraulic systems in its machinery. Using the guide in this video: https://youtu.be/6HSY3R5EY8o?si=PcewUMaMH-3mrmpN Create your own syringe grabber.

Investigative and Evaluative Activities

'Types and causes of pollution'	'Problem values'	'Pugh's Matrix'
Investigate the main causes of pollution and the effects these have on the environment. What are the key issues with the various types of pollution and how might we begin to tackle them? Make a chart and discuss as a group to help define the area you wish to focus on.	Once you identify the causes and effects of pollution, you can decide which area of environment pollution will have the greatest value if solved. Add to your existing analysis, the potential benefits of solving one issue over another. They are all equally important, but you cannot solve every problem at once. However, consider if your solution may have more uses than you originally intended.	The Pugh Matrix is a tool that uses a criteria-based matrix to identify the best solution against relevant user requirement criteria. It involves comparing each solution against a standard set of specified evaluation criteria to find the best possible solution against viable alternatives.

