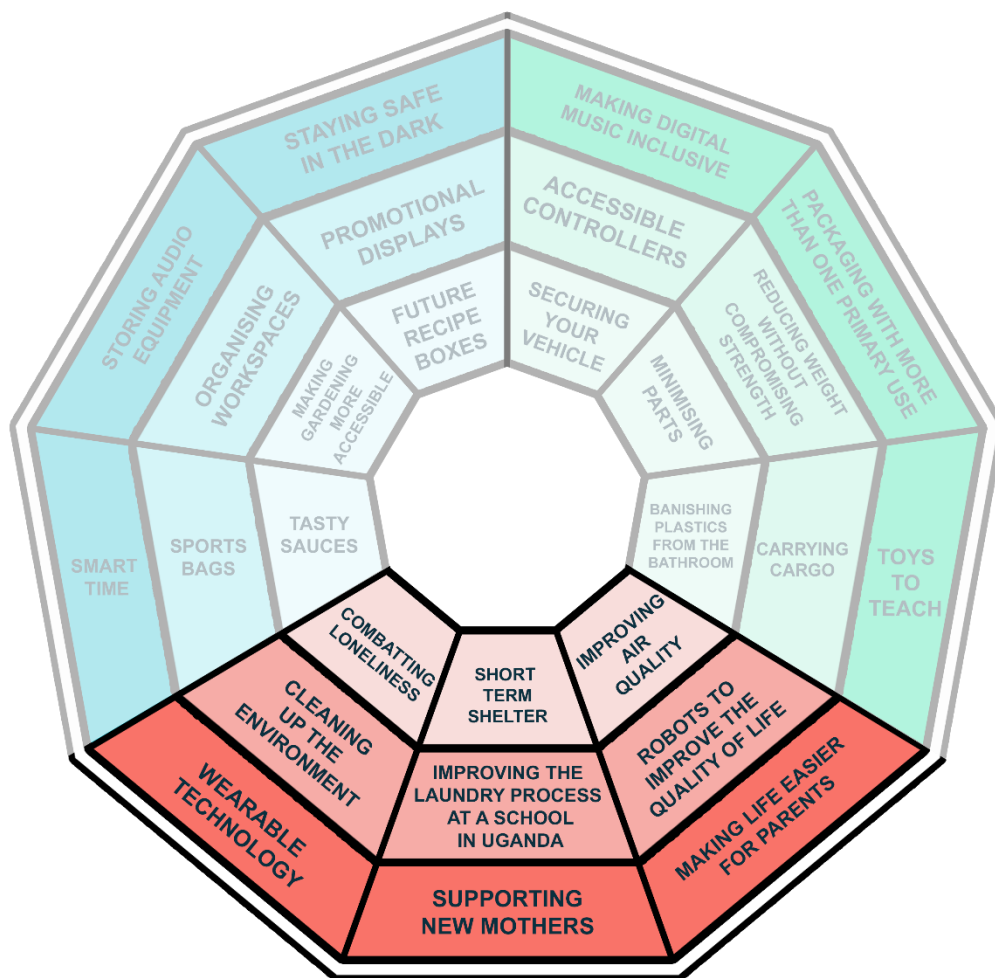


INSPIRED BY INDUSTRY

Robots that improve the quality of life

#InspiredbyPTC



Introduction

This context has been created to allow for a range of opportunities for students to explore user centred design and innovation through the development of a robot that can improve the quality of life.

Materials

There are no specific material requirements, but there will be elements of mechanical and electronic systems depending on the complexity of the challenge and the outcome. Fundamental to this though is the exploration of automation or mechanisation for a robot to perform a task that a human might not be able to or wish to. This context also supports the development of coding and a range of input and output sensors.

Potential outcomes

The prototype outcome(s) will need to be realised in a form that can be tested and evaluated. This might simple be a mock-up with exposed parts, wires etc. to test functionality, or it could be that the prototype resembles a more commercial 'finished' outcome. Alternatively, CAD might be used to create parts and assemblies that can be tested 'virtually'. From the CAD models, some or all components might be made using rapid prototyping technologies.

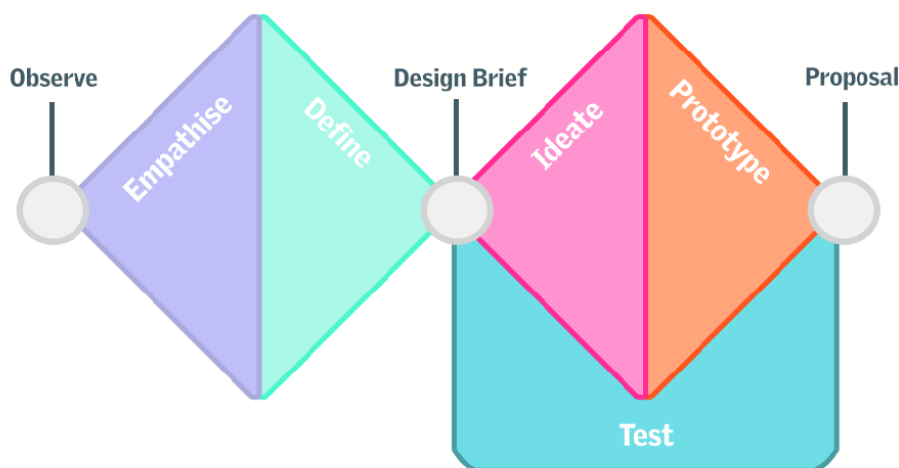
As this is aimed at the final year of Key Stage 3, less support and scaffolding would be expected, but it is important that students are given freedom within this context and so outcomes should vary between students. You may choose to limit to one particular aspect of 'life improvement' or specify a range of components and parts that could be used.

There is an opportunity with this context to combine studies from computer science such as coding and control, or engineering with curriculum elements of D&T such as structural, electronic and mechanical systems. Whilst robots often evoke the idea of moving parts, they may not always have these aspects.

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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 convergent and then divergent may be shown to your students, similar to this 'Double Diamond' diagram.



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

Empathize stage

- Students should be familiar with this term at this stage, for less able students, you could provide additional research and support.
- 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, needed etc.
- This observation may be a video, a chart, or an interview and should allow them to spot 'problems' or identify new design opportunities. Consider limiting to, or suggesting different areas to observe, for example 'home', 'work', 'sport' etc.
- Consider exploring the role of robots to begin with. They are often used with 4D principle – Dull (monotonous), Dirty (unhygienic), Dangerous (risky) or Dear (expensive). Can students think of areas linked to these where a robot may be of use?
- Consider one aspect of 4D's e.g. 'Dull' and consider something monotonous to recreate. This may be ironing, sweeping, dusting, cleaning the whiteboard... 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 technology – this is just a stage to highlight issues and concerns.
- Students can get additional information to help them later on in the context. Research is not always done at the beginning of the project; it is wherever you need further information.
- Consider looking at videos of robots in action to stimulate ideas. As mentioned earlier – these often having moving parts, but this may not always be the case.

Define stage

- This is where students try to get the real root of the problem and decide what they are going to do.
- There may be a whole range of 'users' or applications identified, but define the precise problem they are tackling. You may want to get them to back up the reason it is important – possibly looking at stats and an infographic?
- 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 design brief and, where necessary, a product design specification. Consider using columns such as 'Essential', 'Desirable' and 'Definitely not'.

Ideate stage

- Encourage students to think wide initially. No ideas are too silly, too big.
- Ideas can also be produced through making. Get students experimenting with mechanical components and electronics in the early stages of ideation.

- 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.
- 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 and 3D drawing are good, especially if moving parts or schematics are considered – 2D may be preferable.
- More research may be needed at this stage. Consider a handling collection of components and mechanical devices, or electronic components. Explore what different programmable components you have access to, can achieve.
- Ideas don't have to be revolutionary and completely new. A product can be an evolution or improvement of an existing solution. Maybe they can start with an existing product and improve it. This [VIDEO](#) is a good introduction to this for older students / teachers.

Prototype stage

- There are a range of products / solutions and devices to explore in this unit. Products such as:
 - [VEX](#)
 - [LEGO Mindstorms / Spike](#)
 - [Sphero](#)
 - As well as programmable components such as Arduino, Crumble, micro:bit, Picaxe etc
- 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.
- It is worth discussing with students WHY to make a prototype. What things could it test? - Size, comfort, aesthetics etc. Choosing the correct approach for the correct type of test or feedback is important.
- Prototypes may be small elements such as a grabber to pick up an empty bottle, or a lid closing using a servo.
- Remember that prototypes can be quick mock ups, test rigs or working models. They can also be 'virtual' using more advanced 3D CAD software. Some students may even be in a position to explore animations using 3D CAD of elements.
- Recording the prototyping / testing stage by using video recording devices would be good. This allows quick evidence capture and narration over the top. Even if a 'perfect' product is not completed during the time, recording progress through videos can be useful.
- Throughout the process, ensure students follow procedures for health and safety and understand the process of risk assessment.

Test stage

- Although this is the final stage of the design cycle, encourage students to evaluate throughout and act on their feedback (and consider the feedback of others too). It is not a final thing, but a step to improve further.
- To help students that are reluctant to improve their idea, consider prompts such as "What if money was no object?" "What if you had access to advanced electronics?"

“What if it had to be made in one day?” “What if you needed to make 100,000?”
 “What if it had to be made cheaper?” “What if it had to be more energy efficient?”.

- This could be a good opportunity to explore mathematical content by getting students to calculate angles of movement, amount of material used etc.
- How can students get feedback from users? Could they use technology to get a wide range of feedback – e.g. a Google Form?
- Get students to think about the main problem they identified earlier – does the robot outcome achieve them and does it make life easier? Is there potential there and what would need to be developed? It is likely that the device is scaled down both in terms of size and also power requirements, but the test is to prove or disprove a concept, so if the final product cannot lift a full-sized car, but manages a toy plastic vehicle, we are probably happy with the concept!
- Encourage students to test and evaluate against the initial design criteria/specification, and to involve the user or members of the target audience.
- Extensions / further tasks may be to consider safety elements to the design. What would be needed if it was in an industrial environment or a home environment and how would the needs of both change?

Focused tasks

<u>‘Modelling’</u>	<u>‘CAD models’</u>	<u>‘Laser cut templates’</u>	<u>‘Micro:bit starter’</u>
Modelling the structure, look or function of your robot before making more detailed developments can help with the development of the process. Use a range of modelling materials.	Using CAD to create models on screen that can be animated and tested virtually. Parts can also be created from these models.	If your robot uses flat panels for construction, you could design panels that link together using CAD and a laser cutter.	Getting started with micro:bit to test simple coding as well as input and output.
<u>‘Crumble starter’</u>	<u>‘Mechanical assemblies’</u>	<u>‘Coding’</u>	<u>‘Communication’</u>
Getting started with crumble microcontroller. Incorporating motors, sensors, actuators etc.	Create complex assemblies using CAD and test these as they would perform if made from real components. A good opportunity to expand CAD skills ready for GCSE and beyond.	While this is often covered in computing, coding and control are also aspects of D&T especially when embedding or incorporating electronics. Use knowledge gained from computing to apply to design problems	Expressing complex ideas, such as those for a robot, will require strong communication skills. Use this opportunity to develop 3D drawing skills using analogue and digital methods as well as other media such as animations, video, annotated diagrams etc.

Investigative and Evaluative Activities

<u>'Toy teardown'</u>	<u>'Reverse engineer'</u>	<u>'Human factors'</u>	<u>'Industry 5.0'</u>
Take apart a robot, possibly a toy. These have been around for longer than you may think, and many simple robots can be found at low cost or even for free! Remember, they don't need to be fully working.	Look at existing code or components used to create output similar to what you intend for your robot. You can use this reverse engineering approach as you know the outcome already worked.	Robots and AI have had some bad press and films often portray them as being a threat to society. Evaluate and discuss the implications of robots replacing humans in some scenarios. Complete a SWOT analysis of your findings.	We can look at the history of design and technology through the various 'Industrial Revolutions' Industry 5.0 is upon us and is concerned with sustainability, developing resilience and working with technology for a better future. How can we adapt our current lifestyle to incorporate these ideas?

